Social and Technological Transformation of Farming Systems:
Diverging and Converging Pathways

Proceedings of the 12th European IFSA Symposium
12th - 15th July 2016 at Harper Adams University, United Kingdom

Volume 1

Andrew Wilcox and Karen Mills (Eds.)
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Preface

As a university that focusses on agricultural and environmental systems research and education it was an honour for Harper Adams to host the 12th European IFSA Symposium in the summer of 2016. These proceedings demonstrate that the event prompted a broad ranging debate about the future of farming, and the growing awareness of the potential to harness new technologies for application in agricultural practice.

With its overarching theme of social and technological transformation the Symposium was timely and necessary, given the changing political situation within Europe and its consequences for future farming support arrangements. These developments will require us to think again about how we secure future food supplies whilst better protecting the environment and, in some cases, to reimagine our approach to modern agriculture.

The organisers of the Symposium, including the Chair, Dr Andrew Wilcox, are to be congratulated for having assembled such an interesting programme. Contributors covered a variety of types of innovation including, importantly, examples where farmers had taken the initiative to improve their business performance by adopting new techniques. There was much discussion about the concept of sustainability, what this means for food chains and the environment and how it might be assessed. Some of the workshop sessions addressed the methodology for investigating farming systems transformation, while others considered questions of governance and policy, including vital issues such as the boundaries and respective roles in innovation systems.

The Symposium delegates had the chance to see some of the innovative activities being conducted at Harper Adams. These included our transformational research in agricultural engineering and precision farming that has recently led to the ‘world first’ Hands Free Hectare Project, where a barley crop was grown using only robots and drones. The technology is now available to take on such challenges, but the Symposium reminded us that it brings with it many questions for society that also need to be addressed. Our aim is therefore to create an ecosystem for collaboration between engineers, social scientists, crop scientists, livestock scientists and entomologists, now a hallmark of this institution, as a means to achieve greater understanding of how to address the food chain issues that face us all.

The Symposium reflected this endeavour. With participants from across Europe and as far afield as Japan, Nigeria, the USA, Uruguay, Australia and New Zealand, and from an equally wide variety of disciplines, the event provided a global assessment of the state of play in the development of our farming systems. There are many important questions for us to address as we face a rapidly changing world, but amongst these, one of the most important must surely be how we transform our approach to the production of food. The Symposium provided a unique opportunity for reflection on this vital topic, and Harper Adams University was delighted to have been part of that process.

Dr David Llewellyn

Vice-Chancellor
Introduction

Understanding farming as systems recognises the interconnections and dependencies among its many human and non-human dimensions. As changes in farming systems take place at all levels (eg individual to farm, local to global etc), understanding the nature of these interconnections and dependencies can be challenging. IFSA’s 2016 Symposium focused on particular kinds of change - social and technological transformation. The Symposium considered not only what is changing in terms of these dimensions and their contexts, but also how they related to each other and how purposeful social and technological transformation of farming systems in different parts of the world are realised and how they could be brought about in the future. The concept of ‘transformation’ rather than just change is at the core of several different ‘applied’ systems traditions and is a particularly appropriate focus for IFSA. It is relevant to learning, methodology, sustainability, innovation, institutions and governance that all featured in the themes of the symposium. The focus on the social and technological was, however, not exclusive; interconnections and dependencies with other dimensions of change (eg environmental, economic or political) were fully discussed.

The relationship between social and technological dimensions of farming systems is particularly relevant to our current times with different communities responding to these dimensions in a range of ways – on diverging and converging pathways in relation to culture, values and purpose, capital intensity and to scales and nature of operation. In 2016, farming in Europe and indeed across the world faced many issues including climate change, food security, food quality and safety, water and soil security, waste management, energy, conservation of biodiversity, resilience of communities, multi-functionality, farm restructuring, competition and innovation. The situation in Europe became more complex following the decision of the UK to exit from the European Union.

The symposium welcomed a diversity of perspectives on farming systems and different narratives of pathways. The IFSA Steering Committee have strived to attract researchers and practitioners from both natural and social science backgrounds who are new to systems thinking and who may be able to contribute constructively to the debate on how we can design and deliver more sustainable farming and livelihood systems for the future.

Dr Andrew Wilcox

Crop and Environment Sciences Department, Harper Adams University

June 2018
Workshop Themes

Theme 1: Innovation, knowledge and learning processes

Currently it is widely acknowledged that the new context (including biophysical/environmental, technological, policy and socioeconomic challenges) relating to (sustainable) agricultural and rural development generates additional knowledge needs and calls for different ways to support learning and innovation. The need to address multifaceted and increasingly complex problems reinforces the requirement for new forms of research, learning and problem solving that integrates the varying perspectives and insights.

The cooperation of diverse experts and practitioners is required and various ‘cross-disciplinary’ forms of learning and research, taking into account the complexity of issues and the fragmentary nature of knowledge, needs to be employed. Such approaches accept local contexts and uncertainties, address both scientists’ and society’s diverse perceptions of an issue through communicative action and application in order to produce practically relevant knowledge.

Consequently, ideas about the generation, dissemination and use of innovations have also changed. The once dominant linear model, according to which scientists/researchers are in control of the production of technological devices, is nowadays severely challenged. Contemporary ‘interactive’ approaches emphasise the iterative, adaptive nature of innovation; systemic approaches such as AKIS and AIS have emerged. In this respect, the focus has shifted towards processes (instead of the emphasis on structures) with knowledge conceived as being constructed through social interaction. Thus particular attention is given to (social) co-ordination and networking. Moreover, to take into account power relationships and to avoid or overcome gaps (cognitive, information, managerial or system) and the resulting failures, growing attention is given to various types of (process) ‘intermediaries’ (facilitators, third parties, (knowledge/technology) brokers, bridging organisations, intermediaries, boundary organisations, etc).

Within these circumstances, Theme 1 aimed at exploring both the theoretical (concepts relevant to analyse innovation, knowledge and learning processes in the context of sustainable agricultural/rural development) and practical level (case studies exploring the results of relevant projects in different socio-cultural, economic and institutional contexts):

- The current state of art on innovation, knowledge and learning processes;
- Systemic and multi-stakeholder participatory strategies, methods and tools supporting network/platform building, social learning and action, innovation and adjustment to policies in diverse AKIS/AIS configurations;
- Emerging ‘intermediation’ roles and advisors’ needs in terms of training (capacity building);
- The current methods to assess the impacts of innovation (participatory, external) including the impact pathway approach.
We invited participants from natural and social sciences particularly, those interested in knowledge needs and support for learning and innovation within agriculture, to contribute to workshops that addressed the issues in this theme.

In Theme 1 ten workshops were held:

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<tr>
<th>Workshop</th>
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<tbody>
<tr>
<td>Workshop 1.1</td>
<td>Generating spaces for innovation in agriculture and rural development</td>
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<td>Workshop 1.2</td>
<td>Monitoring and evaluation for learning and innovation</td>
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<td>Workshop 1.3</td>
<td>Using a co-innovation approach to improve innovation and learning</td>
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<td>Workshop 1.4</td>
<td>From farmer to “eco-preneur” in multifunctional agricultural knowledge and sustainable regional development: participatory curricula development and implementation of educational measures</td>
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<tr>
<td>Workshop 1.5</td>
<td>Pathways towards sustainability in the agricultural knowledge and innovation system: the role of farmers’ experiments and innovations</td>
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<td>Workshop 1.6</td>
<td>Merits and limits of innovation platforms to promote sustainable intensification in farming systems</td>
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<td>Workshop 1.7</td>
<td>Scaling up and scaling out transformative farming practices: critical assessment of tools, methods and skills</td>
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<td>Workshop 1.8</td>
<td>Cooperation as a key issue for innovation and learning processes in sustainable land management</td>
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<td>Workshop 1.9</td>
<td>Inclusive innovation</td>
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<td>Workshop 1.10</td>
<td>Practical experiences and methodological concepts from the first years of EIP-Agri implementation</td>
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Theme 2: Methodology and frameworks of farming systems transformation

This theme intends to create a platform for methodological discussions regarding the development of innovations, technologies and practices. Farming Systems research, compared with “classic” approaches, regularly aims at a more holistic rather than reductionist understanding of agriculture and rural development. On the other hand, as “systems” are always models or pictures of reality and resources are limited, there is always the challenge to reduce complexity of the real-world in a meaningful and feasible way. Research within this context calls for a meaningful and creative use of methods and methodologies in both the natural and social sciences, be it single-person or large-group research. In the past decades a wide spectrum of methods has been developed. Important questions are related to the “transformation of methods”, i.e., what are the challenges with respect to transformation of systems, and what does this mean for development or adaptation of methods?

From the beginning farming systems researchers intend to create solutions for “real-live” problems. Such research is often case-specific analysis and calls for contextualisation of solutions. The question then is how to generalise findings?

More and more, farming systems research is confronted with the societal demand to go even beyond research, contribute to the implementation of solutions and thus bring their concepts and results into practical use. Such research is demanding for integration of concepts, theories and results, and for cooperation and participation amongst researchers (interdisciplinarity) as well as between science and practice (transdisciplinarity).

We invited participants from both the natural sciences and social sciences to offer workshops in order to discuss theoretical and practical approaches, concepts and empirical cases in various fields and settings:

- The state of the art of quantitative and qualitative methods in ecologic, economic and social systems analysis. Contributions may vary from new approaches in carbon sequestration to modelling of land use changes; from cost-benefit analysis to economic multi-agent models; from social network analysis to PRA/PLA;
- Methods to improve access to information and information exchange;
- Approaches and methods that enable a dialogue amongst various stakeholders and promote mutual learning;
- Methods to include practical knowledge, of generation and dissemination of knowledge in a transdisciplinary research setting;
- Action-oriented methods to promote implementation of complex solutions.

A focus of discussion was the aspect of “integration”, by method triangulations and/or approaches and methodologies in process and project management: Ex ante approaches such as scenario analysis and modelling, in-process approaches such as (participatory)
impact monitoring, or ex-post approaches of (participatory) monitoring and evaluation were also welcomed.

In Theme 2 five workshops were held:

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<tr>
<th>Workshop</th>
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<tr>
<td>Workshop 2.2</td>
<td>Sustainability assessments at farm level for catalysing practical change</td>
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<td>Workshop 2.3</td>
<td>Well-being in rural areas: how is it affected by different farming systems?</td>
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<td>Workshop 2.4</td>
<td>Temperate agriculture sustainability assessment beyond the individual farm level</td>
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<tr>
<td>Workshop 2.5</td>
<td>Beyond participatory methods-approaches for facilitating transformation of agriculture and agri-food systems</td>
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<tr>
<td>Workshop 2.6</td>
<td>Management of interdisciplinary research processes</td>
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Theme 3: Pathways towards sustainable agri-food systems – tensions or synergies?

We are told that feeding the future world population will require a 60 percent increase in total agricultural production. This is set against the background of climate change, degraded natural resources (soil and water insecurity), and socioeconomic challenges (global economic drivers, competition, threatened rural livelihoods, social injustice). These multiple challenges require change (e.g., technical, social, cultural, technical, institutional) and have led to a range of responses with respect to developing sustainable agri-food systems which can produce food and maintain ecological functions (and in doing this deliver a multi-functional food system). These include approaches such as sustainable intensification, climate smart agriculture, ecological intensification, conservation agriculture, agro-ecological farming and organic farming. These share common principles, in that they aim to design more productive, sustainable production systems that save on inputs (pesticides, chemical fertilisers, water and fossil fuels), are less harmful to the environment, and so do not degrade ecosystem services. However, these approaches diverge significantly in other respects, notably they emerge from different paradigms (technically efficient, commercially-focused, large-scale agriculture versus socially responsible, community-centred agriculture often applying ecological principles). These are distinguished by the extent of capital investment, scale, tenure arrangements and labour inputs, but above all, values. The systems aligned to social development coexist more easily than others with rural development and other livelihood options (e.g., tourism, energy).

This sub-theme aimed to examine these different pathways to sustainable food production (theoretical and empirical) and addressed questions such as:

▪ What are the different pathways of sustainable food production in different contexts?

▪ What theoretical perspectives exist to understand pathways of sustainable food production?

▪ What methods are best suited to understand pathways of sustainable food production?

▪ To what extent do these different pathways (current and future) diverge or converge/have synergies?

▪ What needs to change to move farming systems along pathways to sustainable food production and how do we measure this change?

▪ Is scale an issue— is it only large scale commercial farmers who seek efficiencies and smart farming (e.g., sustainable intensification)? Is it only smaller scale farmers/smallholders who can follow a ‘social’ model (e.g., community supported agriculture, agro-ecological farming)? Or are these becoming stereotypes that might constrain how we move forward?

▪ Is it important to debate the different values, objectives and reward systems that are embedded in these systems, and who gains and who “loses” from these different systems?

We invited participants from natural and social sciences, particularly those experienced in interdisciplinary approaches to contribute to workshops that addressed any of the issues and implications that related to this theme.
In Theme 3 three workshops were held:

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<tr>
<th>Workshop</th>
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<tr>
<td>Workshop 3.1</td>
<td>Sustainability of food chains: contested assessments</td>
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<td>Workshop 3.3</td>
<td>Pathways for land-use: the sustainable avenue of agroforestry</td>
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<tr>
<td>Workshop 3.4</td>
<td>Boundary spanning between agroecological and conventional production systems: implications or pathways towards more sustainable production</td>
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Theme 4: Emergence and application of new technologies

Globally, there is currently an unprecedented pace of change in the application of technology to support agriculture. There are many drivers of the change process, including improvements in techniques of animal and plant breeding, application of genetic modification, sustainable energy generation, development and use of robotics, remote data collection and monitoring systems, use of decision making tools and models, precision agriculture, use of drones and the increased use of Big Data. Many of these changes include some new technologies developed by scientists who previously have had limited connection with agriculture.

Whilst the potential benefits of these technologies are very easy to understand at a local scale, their potential impacts on farming systems are less well understood. For example, Blackmore (2014) has outlined plans to develop small robots that can intelligently detect if salad crops are ready for harvest using sensors and carry this out with minimum damage to the soil. If this technology was adopted on a wide scale, there is speculation that agricultural robots will eventually replace semi-skilled drivers and unskilled pickers. However, it has been suggested that an equal number of highly skilled agricultural robot engineers will be needed to service the new technology. There may also be a reduced need for management decisions on the ground as the technology also automates some of these processes. Potentially there are gains to certain sectors of the agricultural labour market, benefits to the environment and advantages to the consumer in the form of cheaper prices. However, this is at the expense of employment amongst both the least qualified individuals within the agricultural workforce and also individuals who possess higher level skills such as agronomists.

Such difficulties in predicting the outcomes of such developments in technology are further exacerbated by differences in the scale and type of farming operations, lack of standard methods of quantification, geographical location and government policy with regard to technological development. There are also implications in terms of side-lining/under valuing (and ultimately losing) land managers’ local and experiential knowledge which some argue is irreplaceable.

This theme was an opportunity to engage in a constructive dialogue between farmers, educators and scientists about the systemic impacts of these new technologies within new social, political and environmental contexts and to explore the questions that they raise for research policy and practice and addressed questions such as:

- Can we classify new technologies more effectively?
- Who are the beneficiaries and losers following the adoption of new technologies in agriculture? How can we quantify this in a meaningful way?
- What are the effects of farming scale on the uptake and application of new technology? Are there any common themes between different types of farmers?
- Does new technology make agriculture more or less sustainable? Will technology improve food security?
- To what extent can we effectively model the impacts of a new technology in agriculture? Are the same models applicable for a range of new technologies?
- Will new technology facilitate significant changes within rural societies and their structures?
What are the implications for land managers' learning and experiential knowledge production?

We invited participants from natural resources, engineering, human and social sciences, particularly those experienced in interdisciplinary approaches, to contribute to workshops that addressed any of the issues and implications that related to this theme.

In Theme 4 two workshops were held:

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<th>Workshop</th>
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<tr>
<td>Workshop 4.1</td>
<td>Boosting research outputs: novel approaches for integrating research translation with interactive co-innovation</td>
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<tr>
<td>Workshop 4.3</td>
<td>ICT to help on participatory approaches for the agroecological transition of agriculture</td>
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Theme 5:

Agriculture is characterised nowadays by the diversity of pathways (organic farming, integrated farming, precision farming etc) that seek to combine a more sustainable use of resources with good economic and sociological conditions for the development of rural areas. These farming systems may be combined or compete at different levels, international, national or regional. The question addressed in this subtheme is about the intended and unintended effects of policy, governance and institutions on the convergence or divergence between trajectories of production systems. Do they enable a co-existence of different systems, or do they reinforce the domination of specific systems over others?

Many individuals and groups strive to bring about changes in relation to food, farming, rural areas and environment. Such changes concern livelihoods, wellbeing, communities, management of wastes, food, energy, technology, food security, productivity and biodiversity. Interconnections among such changes or transformations are well recognised. As Donald Schön observed over forty years ago, transformations influence one another and the transformation of a system as a whole influences the context in which each local system experiences its own transformations. In recent years, as evident from IFSA’s symposia over the past two decades, there has been increasing emphasis on collective multi-level learning processes and multi-stakeholder dialogue processes to bring about transformations at the level of ‘whole systems’ – for instance in relation to (i) catchment-based approaches to address issues of water scarcity, flooding and pollution and (ii) networks of local and regional food production and distribution.

A substantial discourse has also developed on what kinds of governance, policy and institutions enable and constrain such learning in moving towards collective action. It is this latter area that this sub-theme specifically wants to address. Different farming systems might need different forms of learning that could be supported by the adoption of different public policies such as technology transfer for precision farming and collective learning for agro-ecology.

Policies and institutions designed for one purpose often end up overseeing another unless governance is adaptive and responsive to potentially rapid changes in conditions.

Workshops in this sub theme addressed questions such as:

- Why do some initiatives (eg relating to organic farming, farmers' markets, farming and wildlife or land care) succeed in scaling up from a local level whereas others fail?
- How do services such as advisory services support innovation and orient the innovation choices?
- What kinds of governance enable systemic and adaptive responses to climate change?
- Which aspects of EU policy and legislation have enabled farming communities to do ‘better things’ (second-order change) rather than doing things better (first order change)?
- What kinds of public policy (incentives and subsidies, regulatory frameworks, R&D planning) can help build sustainable food systems - or further reinforce industrial agriculture?
We invited participants who are interested in the development, application and interaction of policies and governance within agricultural systems, to contribute to workshops that addressed issues and implications that related to this theme.

In Theme 5 nine workshops were held:

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<tr>
<th>Workshop</th>
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<tr>
<td>Workshop 5.1</td>
<td>Developing agricultural advisory systems for innovation: governance and innovative practices</td>
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<tr>
<td>Workshop 5.2</td>
<td>Farm succession, inheritance and retirement: challenges for agricultural futures</td>
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<td>Workshop 5.3</td>
<td>Rural development policies in the peripheral Southern and Eastern European regions</td>
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<tr>
<td>Workshop 5.4</td>
<td>Exploring farmers’ conditions, strategies and performances in a context of multi-dimensional policy requirements, market imperfections and globalisation: towards a conceptual model</td>
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<tr>
<td>Workshop 5.5</td>
<td>Value chain research and development – approaches for diverse farming systems</td>
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<tr>
<td>Workshop 5.6</td>
<td>Food governance for metropolitan and local food systems – connecting urban and rural</td>
</tr>
<tr>
<td>Workshop 5.7</td>
<td>There are other options: boundary issues in innovation system governance</td>
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<tr>
<td>Workshop 5.8</td>
<td>Enabling innovation – the transformative (innovative) capacity of farmers and rural institutions</td>
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<tr>
<td>Workshop 5.9</td>
<td>Public food procurement policies: local and organic food in public catering systems</td>
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Field Trips

Field Trip 1: Farming at different scales and intensities

This field trip visited two different farms that have alternative approaches to production. The first was Wall Farm, Kynnersley, Shropshire. Wall Farm is a 162 hectare mixed livestock farm which has been managed under UK Government Environmental Stewardship schemes for the last 25 years. The farm has received payments to reduce the intensity of agricultural management and has based their farming system wholly around this requirement. The farm has a mix of Aberdeen Angus, Stabiliser and Red Poll cattle and Hebridean sheep, two thirds of which are crossed with a continental ram. The farm sells animals as breeding livestock and for meat through outlets including Dovecote Park, for Waitrose, and local rare breed butchers. Twenty four hectares at the centre of the farm is a Scheduled Ancient Monument (statutorily protected under UK legislation). The earth ramparts of the Iron Age Lowland Hill Fort can still be clearly seen today and restrictions are placed on how this land can be farmed. The whole farm is managed under an extensive grazing system which suits the range of habitats that have been created under the various environmental agreements. As part of the environmental enhancement of the farm, a large area of species rich wildflower meadows and wet grassland for both breeding waders and over wintering birds have been established. We also have a small area of arable ground which is managed primarily for environmental objectives.

The second farm was Lea Manor dairy farm (http://www.grosvenorfarms.co.uk/our-farming/dairy-farming.aspx), part of the Grosvenor Farms estate, owned by the Duke of Westminster. Grosvenor Farms produce about 48,000 litres of milk a day, some 17.5 million litres a year which is processed by Müller Wiseman Dairies and sold to Tesco as liquid drinking milk. The new Lea Manor dairy farm is a significant investment into the future of food and energy and is intended to help meet the increasing demand for milk in a sustainable way. The farm has been carefully designed to be as comfortable as possible for the cows to live in. It has been built to the highest standards and incorporates the latest technologies to develop a farm that is industry leading in terms of animal health, welfare and comfort. This is considered to be the best way both to ensure the health and wellbeing of the herd and to provide the efficiencies which modern day farming requires to meet the nation’s demand for good value milk. The system includes a sophisticated monitoring system which identifies each cow for lameness as they walk across a sensory platform after every milking enabling staff to identify any issues approximately two weeks before there would be any visual signs. The whole facility has also been fully badger proofed in order to better protect the herds from TB infection. Water is provided through an environmentally friendly bore hole and is used to clean the sand in the cattle’s living areas ensuring about 85% can be reused. Solar panels on the south facing roof of one of the farm buildings will generate the energy to power the farm with the residual entering the national grid. Large cubicles and sheds provide space for the cows to eat, sleep, walk around and socialise in.

Organisers: Dr Andy Wilcox (awilcox@harper-adams.ac.uk)
            Professor Liam Sinclair (lsinclair@harper-adams.ac.uk)
Field Trip 2: Agroforestry and forestry

Delegates opting for this programme visited two contrasting land management systems in which trees play a fundamental role, one in England, the other just over the border into Wales. The first visit was hosted by Mr. Peter Aspin at The Hollies, Wem, North Shropshire (http://www.silvaspin.org.uk). His specialist, organic small-scale (approximately 16 hectares) agroforestry system rears youngstock for dairy use on high-quality pastures with ‘alleys’ of grassland divided by rows of mixed species of trees. This system is described as, ‘a method of land use whereby trees, perennial ground cover crops (in this case grasses, clovers and herbs) and livestock (in this case bovines) are produced on the same piece of land’. The system allows both grazing and browsing by the cattle and ‘a rich and varied diet naturally leads to healthier and more disease-resistant animals.’

The second part of the trip crossed the border into Wales, to Coed Llandegla, west of Wrexham, where we were hosted by Tilhill Forestry (http://www.tilhill.com) the managing agents for the forest owners, the Church Commissioners. We explored the forest using the forest road system, guided by the forest managers. Coed Llandegla is a 650 ha. mixed-age commercial forest producing high-volume conifer crops, principally Sitka spruce (Picea sitchensis). It is also home to an award-winning outdoor recreation business providing extensive mountain bike, running and walking trails that attract over 250,000 visits per year (http://oneplanetadventure.com).

Organiser: Jim Waterson MICFor., MRICS (jwaterson@harper-adams.ac.uk)

Field Trip 3: Organic and community farming

The first part of this trip involved a visit to Fordhall Farm Community Land Initiative (http://www.fordhallfarm.com). Fordhall Organic Farm, based in North Shropshire, England has been chemical free for over 65 years, rears cattle, sheep and pigs on an outdoor extensive grazing system and has been in community-ownership (8000 people) since 2006. This means that the owner, Fordhall Community Land Initiative, is committed to building a sustainable future whilst guaranteeing that farming will be an affordable way of life for generations to come. Fordhall Farm is also one of the longest running natural organic farms in England. Many of the initial supporters were personal friends of the late Arthur Hollins and recognised his ground-breaking research into organic farming. The visit focused on community ownership and eco-diverse approaches to sustainable land and livelihood systems.

The second part of the trip involved a visit to Timothy Downes farm at Longnor, South Shropshire. Tim is a partner, with his wife Louise, in the family 284 hectare organic dairy farm near Shrewsbury. He milks 300 cows, as well as producing 150 mostly Aberdeen-Angus cross beef cattle per year. The milk is free from antibiotics and is sold to the Organic Milk Suppliers Co-operative (OMSCo). The milk is exported to the US market and goes into cheese, milk protein & baby foods. Tim also plants trees on his farm to support his farming system (https://www.woodlandtrust.org.uk/publications/2013/05/how-trees-benefit-dairy-farms)

Organiser: David Gibbon, Agricultural and Rural Livelihood Systems
Field Trip 4: Integrated & organic farming

The first part of the trip was a visit to Robert Kynaston’s Great Wollaston Farm at Halfway House near Shrewsbury, Shropshire. Great Wollaston is a mixed lowland farm which has been a LEAF (Linking Environment and Farming) demonstration farm since 2002. The main income is from a dairy enterprise consisting of an 85 cow closed herd with dairy replacements and beef cattle. Most of the feed for the cattle is grown on the farm with 85ha of arable cropping consisting of winter wheat and barley combined for grain and spring barley and peas taken as an arable silage. The grassland area consists of high clover leys and the remainder of the farm is managed as a variety of different habitats for wildlife including 10ha of woodland which also provides the feedstock for a 65kwatt biomass boiler. Robert has also recently installed 20kwatt of solar voltaic panels. Robert has worked with the Royal Society for the Protection of Birds on various projects and field trials as well as hosting various research projects and student visits for Harper Adams and other Higher Education providers.

We than visited Green Acres Farm which is a 220ha mixed organic farm in Shropshire. The cropped land follows a five year rotation driven by a one year clover ley, used either for grazing or silage by the pedigree Hereford cattle, or red clover seed production. Crops grown include, milling oats, wheat, peas and quinoa. Three types of peas are produced specifically for a retail company and packaged with the farm name. There is a substantial green-waste composting enterprise which receives garden waste from local communities and produces around 4000 tonnes per annum of compost, all of which is used on the organic land, raising soil organic matter and improving fertility. All the land is farmed under agri-environment schemes both to preserve and improve conservation and provide educational opportunities for local schoolchildren. Green Acres Farm is diverse in its enterprises, its cropping and its marketing.

Organiser: Louisa Dines (ldines@harper-adams.ac.uk)

Field Trip 5: Upland resource management

This field trip considered upland resource management and the issues that affect farming with multiple partners and owners and the transitions to sustainable land management. The first visit began at Carding Mill Valley which is part of the Long Mynd, a 2000 hectare area of upland in South Shropshire. Much of the land is owned and managed by the National Trust. The Long Mynd is also part of the Shropshire Hills Area of Outstanding Natural Beauty, a statutory designation offering protection to important landscapes. The Shropshire AONB is an important place for wildlife, geology and archaeology. Following an overview of the Long Mynd the visit drove to the top of the Long Mynd for interactive discussion with National Trust Staff and a landscape officer for the Shropshire Hills AONB Partnership. Discussion focused on conservation, agri-environment and the Upland Commons Programme. In the afternoon the trip continued with a visit to the Stiperstones National Nature Reserve (NNR) and a walk to the top of this contrasting Upland Area, led by the reserve manager from Natural England. Topics for discussion included visitor management and sustainable grazing.

Organisers: David Gibbon, Agricultural and Rural Livelihood Systems (dgibbon662@gmail.com)
Chris Blackmore, Open University (chris.blackmore@open.ac.uk)
Field trip 6: Special workshop and demonstration of Harper Adams robotics

This special IFSA workshop and demonstration considered social and environmental risks of robotics and autonomous systems (RAS) in major farming systems. The morning gave delegates an opportunity to learn about some of the current and possible future developments in RAS for farming. This included demonstrations of robotics and autonomous systems in the Harper Adams Agricultural Engineering Innovation Centre. In small groups, participants received demonstrations of:

- autonomous laser weeding
- controlled traffic farming
- robot tractor
- unmanned aerial vehicles

In the afternoon there will be a chance to hear about the relevant risk governance issues in other recent technology advances, and to contribute to discussion of the wider impacts and risks of RAS in different farming systems. There was a keynote presentation from Professor Phil Macnaghten (University of Wageningen, The Netherlands) on 'A framework for responsible innovation - lessons learned from GM crops and other technological innovations'. Four breakout groups each discussed one major farming system:

- large-scale agricultural commodity crop production
- protected horticulture and/or plantation crop production
- extensive rangeland livestock grazing
- intensive housed livestock

The session culminated in the identification of emerging themes and their relevance and impact on farming systems.

Organiser: Professor Peter Kettlewell (pskettlewell@harper-adams.ac.uk)
Dr John Reade (jreade@harper-adams.ac.uk)
Potato late blight (*Phytophthora infestans*) is one of the largest problems in organic potato production due to a lack of late blight resistant varieties and of appropriate fungicides. As breeding varieties for the relatively small organic sector is economically a challenge for commercial breeding companies, a special (classical) breeding programme (‘Bioimpuls’) was designed in a participatory manner according to the traditional way of potato breeding in the Netherlands (Almekinders et al., 2014). The team consists of breeding researchers from Wageningen University and Louis Bolk Institute, and six commercial breeding companies. By setting up yearly breeding courses, over 10 farmer breeders are now linked to this programme and are actively involved in the yearly selection. To allow the new varieties to be adapted to organic farming systems, several variety characteristics need to be improved. These include (in addition to late blight resistance) resistance to other diseases such as Rhizoctonia, Alternaria, viruses and scab, as well as nitrogen use efficiency, good storability without chemical sprouting inhibitors, good flavour and, last but not least, good market performance, e.g. appropriate flesh colour and a smooth skin. The focus is not merely on varieties that are adapted to low-input and organic growing conditions, but also on variety characteristics that allow a resilient farming system to function as a whole. This includes long term durability of resistance and measures to avoid breakdown of the new resistances by combining genes from different wild potato relatives and by selecting for clones that are not too late maturing to reduce the time of exposure to late blight infestation. The results will lead to a diversity of varieties as not only the general requirements are taken into account but also the individual selection criteria of each participating farmer due to differences in soil type, rotation, specific disease pressure, nutrient requirements, etc. Active commitment of other chain actors such as wholesalers and retailers is essential and was developed during an additional EU project (COFREE) enhancing market acceptance of the current eight late blight resistant varieties. By embedding this breeding programme within the conventional breeding sector with commitment of the organic farmers and other chain actors, this systems approach does not only aim at ecological sustainability based on the values of organic agriculture but also on socio-economic continuity after the project ends.

Reference
Acknowledgement
This breeding programme Bioimpuls (2009-2019) is financially supported by the Dutch Ministry of Economic Affairs under the Green Breeding Programme, see www.louisbolk.nl/bioimpuls.

Biography of Edith T. Lammerts van Bueren

Dr. Edith T. Lammerts van Bueren (1952) was trained at Wageningen University in agronomy and has more than 25 years of experience in organic research and management. After being involved in a broad field of organic agriculture for many years, she specialised and pioneered in plant breeding and genetic resources for organic, low-input agriculture and has put this subject to the European agenda. She has held a chair at Wageningen University in the Netherlands as professor of Organic Plant Breeding since March 2005. She is also senior researcher Organic Plant Breeding at the Louis Bolk Institute in the Netherlands, a research institute specialising in organic agriculture, health care and nutrition. Edith was co-founder and president of the European Consortium for Organic Plant Breeding (ECO-PB) for 10 years, and is now chair of the Section Organic and Low-input Agriculture of EUCARPIA (European Association for Research for Plant Breeding). She aims at building bridges between existing expertise among both farmer breeders and professional breeders, and incorporating the efforts of other stakeholders towards chain-based or community-based breeding models. She is also active in a broader field of sustainability and chairs a Dutch scientific interdisciplinary think-tank Council for Integral Sustainable Agriculture and Nutrition, which published their first report in 2012, and successfully elaborated on two cases studies (2013, 2015), see www.ridlv.nl.
Opening Plenary 2

Globalization, China and the New Zealand Dairy Assemblage

Michael Woods

Aberystwyth University, UK (zzp@aber.ac.uk)

This paper examines how the globalisation of agriculture is reproduced through small-scale processes and practices of assembling and re-assembling not only transnational flows of commodities, capital, labour and material inputs, but also the physical and organisational structure of individual farms, and how these changes impact on the wider rural environment and rural communities. A case study focuses on the recent evolution of the dairy industry in New Zealand in response to shifting global markets, particularly the growth in demand for milk powder from China. Since deregulation in 1984, New Zealand agriculture has been particularly exposed to global economic trends and competition, with adjustment driving re-structuring of the industry including the expansion of the dairy sector. By adopting an ‘assemblage’ approach that emphasises relationality, contingency and the combination of human and non-human actants and components, the paper analyses these developments at three levels. Firstly, it traces how the growth of New Zealand dairy trade to China was facilitated by the assembling of diverse technological, financial, transport and representational components, including the coding of New Zealand dairy produce as ‘pure’ and ‘untainted’. Secondly, it examines how the rise in value of dairy products stimulated conversion of sheep and beef farms and forestry land to dairying, with conversions involving the re-assembling of farm systems, including the incorporation of components sourced internationally, such as cattle feed from Australia, hybrid maize seed developed in the US, and irrigation systems manufactured in China. Thirdly, as farms are embedded in rural environments and communities, the paper explores the wider consequential effects of dairy conversions, from watercourse pollution and changes in the appearance of the landscape, to in-migration by Filipino farmworkers and the wear of increased tanker traffic on rural roads. As such, the paper argues that globalisation as experienced in farming communities is not a top-down imposition, but is the outcome of multiple, inter-connected and inter-dependent actions at diverse scales.

Biography of Michael Woods

Michael Woods is Professor of Human Geography at Aberystwyth University in Wales and has research interests that primarily focus on issues of globalization and rural change, rural politics and protest, and community governance and participation. He is currently leading a European Research Council project, GLOBAL-RURAL, which is investigating the restructuring of rural economies and communities by globalisation, and is also Co-Director of the ESRC WISERD/Civil Society Research Centre and a former Co-Director of the Wales Rural Observatory. Michael is Editor of the Journal of Rural Studies and author of a number of books, including the textbooks Rural (Routledge) and Rural Geography (Sage).
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Convenors: Gianluca Brunori, Erik Matjis, Dominique Barjolle, Mario Giampietro, James Kirwan, Damian Maye, Luca Colombo and Rudolf van Broekhuizen

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Workshop Theme 1: Innovation, knowledge and learning processes

Workshop 1.1 Generating spaces for innovation in agriculture and rural development
Convenors: Alex Koutsouris, Andrea Knierim and Eelke Wielinga

A successful innovation process is considered as resulting from people’s specific activities and an enabling environment which together contribute to ‘generating spaces for innovation’. What can be done to lower the thresholds for actors with a view to their contribution to the flourishing of innovative initiatives in agriculture and rural development? This was the central question for this workshop. Manifold field studies on innovation processes in the domain of agriculture and rural development have, among others, demonstrated the importance of participatory approaches for e.g. technology development, the importance of knowledge exchange among peers e.g. farmers’ field schools and the importance of social learning and ‘co-construction of knowledge’ in innovation processes. Nevertheless, both the EU and the World Bank have underlined that research is insufficiently related to practice, i.e. on the one hand, science-driven innovations remain on the shelf due to no/little dissemination activities while, on the other hand, farmers’ needs are not addressed during innovation generation, and hence innovations are not relevant (enough). In parallel, innovative ideas from practice are not captured and spread, i.e. local or practice generated innovations with strong potential for dissemination are not recognised or diffused and a shift from science-driven to innovation-driven research has not yet taken place, implying that the institutional, methodological and behavioural changes that are required for such a shift are not yet comprehensively explored, and relevant findings and experiences are not systematically documented and assessed.

Nowadays, an agricultural innovation system (AIS) is seen as a network of organisations focused on bringing new products, new processes, and new forms of organisation into economic use, together with the institutions and policies that affect their behaviour and performance. From an innovation systems perspective, several actors are seen as relevant to agricultural innovation, including entrepreneurs, researchers, consultants, policy makers, suppliers, processing industries, retailers and customers. An actual example for the support of innovation processes is the European Innovation Partnership (EIP) approach. The EIP adheres to the ‘interactive innovation model’, which focuses on forming partnerships. Such an approach not only helps co-creation of innovation processes, but also speeds up the introduction of innovative ideas, and it is expected to support the targeting of the research agenda as well as relevant research to switch to a problem-solving mode. In this respect, a group of actors in the system referred to as intermediaries, brokers, facilitators, etc. have emerged. The main responsibility of this group of actors is to assist agricultural entrepreneurs in coping with challenges such as articulating their innovation needs, contracting appropriate services for support of their innovation projects and successfully executing these projects. Such intermediaries are seen as a bridge between the demand and supply side of agricultural knowledge infrastructure; intermediaries are seen as actors assisting stakeholders to overcome information, managerial, and cultural and cognitive gaps, in relation to innovation process. In this workshop, papers on the roles and activities of this type of actor were especially invited while more general papers on the broader institutional conditions for the ‘generation of space for innovation’ were also welcome.
Stimulating innovations: building bridges and generating spaces

Wielinga, E. 1, Koutsouris, A. 2 and Knierim, A. 3 (1)

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2 Agricultural University of Athens, Greece
3 University of Hohenheim, and ZALF Müncheberg, Germany

Abstract: This paper aims to summarise the main features of the AgriSpin project. The project is being financed by the Horizon 2020 research program of the European Commission aiming at contributing to system-oriented innovation research in agriculture and as complementary to the policy instrument EIP AGRI. The idea behind EIP AGRI is that innovation emerges from interaction between stakeholders. Following this idea, the focus of attention shifts from diffusion of innovations to ways for creating space in which interaction might lead to innovation as a co-creative process. The AgriSpin project (“Space for Innovations in Agriculture”) comprises 15 organisations in 12 EU countries cooperating for a period of 2½ years (March 2015 – October 2017) to address questions pertaining to advisory work in relation to the stimulation of innovations at farm level. This paper aims to describe the main features of the project focusing on its conceptual background and methodological challenges whilst also pointing to some remarkable results (pearls and puzzles) that can be observed so far.

Key words: Innovation, innovation support services, networks, partnership, AgriSpin, EIP.

Introduction

Currently there is concern about a number of issues/bottlenecks pertaining to the generation, dissemination and use of innovation in agriculture such as (EU SCAR 2012, 2014; World Bank 2012):

a) Research is insufficiently related to practice, science-driven innovations remain on the shelf due to no/little dissemination activities
b) Farmers’ needs are not sufficiently addressed during innovation generation, hence innovations are not relevant (enough)
c) Innovative ideas from practice are not captured and spread, i.e. local or practice generated innovations with strong potential for dissemination are not recognized or diffused
d) A shift from science-driven to innovation-driven research has not yet taken place, the institutional, methodological and behavioural changes that are required for such a shift are not yet comprehensively explored, findings and experiences are not systematically documented and assessed.

Such tasks were included in the mandate of state/public funded bodies aiming at bridging the gap between agronomy-science and farming practice, i.e. mainstream or ‘conventional’ extension.

Since the 80s, public extension has been found to suffer from a number of shortcomings, so many countries started implementing and experimenting with different processes (decentralisation, contracting/outsourcing, public-private partnerships, privatisation etc.) in the provision of extension services, resulting in pluralistic advisory services (Alexopoulos et al., 2009; Cristóvão et al., 2012). Recently though, in their exploration of current developments in

1 The authors are part of the science team of the AgriSpin project.
extension, Cristóvão et al. (2012) highlight the importance of a “new extension approach aiming at participatory, group learning and networking with extension agents acting as facilitators” (p. 214); nonetheless, facilitation is “largely underdeveloped especially on the part of European extension organizations” (p. 219). Furthermore, European Agricultural Knowledge and Information Systems (AKIS) show a high diversity (Knickel et al., 2009; Hermans et al., 2015; Knierim et al., 2015). Thus the provision and performance of extension varies considerably.

Given such issues pertaining to agricultural innovation enhancement within the EU, the EU Innovation Policy for Rural Development currently pursues the establishment of the European Innovation Partnership AGRI (EIP). This policy instrument relies on partnerships and ‘bottom up initiatives’, mainly through ‘Operational Groups’, in order to bridge the gap between actors across the value chain (especially between research and practice) and facilitate the co-generation of innovations through the employment of facilitators/ innovation brokers (Regulation (EC) No. 1305/2013; EU-SCAR 2012, 2014; Hermans et al., 2015). The next section elaborates on the theories and concepts backing the authors’ understanding of the ‘facilitating the co-generation of innovations’ through building bridges and creating spaces.

**Discourse on innovation support: an overview of literature**

During the last decades, a number of new systems of innovations (SoI) approaches have emerged in the non-agricultural literature which see innovation in a systemic and interactive way, i.e. that innovation emerges from networks of actors as a social (and institutional) as well as a technical process, a nonlinear process and a process of interactive learning (Koutsouris, 2014). These approaches build on networks as social processes encouraging the sharing of knowledge and, notably, as preconditions for innovation. Communities of Practice (CoPs), for instance, are described as people engaged in a process of collective learning in a shared domain of interest (Wenger et al., 2002). Such concepts and approaches focus on processes instead of the emphasis on structures. Knowledge is conceived as being constructed through social interaction – i.e., not transferred but instead continuously created and recreated. Thus, particular attention is given to (social) co-ordination and networking. Moreover, in order to avoid or to overcome gaps (cognitive, information, managerial or system) resulting in network and institutional failures (Klerkx et al., 2012) growing attention is given to various types of (process) ‘intermediaries or facilitators’. For example, Van Lente et al. (2003) distinguish ‘systemic intermediaries’ as actors working mainly at the system or network level to facilitate actor interactions; Haga (2009) argues for the need to orchestrate networking enablers and thus for ‘mediators’ or ‘brokers’ as ‘independent players’ in networks aiming at a) acting as points of passage to external actors outside the network, bringing in experience and expertise, and b) building internal network resources and network structure - upon which network governance and processes depend; and Shea (2011), cites Gagnon according to whom “...knowledge brokers, networks, and communities of practice are innovative ways to disseminate and facilitate the application of knowledge. Integrated exchange, involving active collaboration between researchers and knowledge users, built on trust and frequent interactions, holds particular promise.” Finally, Howells (2006) in his well-known working definition prefers to employ the term ‘innovation intermediary’ for “[A]n organization or body that acts as an agent or broker in any aspect of the innovation process between two or more parties. Such intermediary activities include: helping to provide information about potential collaborators; brokering a transaction between two or more parties; acting as a mediator, or
In agriculture, based on SoI approaches there has been a conceptual shift from the TOT model to network and systems approaches such as the agricultural knowledge and information systems (AKIS) (Röling & Engel, 1991; Rivera & Zijp, 2002) and, more recently, towards agricultural innovation systems (AIS) (Klerkx & Leeuwis, 2008a; Klerkx et al., 2010; Leeuwis, 2004). Contrary to Rogers (1962, 2004), these approaches claim that the process of innovation is messy and complex; new ideas are developed and implemented by people who engage in networks and make adjustments in order to achieve desired outcomes (Van de Ven et al., 1999). Nowadays innovation studies increasingly focus on learning itself, with emphasis on facilitation and the processes of human interaction from which learning emerges (LEARN Group, 2000; Röling & Wagemakers, 1988).

In this respect, intermediaries aim to assist agricultural/rural entrepreneurs in coping with challenges such as articulating their innovation needs and contracting appropriate services to support their innovation projects and successfully execute these projects. A typical AIS is constantly evolving towards adopting a multi-stakeholder learning approach to withstand global challenges and includes a wide range of actors such as scientists, farm advisory services, services, farmers/farmers' groups as well as innovation support services. Intermediaries thus aim at enhancing the interaction between such varieties of actors. Such intermediaries are thus seen to act as a bridge between the demand and supply side of agricultural knowledge infrastructure (Klerkx & Leeuwis, 2008a, 2008b); they focus on ‘exploration’, i.e. sharing and synthesising, and thus the creation of new knowledge (Levinthal & March, 1993; Murray & Blackman, 2006). Their major role is that of the co-learning facilitator (usually found in literature as ‘facilitators’ or ‘innovation brokers’) aiming at the development of shared meaning and language between dialogue partners in order to stimulate change and develop solutions and innovation. The engagement of stakeholders in dialogue, despite its difficulties and its time consuming nature (since (social) learning and change are gradual), is necessary so that critical self-inquiry and collaboration will be achieved.

Summarising, Klerkx and Leeuwis (op. cit.) identify three major functions of an innovation broker: a) demand articulation, b) network formation and c) innovation process management (Kilelu et al., 2011).

Nevertheless, despite Hekkert et al.’s (2007) argument on the important contribution of innovation brokers in innovation systems the topic has not been extensively embraced by the agricultural academic and research community with the notable exception of the Dutch agricultural sector (e.g. Hermans et al., 2013; Klerkx & Leeuwis 2008b, 2009a, 2009b; Klerkx & Nettle 2013; Klerkx et al., 2010; Klerkx & Jansen, 2010; Wielinga & Vrolijk, 2009). For example, in his study on the changing role of government in the Dutch agricultural sector, Wielinga (2001) recognised the crucial role of networks and intermediate actors who fuelled those networks in the decades in which the sector became extremely innovative, and warned that in the neoliberal market conditions this function got lost and should be rehabilitated. He thus underlines that innovation emerges from networks, and no network can function well without a “Free Actor” who has space to do whatever is necessary to keep key actors in the network connected. Additionally, a large scale experiment with over 120 networks of farmers in animal production showed that such networks could very well become innovative, provided that the initiative was their own, and they were facilitated in a way that was appropriate for
such networks. Such facilitation requires tools that differ from what is common in project management (Wielinga et al., 2008, 2009).

Furthermore, Wellbrock and Knierim (2014) have shown that collaborations start with informal get-togethers of motivated individuals interested in a certain development trajectory in their specific area. Through these informal get-togethers, different stakeholders are given the opportunity to exchange their ideas, share their knowledge and together develop new ideas and projects. This process of joint reflexivity is arguably a crucial component of learning; it is joint reflexivity that leads to shared understanding as people learn to work together to address their development goals. The informality of the initial meetings seems important in providing a non-threatening space in which to exchange ideas and learn about each other. Such encounters can be considered to have occurred initially in an institutional void (Hajer, 2003). One could further argue that institutional voids are necessary for innovation (Wellbrock et al., 2013a, 2013b), because they allow stakeholders to negotiate new, joint ways of working together and to formulate new institutions that can be agreed upon by all partners in the collaboration (Wellbrock et al., 2013b; Wellbrock & Roep, 2015).

The AgriSpin project aims at relating concepts to practice and to enrich theory from practice through the in-depth exploration of a series of innovations at farm level with special focus on what support service providers actually do to stimulate such innovations.

The AgriSpin Project
In the AgriSpin project 15 organisations in 12 EU countries cooperate for a period of 2½ years (March 2015 – October 2017). Twelve partners in the consortium are farmers’ organisations and farm advisory services, with an intermediate role between farmers, researchers and other stakeholders; the remaining three partners are scientific institutes with a focus on knowledge systems in agriculture. The project is funded by the Horizon 2020 Program of the European Commission. The project will be half-way when the IFSA conference takes place. This paper aims to summarise the main features of the project, as well as some first pearls and puzzles collected so far from the perspective of science-related members of the project consortium. With this paper, we present ‘work in progress’ and various aspects (for example, the cross-visit methodology) are continuously being reviewed and improved.

Rationale
The idea behind the approach of the AgriSpin project is that all partners have their own experiences, ideas and approaches for supporting innovations at farm level, which are worth sharing with others; a silver bullet for stimulating innovations does not exist. Every partner is working in a context that has been historically grown and that has its cultural particularities. But there is a lot to learn from studying these different innovation systems, and that is what the project intends to facilitate.

The focus is on regional innovation systems. This is because in many countries there are considerable differences in cultures, organisational structures and even policies between different regions. The institutional environment has considerable influence on the capacity of a region to find new answers to emerging challenges. When we assume that good initiatives for innovations are everywhere, the thresholds for taking the necessary actions for bringing
such initiatives into practice vary a lot in different regions throughout Europe. Stimulating policies such as subsidies for experiments or mitigating risks can lower such thresholds, while restrictive rules and lack of civil acceptance make them higher. Dialogue with the 'enabling environment' about its role and possible measures is therefore an important component of the project as well.

**The main project activities**
The project consists of three steps:

a) First, all partners were asked to deliver a story that would illustrate a typical innovation process in which they were involved. This would provide a baseline for comparison later on: how did partners describe innovation, and what—in their opinion— mattered most during the innovation process? It will be interesting to follow if, and in what way, these views change in the course of the project due to the intensive interactions taking place.

b) The second and major step is the organisation of cross visits. Most partners are hosting one cross visit. During 3-5 days a visiting team, composed of colleagues from other partner organisations, studies a number of innovation cases, presented by the host. This team visits farmers and other key actors, and tries to understand the process that has taken place. In a wrap-up meeting the visitors give feedback about what they have observed.

c) In the last part of the project period all partners are required to participate in cross-cutting reflections and to enter into dialogue with their regional authorities and other major actors related to innovation in agriculture, to explore possibilities to profit from what has been learned during the cross visits. Furthermore, the methodology will be offered to other interested parties.

**The Book: stories from all corners, to start with**
As aforementioned, for this initial book, the partners were asked to write a story of an innovation process in which they were involved. Partners were strongly stimulated to frame it as a story telling how it started, what happened after the first initiative, and how far the initiative has come. Additionally, the authors were asked to include their own analysis of what made the difference in this story. The kind of examples the partners came up with, the terminology they used, the concepts and the assumptions beyond these stories all tell us something about what the partners think about what matters most in innovation processes. Next we summarise the pearls and the puzzles as they appear in the stories.

**Summary of pearls**
- *Innovations can be technical, organisational and social*: all angles are valid and interesting.
- *Initiators can be anywhere*: the initiative for an innovation process can come from an entrepreneur, an advisor, a researcher, a politician or anyone else. It does not seem to matter where the first idea came from, as long as the partners in the process embrace it and make it their own.
- *Innovation support is about building bridges*: connecting partners who carry the initiative with those who can support the process in one way or the other. This appears to be the recurrent role in practically all stories.
Summary of the puzzles

- **Reflection on the dynamics is needed.** How do support agents make a difference? It appears hard for the authors (mostly these support agents themselves) to clarify this question. If a new structure has been installed to connect major actors, when does this structure become effective? If soft skills are important for the backpack with which support agents approach their partners, what skills do they need and what tools can they apply?

- **What can be done if bridge builders are lacking?** Some stories show that intermediate structures are lacking. This does not necessarily mean that bridge builders are not there, but the threshold for doing what needs to be done is high. The puzzle is: how to lower this threshold?

- **The underlying assumptions are to be clarified.** It will be most helpful for the joint learning process to dig deeper for the assumptions partners make about innovation processes. This first exercise of the project makes clear that it is not so easy for the partners to make this type of reflection. It will be most interesting to follow what all the intensive interactions that are foreseen in the AgriSpin project will do to the way partners think and act.

**Examples of cross visits**

While finalising this paper (early April 2016), 7 out of 13 cross visits have taken place. According to the AGRISPIN methodology, during each cross visit a number of cases (3-5) are explored in-depth focusing on: (a) innovation process; (b) actors and networks; (c) environment and (d) characterization of innovation. For such an in-depth exploration a methodological approach for peer-to-peer cross visits, aimed at exploring innovations at farm level, deriving lessons from successes and failures, inspiring each other and initiating improvements in the existing support system is constantly developed/improved.

The exploration is based on semi-structured interviews with the farmers as well as other actors (notably, support services) involved in the innovation at hand. Interviews are carried out based on a number of questions addressing the four aforementioned elements (a) to (d). Following the cross visit visitors discuss the innovation case with the help of a number of tools (notably time-lines and the innovation spiral) in order to (re)construct the innovation trajectory.

Based on such exploration of each innovation case, the cross visit team concludes with an overall assessment of the cross visit (i.e. of all the innovation cases examined) in terms of (x) Pearls; (y) Puzzles and (z) Proposals, presented and discussed with local stakeholders during a symposium organised on the last day of the cross visit. The preliminary results of two of the cross visits, i.e. Guadeloupe (France) and Tuscany (Italy) are outlined below.

**Synopsis of the Guadeloupe cross visit**

In Guadeloupe a policy-induced set of innovation processes was studied. Hence, there was a two-level innovation case setting: a) the RITA («Réseaux d’Innovation et de Transfert Agricole» - agricultural innovation and dissemination networks) program as such; and b) 3 cases of innovative agricultural diversification measures (in citrus, yams and bee production) enhanced by the RITA.

The RITA program has enhanced the cooperation of various agricultural organisations at both the regional institutional level - so that the decision makers know better about each other - and the farm level - where a concrete cooperation among the technical staff takes place. In
particular the agents of the agricultural chambers are more aware of further actors operating for the sake of farmers. Equally a better knowledge of the work of CIRAD and INRA has been gained. A further gain is the involvement of political decision makers comprising both the representatives of the national ministry of agriculture and of the regional department council. Currently a very important shift of responsibility is to be realized through which the RITA programme will be transformed from a national top-down and ministry governed intervention into a regionally anchored, EU funded instrument. So far RITA was successful in building bridges among the various actors so that there is mutual knowledge about agency possibilities and limits with a specific focus on science-practice interfaces. RITA has also created new spaces for actors like specific farmers’ organizations to formulate their research interests and needs (e.g. in livestock production). However, given the relatively short time of the program’s existence, no concrete results can be assessed at this level of innovation process.

With regard to the problem of the Citrus Greening disease three innovative strategies were explored: an individual one, a science-practice cooperation and a governmentally supported business approach. Meaningful bridges among various actors, such as the Chamber of Agriculture, a producers’ organization and the research body CIRAD, were observed in the second case. However there was obviously no fast and satisfying answer to the problem. So individual actors who once relied on citrus production looked for either new fruits and crops or alternative livelihood strategies. The scientifically promoted idea of eliminating the affected citrus trees was not at all supportive for the creation of spaces for innovation - rather the contrary!

The production of yams is important in Guadeloupe as one of the population’s staple foods. Although confronted with severe challenges from both ecological and market aspects there is an on-going interest amongst farmers to produce yams despite the lack of productive and resistant plant material. A long-standing research line on yams from INRA has failed to bring the expected breakthrough. Supported by RITA a new network has been created linking a farmers’ organization with CIRAD and supporting especially one farmer in making field trials with interesting plant material (building bridges). Around these field trials a field day was organized that successfully created spaces for the meeting and the exchange of various actors in the sector and also attracted new farmers who were interested in getting engaged in commercial yams production.

The case that revealed the widest and most concrete impact is the beekeeping and queen-breeding one of the beekeepers’ organization. Here, the organization was almost at the level of job creation through the production and sales of a variety of locally bred bee-queens. Moreover, the organization had lobbied successfully within municipalities for the maintenance and the reestablishment of hedges and other naturally flourishing sites in order to provide bees with fodder sources. This has built bridges among various actors within a regional, landscape level. In addition, through the establishment of a shop for beekeeper equipment (and for honey and honey related products) and through offering training courses for beekeeping, the organization creates spaces for innovative practices.

The cross visit aroused the attention of the local decision makers. They participated in the discussions. After the visit it was decided that the second phase of RITA should be approved.
Synopsis of the Tuscany cross visit

In Tuscany a number of innovation cases were visited and studied. As with the case of Guadeloupe, a two-level innovation setting was observed: on the one hand the work of ARSIA/Tuscany Region and on the other the specific innovative cases visited. ARSIA (The Regional Agency for Development and Innovation in Agriculture and Forestry) was a technical and scientific agency for the region of Tuscany until January 1st, 2011 when ARSIA was abolished and all activities were transferred to the responsibility of the Tuscany Region. ARSIA and the Region played/play a significant role in terms of a) actively promoting policies at the regional level; b) encouraging links between stakeholders, notably between scientists and researchers and between farmers and rural communities, mainly through the setting up of round tables; c) participating in international projects and putting together relevant regional projects and d) funding specific farmers’ investments. These points were verified at least as far as the case studies visited in Tuscany are concerned (see below). The Agency/Region were/are involved in a wide range of activities including social farming, agritourism, biodiversity, forestry, phytosanitary services, animal production, artisanal production, (typical) local products and products of geographical indications, marketing, training, etc.

However, the lack of advisory service and of coordination of the regional AKIS is profound after the abolishment of ARSIA. This, in turn, has resulted in a) a lack of structured links between actors - thus the increased importance of personal relationships, b) the lack of a clear vision on the part of the Region (for example, who to support - large or small-scale farmers, what to support and which innovations are appropriate for each farmers’ categories etc) and c) sometimes, the lack of recognition of the Region’s contribution into innovatory projects and the understanding of its role as merely a funding provider.

The cases visited in Tuscany concerned: a) the Floriddia farm (the rediscovery and cultivation of ancient wheat varieties and the production of organic bread and pasta); b) the Maremma cooperative (production of the Pecorino Toscano PDO cheese with nutraceutical properties implying the restructuring of the whole animal farming management system); c) a winery producing high quality wine and engaged in activities in order to valorise local varieties, control inputs and allow for traceability and d) the University of Pisa actively involved and driving a social farming project.

Interesting points drawn from the case studies are as follows:

a) The role of ideology (organic farmers/Floriddia), ethical commitment (organic farmers; social farming) or local identity and fame/branding (wines) in the initiation/triggering of innovations;

b) The commitment of the initiators to their innovation, despite in some cases problems with economic viability of the project, personal time and expenditure, etc.;

c) The involvement of university staff in these projects (although on a personal basis) - except in the social farming case in which the university is the heart of the innovation;

d) The attempts in all cases to establish networks with relevant actors during innovation initiation and now to expand them, notably:

i) in the organic farming network (related to the Floriddia case) the role of such networks in both dissemination (local farmers network to cultivate the ancient cultivars and have formed a wider network comprising farmers, scientists, bakers, processors, consumers, marketeers/distributors, doctors and other medical and health specialists, etc. to support the case) and policy making (national law on biodiversity for which a national network played an
important role and the refutation of the EU Commission proposal on seeds based on the resistance of a pan-European network) should be stressed and ii) in the case of social farming efforts that led to the national law for social farming.

e) The need for innovations as responses to market demand (high quality wines, Pecorino cheese with nutraceutical properties); social demand and sensitization (social farming, organic farming) or scientific progress (cheese with nutraceutical properties and the related new animal production management systems, biodiversity and the preservation of local seeds and breeds, new technologies allowing for soil, inputs and overall production management and traceability in viticulture and wine-making);

f) The step-by-step introduction of innovations in cases of complex changes (new animal farming management for the production of cheese with nutraceutical properties; from quality related concerns to environmentally-friendly cultivation techniques to high-tech precision farming and traceability systems in wine production) and the adoption of the changes by younger farmers eager to experiment with the assistance of the university staff in the first case.

g) The need to secure the economic viability of the businesses in all cases, the equitable distribution of costs and benefits (between the members - animal breeders, and the cheese producing cooperative) and the contribution to local, sustainable development (for example, less working hours in order to increase employment in Floriddia; the environmental, social and economic role of animal farming in Maremma and the low prices of the organic social farming products in the local market).

Reflections half way

The aim of AgriSpin is to learn from each other and with each other about ways to support innovations at farm level. In this respect, thus far, our work within the AGRISPIN project has revealed a number of interesting points worthy of further exploration.

Many examples confirm that successful innovations are often the result of synergy among three dimensions: technical, organizational and institutional. Innovations are a combination of implementation of new technologies and practices (hardware), new knowledge and ways of thinking (software) and new institutions or organizations (orgware).

It has been shown that the first spark for an innovation can arise anywhere in a knowledge system. Clearly our stories do not support the idea that was common for quite some time that innovation flows from the source (research) to the end users (farmers), and that the job of innovation support consists of transferring knowledge. The multiple triggers of change (ideological, technical, market, scientific, policy, etc.) should also be underlined, along with the fact that new ideas come about when actors adopt a reflexive stance towards their own situation. Reflexivity implies challenging conventional thinking, problematizing aspects and developing novel interpretations.

Networking has also been shown to be an effective way of coordinating a shared activity and crossing boundaries, disciplines, organisations, hierarchies and scales. It can increase the number of actors (individuals and groups) who share an innovative idea and directly contribute to the formulation of projects and policies. Networks are thus spaces which bring together those involved in purpose-driven learning and knowing processes, allow for the creation of synergies and encourage (social) learning and innovation.
The need for facilitation becomes very obvious. Facilitation organizes the learning environment and learning processes. It allows for critical discussion among participants around an activity or experience they share and, over time, deeper levels of understanding, inquiry, and innovation can be created within the participant network; it thus produces more effective learning in participants' domains of existence.

Further study and clarification is needed and a number of issues are to be explored further within the AgriSpin project: a) why do some innovations become successful while others get stuck?, b) what the support service providers actually did to help farmers realise an innovation and c) can particular phases of an innovation process be identified and what is needed and helpful in each phase? It will also be interesting to explore partners' theories-in-use and where the interaction in the project will lead in terms of concepts and approaches.

Based on the detailed analysis of all the 13 cross visits, the project has collected best practice examples and will make them available to a wider public; the aim is to enable local, regional, national and European actors involved in supporting innovations at farm level to improve their practices and support services and thus to create space for innovations. Additionally, the project will develop a toolkit of best-fit innovation practices and support services across Europe which can be used by stakeholders to strengthen their innovation capacity. It will provide new insights and ideas on how to improve innovation and demand driven research in the agrifood chain. In this respect, in the second phase of the project partner organisations will organise relevant seminars with authorities and other key actors in their region.

Finally, colleagues who meet each other several times in intensive cross visits build up relationships which can lead to new joint activities. The start has been made, but it is still too early to predict how this will evolve. The space for a professional network that lasts after the project has ended has been created.
References


How to implement effective and efficient agricultural innovation support systems? Some insights from an European cross – country analysis

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Abstract: It is acknowledged that innovations in agriculture and rural development need to be adequately fostered. Within a system approach applied to this matter, the role of people and organisations able to catalyze innovation through bringing together of actors and facilitating their interaction is growing in relevance. In such a model the intermediaries are assumed to play a key role in developing social impact and sustainability outcomes for regional rural development. In this perspective, the European Innovation Partnership for agricultural productivity and sustainability (EIP-AGRI), which can be perceived as a platform based on interaction among farmers, researchers, and advisors/extensionists, represents a useful tool for a better understanding of applied innovation processes. Grounded in the activities performed within the EU AgriSPIN project, in this paper we attempt to contribute to the identification of effective and efficient approaches for the implementation of the EIP-AGRI strategy. Specifically, we present some preliminary findings on the functioning of EIP-AGRI system and Operational Groups across five European regions and countries (Italy, Poland, Germany, The Netherlands, and Belgium), by comparing different implementation modalities of the EIP strategies. With this analysis, we aim to portray the practical implications for agricultural innovation support systems. In addition, we interpret the role and the actions undertaken by public authorities in supporting such innovation systems in their regional contexts. Finally, we try to explain the enabling dynamics behind institutional uptake of these innovations into the local public support systems, by addressing the issue of “institutional change” at both regional and local levels.

Keywords: Innovation systems, sustainable agriculture, knowledge networks, innovation support systems, innovation brokers.

Introduction
In the agricultural sector, innovation is vital for sustainable economic, social and ecological development. Efforts to overcome the numerous barriers to effective innovation and cooperation are thus central to the public interest and justify public investments. To that end, the need for a systemic approach to innovation in agriculture and rural development is becoming largely acknowledged. The innovation system framework has been developed through decades of intellectual debates and featured relatively recently within agricultural science and rural development studies (Pant & Hambly Odame, 2009). In this development context, agricultural innovation does not result in a one dimensional, linear knowledge dissemination and adoption process, but rather it depends on learning among multiple stakeholders (Leewis & Van de Ban, 2004). An agricultural innovation system (AIS) is characterised by structural elements and dimensions, according to the scale of the system being looked at. Since their identification (Edquist, 1997), innovation systems have been categorised as national or regional according to the unit of analysis (Wieczorek et al., 2012).
A broad definition of structural elements of the system (Johansson & Johnson, 2000) comprises all the parts and aspects of an economic structure and the institutional set up affecting learning, searching and exploring: the production, marketing and finance system. Among the structural elements of innovation systems, it is acknowledged that actors and their interaction play a crucial role in such systems. Wieczorek et al., 2012 identified categories of actors based on their role in the economic activity: civil society, government, NGOs, companies/enterprises, knowledge institutes (universities, research centres, schools) and the one they call “other parties”. Among the last one are included innovation and knowledge intermediaries and brokers, as well as consultants. These insights from agricultural innovation studies have urged policy makers and rural development professionals to adopt different way of performing agricultural extension services (Chowdhury et al., 2014).

The different actors of the AIS thus need to interact with each other: an agricultural innovation system can be strengthened by facilitating collaboration in a network of farmers, extension officers, policy makers, researchers and other actors in the agricultural system (Klerkx et al., 2013; Swaans et al., 2014). Thus, there is the need to enhance the support in this direction.

AIS is promulgated to undertake reforms in the knowledge and innovation support structures and requires operational concepts and tools in order to achieve a real institutional change based on partnership development (Spielman et al., 2009; World Bank, 2012). To that regard, there are a wide variety of policy instruments to support innovation processes, such as research funding, patent regulations or industry standard inducing innovation (Borràs & Edquist, 2013). Recently, the literature has indicated that these mechanisms need to be complemented with “systemic instruments”. Such instruments are oriented towards stimulating a co-innovation approach and orchestrating an adequate combination of individual innovation policy instruments and actors of the innovation system. Moreover, the desired institutional change which characterises AIS operationalisation, needs to ensure on-going adaptation that takes into account learning and experimentation among individuals, organisations and networks as a core development strategy.

In this context, where collaboration among actors in order to speed up innovation needs to be adequately fostered, the European Innovation Partnership for Agriculture Productivity and Sustainability (EIP-AGRI) (COM, 2012), which has the aim of stimulating such a co-innovation approach by fostering synergies between the Rural Development pillar (RD) of Common Agricultural Policy (CAP) and Horizon 2020 policies, can represent a new operational tool to contribute to the desired institutional change. Within this frame the AgriSPIN Project (N°652642) is one of the thematic networks funded under the H2020 EU research programme. It starts with the overall aim of improving innovation intermediary practices and support systems in European agriculture and to provide support to the EIP initiative. The Project also acknowledges that the role of intermediaries should be addressed to support innovation as a collective process of putting knowledge into practice, and achieving multi-stakeholder social, economic and environmental goals (Chowdhury et al., 2014).

This paper is grounded within the activities of the AgriSPIN Project and is aimed to better understand how the co-innovation approach of the EIP works, how it is translated into practice and which kind of barriers it presents. Moreover, we looked at the role of innovation support agents in fostering this approach.
The paper is structured as following: after an introduction of the EIP-AGRI overall approach and an explanation of research methods, the different strategies of EIP implementation in five case study regions and countries will be addressed and compared. We will then discuss their characteristics. To conclude, we will address the issue of the “institutional change” which is needed to foster innovation but also presents several obstacles for its realisation.

The EIP-AGRI overall approach
The Europe 2020 Flagship initiative “Innovation Union” specifies EIP as a new tool for speeding up innovation through linking existing policies and instruments. Consequently, the EIP-AGRI is aimed at fostering a competitive agriculture and forestry sector by promoting the open innovation concept that is based on the interactive innovation model. This concept implies collaboration between various actors to make best use of complementary types of knowledge in view of co-creation and diffusion of solutions/opportunities ready to implement in practice.

The EIP-AGRI falls within two frameworks: CAP - rural development with focus on knowledge transfer, cooperation and counselling, and Horizon 2020 with its thematic networks and multi-actor projects. The EIP follows a bottom-up approach, in which the participants can organise an Operational Group (OG) around a concrete problem from their daily practice. Within an OG farmers and growers, consultants, researchers, entrepreneurs and/or other actors organise themselves around a particular issue, seek solutions and work together on specific innovations. The farmer and his/her question are central to the entire process. Such OGs carry out projects aimed at testing and applying innovative practices, technologies, processes and products with the aim of strengthening the link between research and practice.

The involvement of farmers and growers has the advantage that more research-based practice will inform innovation, that there is more interaction between farmers and growers themselves and that scientists learn more about how their research results are used in practice. Through their participation in OGs producers are co-owners of the innovation process rather than an object of study.

The EIP-AGRI also points out the importance of a supporting environment to incentivise innovation projects. Various types of support are considered important, in particular if done by persons well connected to the agricultural world and who are well networked. These correspond to different professions, such as innovation brokers (people who help to start up a specific group and prepare the project) and facilitators or intermediates (people who help to facilitate the project) and, more generally, innovation intermediaries.

Implementation of the EIP in member countries is started in different periods and follows different modalities. According to a recent update of the Commission, 94 member states/regions will be implementing the EIP within their 2014 - 2020 Rural Development Programmes with regular calls for OG projects. (http://ec.europa.eu/griculture/rural-development-2014-2020/country-files/index_en.htm).

Methods
In order to identify effective and efficient approaches for the implementation of the EIP-AGRI strategy, we started with a preliminary study of such approaches, by realising a cross country, comparative analysis. Within this groundwork we selected five examples, among European
regions and countries, of implementation of EIP-AGRI: Italy, with a focus on Veneto Region; the Shlezwig-Holstein Region in Germany, the Flanders Region in Belgium, the Netherlands, and Poland. These examples were selected according to the differences they presented while approaching EIP-AGRI implementation as well as because they have different organisational structures regarding extension services in agriculture and the management of the RDP. These differences allowed us to cover a broad, although not complete, spectrum of the current situation in Europe.

The data were gathered through a desk research of public documents, papers and direct, semi-structured interviews to relevant actors of each of the five cases. We interviewed people who are directly involved in the implementation strategy of EIP in their region or country (regional and provincial officers, responsible for regional and national EIP service points) and the profile of the interviewees was selected according to the institution in charge of implementing the EIP. The interviews were conducted according to a list of guiding questions aimed at deepening the organisation of the Agricultural Knowledge and Innovation System (AKIS), the overall approach for EIP and the rules for its implementation; for example how the calls for OGs are managed and the role of innovation support services in implementing EIP strategy.

The questions were elaborated with regards to those aspects potentially useful to understand the EIP as an operational tool for better understanding applied innovation processes. We then compared the different scale of management of the EIP system and its functioning, how the EIP fits into RDPs, the management of OGs and their funding and the role of extension/advisory services within the EIP System.

Cross-country analysis
In the following sections results of the cross-country analysis will be presented. These result are organized following the list of guiding questions asked during the interviews.

Poland
The AKIS in Poland is managed at national level and it’s characterised by the presence of the most relevant actors engaged in innovation and knowledge creation and transfer in agriculture. There are several research institutes and universities providing scientific knowledge and the central government is involved with several ministries. Advisory services represent a determinant actor, with very strong and direct relations with farmers and their organisations. The AKIS has a linear, top-down approach and appears to lack capacity in terms of coordination among different actors; farmers are, until now, seen as “clients” by advisory organisations. In July 2015, in order to strengthen the knowledge flow between AKIS actors, as well as to support the implementation of the EIP-AGRI, the National Network for Innovation in Agriculture and Rural Areas (SIR) was established. The SIR is a National Network, centrally coordinated by the Agricultural Advisory Centre in Brwinów. Regional Authorities, with Regional Centres of Agricultural Advisory Services, are regional coordinators of this network. The SIR was in charge of the organisation of an open forum for all actors interested in innovation in agriculture, as well as of the animation of the potential partners of the EIP Groups.

In order to provide coordination, the National Centre for Innovation was created within the Agriculture Advisory Centre. The SIR and the professional advisors of the National Centre
organised targeted focus groups in order to identify strategic priorities and key areas of the National Innovation Partnership at the National level. The focus groups worked on thematic issues considered as priorities for the agricultural sector in Poland and the thematic areas on which OGs will present their projects. These priorities are: crop production, animal production (including animal welfare), organic farming, environment protection and agribusiness. The brokerage is performed by the National Network and by the centre; it is integrated within the policy of rural development because innovation support and the funding of EIP OGs are framed within the national RDP.

Innovation will be supported through a package of measures of the RDP: the measure 16 (cooperation) and the measure 1 (knowledge transfer and demonstration), but also measures related to investments on the farm will be taken into consideration. Poland originally planned to fund 90 OGs; pragmatically, 25-30 will be funded and the first call is expected to be opened before the end of 2016.

**Germany - Schleswig-Holstein Region**

Schleswig-Holstein is a small region in Northern Germany and its AKIS is composed of a small number of actors. There are two research organisations involved: one university which specialised in basic, scientific research and one public research institute of applied science. In addition there is a Chamber of Agriculture as well as 7 farmers’ schools and several private advisors. These actors are partially connected: the Chamber of Agriculture is linked with the advisors but advisors are not interested in university research, as they considered it too far from the needs of farmers; the scientific knowledge providers of the AKIS do not work closely together with farmers’ advisors.

In 2014, in order to support the local innovation process in agriculture, the Ministry (MELUR) set up the Innovation Office EIP Agrar (coordinating body). It is hosted by the Schleswig-Holstein Chamber of Agriculture in Rendsburg. On one side, the Innovation Office supports the Ministry in the implementation of the new EIP agricultural policy instruments and coordinates project work. Simultaneously, the Innovation Office provides OGs with information, assistance and support in the planning, implementation and execution of their project ideas. Networking between groups within Schleswig-Holstein and cooperation in Northern Germany with the regions of Lower Saxony and Mecklenburg-Western Pomerania is another important task. Active public relations work ensures the exchange of information on project results and it supports the desired transfer of knowledge into practice.

Selected EIP Innovation Projects may be product innovations, such as the development of new types of product, or process innovations, which update existing technologies or tools, for example in a regional context. The implementation of EIP in the region is carried out according to the “bottom up” principle, i.e., the need for innovation comes ideally from practical demand and agricultural practitioners play a leading role in the development of solutions.

In order to follow this principle, in 2014, the EIP Agrar Office initiated networking between people and organisations who participated in a “call for innovative ideas” opened by the ministry. The Office acted as brokers and this helped the formation of 20 groups working on 20 projects. In the second phase, a jury was established which selected 17 out of the 20
projects and groups to be funded. The selection criteria reflected the rural development priorities and the "sustainability goals" of Schleswig-Holstein region. The 17 OGs founded in June 2015 are still active and the projects will be funded for three more years. A peculiarity is that these first OGs were not funded by RD funds but with other resources; this has to do with the fact that when the region started the process the RDP was not yet approved. However, the second call will be under the measure 16 “cooperation” of the regional RDP.

The Office is the principal innovation broker and provides support to OGs at different stages of the project development, by facilitating people and by working together as a team, providing information on how to get money and on other administrative matters. The Office still supports individuals and groups who have questions about EIP project proposals, who are looking for project partners, or who require further assistance within the OGs by providing information on funding opportunities, assistance with applications, mediation with research partners and assistance with administrative processing.

**The Netherlands**

The Dutch AKIS or DAISY, which stands for the Dutch Agricultural Innovation System is a Public-Private research partnership. It is also known as the ‘golden triangle from the polder’ or the ‘triple helix’ uniting research, business, and government. According to the Chief Scientific Officer real management of the AKIS is absent. The system expands by itself and with implicit incremental changes. On the other hand the current government recognises the general importance of DAISY and in particular the interaction and cooperation within its ‘golden triangle’ as an important asset and an example for other sectors.

In relation to the knowledge and innovation policy DAISY functions thanks to the presence of the following 5 factors:
- Concentration of information within Wageningen University & Research Centre that is responsible for the actual operational knowledge system;
- The embeddedness of research in a consensus-seeking (polder) democratic society with a high concentration of information content for optimal policy making within the golden triangle of industry, knowledge institutions, and government;
- Innovation, especially aimed at sustainability, is for policy makers a governance instrument that is continuously mixed with e.g. regulations or subsidies;
- Correlation between innovation demands and innovation policies and regulations (for example, no support for organic farming without agreed standards). This development is seen as a necessary fine-tuning process of policies;
- Research is conducted in the form of open interaction and information transfer, which means that outsourcing or tendering can be complicated within this particular knowledge system.

Within this context each province in the Netherlands has to set up its own sustainable innovation agenda, which has to be seen as a document for the long-term agricultural ambitions and priorities of the region. For example, the three Nordic provinces of the country: Friesland, Drenthe and Groningen have written their common agenda in order to face the common challenges and objectives within the current programme. This implies a new role for the provinces in which they have to try out and experiment with new approaches.
Implementation of RDP by the Dutch provinces has been translated into three measures for sustainable and innovative agriculture at the local level: training, workshops and entrepreneurial coaching; physical investment in innovation, promoting sustainability among young farmers and cooperation within the framework of EIP-AGRI OGs. Furthermore, the eligible innovation themes in the Netherlands that have to be implemented at the provincial level have been selected by the National Rural Network and Support Unit for the EIP-AGRI. The Unit also provides assistance to regional authorities, innovation brokers and project initiators.

The inclusion of EIP-AGRI within a broader innovation support system in the Netherlands for now means looking at the state of play of programming, calls, tenders, and difficulties surrounding the implementation of the European Agricultural Fund for Rural Development (EAFRD) at the provincial level in the Netherlands. Until now it has been difficult to execute a combination of measures around an EIP-AGRI and OGs under the national tender regime. Nevertheless, within the 12 Dutch provinces 11 out of 12 regional authorities will execute the EIP-AGRI strategy. The ambition is to establish 90 operational groups in the Netherlands. First calls were expected for late 2015 or early 2016 but are now postponed to the period May – June 2016.

Innovation experts and knowledge brokers from the farmer organisation LTO, Wageningen University, the Dutch golden triangle of agro-food and horticulture sectors, the national government, and the provinces have established a “help install the EIP”-team in order to smoothen the implementation of EIP strategy. Also they have defined the details for EIP-AGRI project approval of the operational groups. In addition, they have extended the rural development network and national EIP platform providing support (current members of EIP-AGRI team plus Netherlands Enterprise Agency, Ministry of Economic Affairs) together with an independent expert team of innovation brokers for judging, evaluating and ranking the proposals.

It should be acknowledged that in the Netherlands the approach of stimulating innovations through networking around bottom-up initiatives in not new and this could facilitate the implementation of EIP. An example is the network programme financed by the dutch ministry of agriculture and carried out by Wageningen University, based on the experimentation among 120 animal husbandry networks of the “Free actors in network” approach (Wielinga & Vrolijk, 2009). After the end of the project, between 2008 and 2013 the Ministry of Economic Affairs established a subsidy scheme for such bottom-up initiatives.

**Italy –Veneto Region**

In Italy, the managements of European funds for agriculture and rural development is an exclusive competence of the Regional Governments and their Managing Authorities; because of this, the implementation of the EIP Strategy is also assigned to Regions. The process, at national level, is to generate an intense debate between regional stakeholders, the Ministry of Agriculture and actors of the “innovation chain”.

The implementation process presented some criticalities, such as the dominant role of some actors in the creation of partnerships and the low interactivity in knowledge and innovation transfer. These criticalities highlighted the importance of the function of innovation brokering
in order to foster the adoption of innovations. To date, all Italian regions have concluded the process of consultation with the EC for the approval of their RDP.

AKIS in the Veneto Region is not a formal organisation, the actors collaborate in an informal network. Farmers and their forms of representation (product organisations and farmers' associations/unions) are recognised as the main actors of the regional AKIS and they appear connected both with universities and secondary agriculture education schools.

The research side of the AKIS is represented by three Universities with their departments of agriculture and animal husbandry. Both disciplines collaborate with the departments of urban and landscape study of these universities themselves; the agricultural landscape as a whole is considered an important resource for the economy of the region and because of that all the scientific areas dealing with this topic (agricultural production, veterinary science, landscape planning etc) need to be adequately coordinated. In Veneto there also exists a regional headquarters of the Council for Research in Agriculture and Agricultural Economics (CREA).

A key role in the AKIS of Veneto is played by Veneto Agriculture, the "regional agency for innovation in the primary sector". The agency is an instrumental body of the Regional Administration and offers training for agricultural advisors, information actions for farmers and testing of innovations within its experimental farms located throughout the region. In addition to training and information, Veneto Agriculture will be in charge of the coordination of the AKIS in Veneto. The regional government as well as the other actors of the system (especially universities and farms) acknowledged that the governance of the system had been lost over time and therefore the need for coordination was strongly expressed.

The region started to work on the implementation of the EIP-AGRI in 2010, when a permanent forum on innovation in agriculture was established; the regional agency played a crucial role in the coordination of this network. The aim of this forum was to define a common regional strategy for innovation in agriculture and to help the regional government to start and manage the process towards OGs. For the definition of the areas of activity of OGs, the region decided to not identify any priorities, in order to guarantee the bottom-up approach as expected by the Commission. Innovation is, in any case, a cross-cutting objective in all measures of the RDP. The choice of valorization of the bottom up approach on the one hand guaranteed an openness in the evaluation of the project proposals, but could also represent a complication from a procedural point of view, especially for the definition of the selection and evaluation criteria to apply. The region planned to fund 27-30 OGs; the calls are expected to be published before summer 2016 and will remain open until October 2016. For new-born OGs, the regional government is considering other sources of funding for the implementation of projects, eg the EAFRD.

Veneto Agriculture will be in charge of the support service for the establishment of the OGs and for the writing and finalisation of the projects. It will also provide support to the regional government, even in the evaluation phase of the proposals, that will occur in two steps: a commission composed of the agency and external evaluators will select the best proposals; a second commission will decide which proposals to fund, taking into account the general guidelines of the region. The Regional Agency assumes the role of innovation broker for the setting up of OGs.
Belgium – Flanders
For a better understanding of the Flemish AKIS it is important to consider it within the context of the Belgian Federation State and the fact that policies on research (partly), innovation, education and agriculture are regional instead of national matters. The vision of the Flemish government is that agriculture is not an isolated entity. AKIS and the supporting policies should provide links and crossovers to ICT, food and other sectors in the bio-economy.

Within the Flemish AKIS several actors are involved in agricultural research: universities, the Institute for Agricultural and Fisheries Research (ILVO), university colleges and experimental stations. When it comes to the extension services the Flemish government organizes collective information or activities and (co-)funds training courses by approved centres. The provincial authorities have complementary activities, for example experimental farms and education initiatives. Other services that aim for individual information and guidance are in general offered by private organisations (especially the Flemish Innovation Centre for Agriculture and Horticulture) or private services with additional government funding (such as the farm advisory system).

The agricultural support system covers a very broad field of activities and most relevant actors in Flanders are the farmers’ organisations. Other actors within the support system are knowledge networks and study clubs, and cooperatives. There is also a general and agricultural education system; in addition to the general secondary education there are around 20 technical and vocational schools that offer an agriculture-related education.

The Flemish RDP 2014-2020 is an instrument with a wide range of measures to stimulate and support competitiveness and sustainability and one of these measures is related to EIP. In this setting, the Flemish EIP-AGRI Service Point acts as an intermediary in the EIP-AGRI network to strengthen communication and cooperation between everyone who is interested in innovation in agriculture. Representatives of the EIP-AGRI in Flanders are working at the Flemish Ministry of Agriculture and Fisheries. The call for the OG is based around the two main themes of the regional government: Conservation Objective and Programmatic Approach Nitrogen (IHD / PAS), but can also be based on other topics relevant for the aims of the EIP-AGRI for agricultural productivity and sustainability. How each OG complements existing innovative initiatives must be made clear and each OG should also examine whether knowledge on the subject is present at the practical centres of the Institute for Agricultural and Fisheries Research, and how this knowledge is used. If the knowledge is not used, it must be thoroughly justified by the OGs.

Within the available Flemish rural development budget, at least five OGs can be selected for financial support. All submitted projects will be evaluated by a committee of experts and the maximum grant per OG is €30,000. The first call is expected from September the 1st, 2016 onwards and at the latest on 1st December 2016, but the Flemish government will launch several calls during the programme period.

Flemish EIP network that is supporting the creation of such OGs is accessible via the Flemish Rural Network that is located in Brussels. The Flemish Land Agency (FLA) is the 'service point' thereof. The FLA is as External Autonomous Agency, part of the policy area Environment, Nature and Energy of the Flemish government. Rural development, countryside and minerals
policy, Manure Bank and Project Realisation are the core divisions of the FLA. In addition to its headquarters in Brussels, FLA has two regional divisions: Western Region, with offices in Ghent and Bruges and Eastern region, with offices in Leuven, Hasselt and Herentals. Additionally, the Platform for Agricultural Research - Agrolink Flanders, functions as a stage for the local innovation brokers working towards implementation of the EIP strategy. In fact, Agrolink Flanders wants to be the recognized contact point for the agro-industry, research community and policy in agriculture and horticulture. It is the main Flemish forum for consultation and agreements between agricultural research and innovative agricultural actors in order to encourage their entrepreneurship. The platform represents a partnership between 17 Flemish universities and knowledge institutions.

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<th>Table 1 - Comparative table of EIP Models</th>
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**Discussion**

The results of our research, although they only include five examples, show different models of implementation of the EIP. Despite the common guidelines provided by European legislation, it is clear that regions/countries can adopt different strategies, also in relation to their internal organisation. Hence, in this section we will examine some key elements of EIP implementation as described in table 1, underlining the main peculiarities of each element and, where present, the barriers or difficulties characterizing the different approaches.

**Management and coordination of the EIP**

The scale of the EIP system is strongly dependent on the form of administrative organisation of different countries and the EIP implementation is managed both at national and regional levels with different intensity of centrality. All member states we analysed have defined national guidelines for EIP implementation but the practical management and the definition of an operational strategy is in most cases entrusted to the sub-government levels: for example, in Italy the regions are the ones who organise the implementation, in the Netherlands it is the provinces. One example of completely centralised management is Poland: there is a national strategy for EIP, which is managed by the government and the National Advisory Centre. Almost all countries decided to set up coordination offices for the EIP. In other countries (eg Belgium), specific contact persons have been identified within existing governmental/state organisations who are in charge of the coordination of EIP. In some cases (eg Schleswig-Holstein) the office is working on the EIP Service Point model installed in Brussels, by providing different kinds of support for establishing OGs such as networking, innovation brokerage, helping with project drafting, etc. These offices are coordinated nationally or regionally, according to the implementation modality chosen for the EIP. Essential for the right functioning of the system is the coordination among the different organisations involved: according to most people we interviewed, coordination in the governance of the EIP is often a critical point.
**EIP and rural development: management and funding of OGs**

In each region/country EIP is framed under the national or regional RDP, which follows the EU prescription. With the exception of Schleswig-Holstein region, which funded the first 17 OGs with other EU funds, in all region/countries the groups will be mostly funded under measure 16 of the RDP, although a co-financing is planned in some cases (i.e Belgium and The Netherlands). Most regions and countries identified some innovation priorities for their agricultural sector and the activities of OGs will be framed within these topics; in most cases these priorities reflect those of the Rural Development and of the EIP strategy. A different approach was followed by Veneto Region, which chose not to identify any innovation priority in order to favour the bottom-up approach and open innovation processes. According to the Veneto regional government, the identification of specific priorities would have influenced the project proposals, the composition of OGs and would have favoured some agricultural sectors over others. The Rural Development rules allow both the funding of the setting up of the groups and of the projects implementation phase. In this regard, in the cases analysed, we found different operating modes. In some case there are singular public calls which will fund both the setting up of the OGs and the projects; in other cases there will be two separate calls, one for the setting up and the other for the realisation of the projects. One commonality among all the cases is the planned duration of projects (at least three years) and the total amount of money for each OGs (ranging from 30,000 to 50,000 euro).

**EIP and support services**

The role of extension/advisory services in the EIP implementation appear to be crucial in the different phases of the implementation of EIP strategy. In most cases, extension/advisory organisations are directly involved in the coordination of innovation brokerage activities, in helping those who are interested in OGs to find partners and building of a project together. Moreover, they will support managing authorities during the process of selection and evaluation of the OGs and projects. In Veneto, where there are no public extension and advisory services, these functions will be performed by the Regional Agency for Innovation in the primary sector (Veneto Agriculture). These activities will be mostly funded with RD P technical assistance funds. Based on the cases analysed, we observe a general tendency to centralise the innovation brokerage activities, directly involving advisory organisations both in coordination and operational actions. The centralisation of such actions guarantees the institutional acknowledgment of the role of the advisory organisations as important innovation facilitators and brokers. To make this system work well, there should be a strong coordination and communication flow between the central offices and those placed and embedded in the territory.

**Conclusions**

The EIP for agricultural productivity and sustainability, can represent a useful tool for a better understanding of applied innovation processes. Our preliminary analysis of some of the EIP implementation modalities, confirms that the role of people and organisations able to catalyze innovation through bringing together of actors and facilitating their interaction is growing in importance.
Comparing the different models of the EIP we can stress the engagement of regional and national governments in transposing this new European approach to innovation in agriculture; also the involvement of support services in the designing of the strategy underlines the willingness to cooperate in order to achieve a more coordinated innovation support system.

European countries are starting now to experience the EIP implementation and more time is needed in order to understand if the adopted strategies will result in the desired outcome. However, this preliminary analysis allows us to understand how different regions and countries interpreted the interactive innovation approach within the EIP and this represents a starting point for further research and insights.

The development of innovation support services requires continued local experimentation, adaptation and learning (Klerkx, Hall & Leewis, 2009). Such innovation support services are an integral part of the AIS (Klerkx, Aarts & Leewis, 2010; Faure, Rebuffel & Violas, 2011) and, to achieve the desired institutional change, there is the need to overcome barriers or gaps that can hinder collaboration (österle et al., 2016). Together, and within the EIP, other tools enabling dialogue and effective collaboration should be encouraged. For example, under the frame of AgriSPIN activities, a so-called “Multiplier Group” will be established, whose members will be European regions’ managing authorities and advisory organisations. The aim of this Multiplier Group is to provide advice on how to better assure the uptake of the interactive innovation approach in European agricultural support services. One of the tasks of the group is to improve national and regional innovation support services within RDP and to suggest possible new operational schemes for the implementation of the EIP.

The project progress could add more insights as to how to address EIP, foster its operational translation in European countries and encourage the overcoming of institutional barriers to innovation uptake.
References


Agricultural networks across EU: what are the key features to enhance farmers' ability to learn and to innovate in cooperation with other actors?

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Abstract: Multi-actors networks are increasingly used by farmers to link between them and to be interactively connected with other partners, such as advisory organisations, local governments, universities and non-farm organisations. Given the importance assigned to the agricultural innovation by EU resorting to the networking between the research chain actors and the farmers, a strong focus on enhancing the creation of learning and innovation networks is expected. In this context it is relevant to have information about the features of such networks that enhance farmers’ ability to learn and to innovate in cooperation with other actors. The main goal of the paper is to contribute to the understanding of which features of agricultural or rural networks enhance the farmers' ability to learn and to innovate in cooperation with other actors, by identifying the influencing factors encouraging the farmers' enrolment and the influence of network stability. The additional goal of the paper is to provide insights into the way these networks link to R&D infrastructures and advisory services. Five case studies comprising heterogeneous networks were conducted in Italy, Germany, Portugal and the UK. The results highlight aspects that show decisively the networks’ ability to provide effective learning and innovation platforms, including bottom-up functioning, informality, leadership and power balance, along with the participation of facilitators when networks are large and heterogeneous. These networks focus on innovation exploitation and depend on the existence of a support subsystem, namely a functioning R&D and advisory services infrastructure. They can fill in gaps in this infrastructure, but they cannot replace it.

Keywords: Agriculture, knowledge and innovation networks, agricultural knowledge and innovation systems (AKIS), multi-actors networks, EIP-AGRI

Introduction

The role of 'horizontal' multi-actors networks for the rural development has been emphasised by Murdoch (2000). This type of network enhances farmers’ learning and innovation behaviour through social interaction and collaboration by joining heterogeneous actors (Hartwich & Scheidegger, 2010; Saether, 2010; Murdoch, 2000) and by enabling their link with formal external entities sourcing knowledge and information (Isaac, 2012; Klerkx et al., 2010; Prell et al., 2010).

On the other hand, the regional innovation systems approach (RIS) that envisages innovation as being the outcome of interaction and collective learning processes, which are systemic by nature and that take place in specific spatial contexts (Lundval, 1992; Cooke et al., 1997; Audretsch, 1998; Asheim, 1999), are now acknowledged, namely by the European Innovation Partnership on agricultural sustainability and productivity (EIP-AGRI), as the new paradigm to
promote innovation in the agricultural sector. The European Innovation Partnerships (EIPs) are a novel framework launched by the European Union (EU), in the context of Europe 2020 strategy for growth and jobs (CEC, 2013), to tackle major societal challenges, such as the sustainable increase in food production, by putting together the researchers and the innovation exploiting actors. The EIP-AGRI states that the multi-actors’ knowledge networks are the ground for innovation processes which take place at the territorial level. Hence, the EIP-AGRI activities focus on enhancing the networking of producers and users of knowledge, comprising farmers, researchers, advisors, business and other individual and collective actors whose interaction generates ‘new insights and ideas, and mobilise existing tacit knowledge into focused solutions’ (EU SCAR, 2013, p. 25).

The approach adopted by the EIP-AGRI emphasises the role of farmers as knowledge co-creators by creating and mobilising tacit knowledge. This approach is an alternative to the model of innovation-diffusion established by Rogers (1962). This model is based on a clear dichotomy of functions between researchers and farmers: researchers are the producers of scientific knowledge and technologies and farmers are the adopters of these technologies (e.g. new seeds, fertilisers, machines and equipment), which incorporate the scientific knowledge. Within this linear model of transferring knowledge, the advisors or extension technicians play a key function: the knowledge transfer between researchers and farmers, mainly in the form of new technologies (Schneider et al., 2012; Saether, 2010; Scoones & Thompson, 1994).

The EIP-AGRI approach, built on the interaction of heterogeneous actors and on the ability of different actor’s to co-create knowledge by mobilising tacit knowledge along with scientific and other forms of codified knowledge, is supported by the agricultural innovation systems theoretical perspective. The innovation systems and related research defines innovation as an outcome of open-ended interactions among heterogeneous actors combining knowledge from many different sources (Wood et al., 2014; Klerkx et al., 2010; Conroy, 2008; Klerkx & Leeuwis, 2008). In addition, other authors emphasise the importance of incremental innovation focused on problem solving (e.g. Kroma, 2006) or on the constant minor adjustments and improvements (e.g. Hall, 2009) that farmers make to be successful.

In rural areas networks are increasingly being used by farmers to link between them and to be interactively connected with other partners, such as advisory organisations, local governments, universities and non-farm organisations. Information and Communication Technologies (ICT) facilitate networking, namely when it is used to share and exchange knowledge. Given the importance assigned to innovation by the EIP-AGRI, and by the recent new wave of rural development programmes (RDP), a strong focus on supporting the creation of agricultural/rural learning and innovation networks is expected in the next few years. However, there is little knowledge on the features and configuration of the best performing innovation networks (i.e. those enhancing farmers’ innovation behaviour) which account for different problem-solving (e.g. adapting to climate changes, introducing novel crops or how to obtain incremental gains of productivity in mature sectors) and for different farming systems and farming styles across Europe. An additional, and relevant, research gap is the lack of knowledge regarding the interface between the networks that exploit innovation and the knowledge support subsystems that underpin it (Saether, 2010; Edquist, 2005), which comprise the R&D, education and training and advisory/extension regional infrastructures.

The FP7 EU project PRO AKIS encompassed among their goals exploring and identifying the possibilities, conditions and requirements of agricultural and rural innovation networks that
might constitute examples for the EIP-AGRI. A set of five case studies, for in-depth analysis, was selected across different European countries. Diverse networks were studied, addressing different problems with quite different configurations, which reflected the heterogeneity of problems and the regional contexts, namely the quality of R&D and advisory infrastructures which the network embeds on (Knierim et al., 2015).

A common methodological approach was followed in the different countries relying on: semi-structured interviews with the network members (or a sample of them) depending on the network’s size; interviewing actors from the R&D infrastructures and advisory services found relevant in the different cases and participant observation by attending meetings and events organised by the networks.

The main aim of the paper is to contribute to the understanding of which features of agricultural or rural networks show determinant to enhance the farmers' ability to learn and to innovate in cooperation with other actors, namely by identifying the influencing factors encouraging the farmers' enrolment and the influence of network stability. The additional aim of the paper is to provide insights into the way these networks link to R&D infrastructures and advisory services.

**Selection of the case studies and data collection methods**

The case studies were selected in each country based on an inventory at country or regional level (depending on the type of AKIS - centralised or decentralised) of the existing agricultural or rural knowledge and learning networks which showed innovative network models by themselves and appeared to have the features to enhance collaborative innovation.

The networks investigated (see Figure 1) included: (a) policy-induced agricultural innovation network in Brandenburg, Germany ('Adapting seeds to climate change'); (b) the 'Anti-Mafia innovation network: from land to fork' (abbreviated as 'Anti-Mafia') - a rural network situated in the Northern part of the Campania region in southern Italy; (c) the 'Cluster of Small Fruits' (CSF), a sectoral and nationwide Portuguese network; (d) a berry pest-monitoring local network, situated in the central-north of Portugal and (e) the 'Monitor Farms' which are farmer-driven networks set up by the Scottish Monitor Programme and implemented by the Scottish government with delivery partners including levy bodies such as Quality Meat Scotland (Madureira et al., 2015).

An exploratory-descriptive approach was chosen to gather information about the structure, content and dynamics of each network. Two different interview guides were constructed and applied through questionnaires, one for the network actors and the other for the facilitators. The interview guides were translated to involved country languages and applied through personal interviews. The number of interviews were around 30 for farmers and 15-20 for the advisors and actors from the advisory and knowledge infrastructure.
An exploratory-descriptive approach was chosen to gather information about the structure, content and dynamics of each network. Two different interview guides were constructed, and applied through questionnaires: one for the network actors and the other for the facilitators. The interview guides were translated to involved country languages and applied through personal interviews.

The case studies

**Policy-induced agricultural innovation network in Brandenburg, Germany**

This network was situated in Brandenburg and involved researchers, farmers, associations and a public authority. It was set up in the context of a project, funded by the German Ministry of Education and Research, and focussed on developing innovative strategies for adoption of practices to counter climate change. Concretely, the studied project and network aimed to test and evaluate crop seed varieties under different climatic conditions. The planned activities were carried out on time, and the project can be considered successful in terms of its realised activities and goals. After a stable working phase of five years, despite an interest in its continuation by a majority of its members, the network dissolved in 2014 due to a lack of available funds for any follow-up network. It was established and ran within a period of public service downsizing in related fields and with a complete lack of public advisory services.

In terms of agricultural production, a structure of big farms is characteristic for Brandenburg, as a result of the history of collectivised farming. In 2010, the average farm size in Brandenburg was 240 ha (compared to an average of 56 ha in Germany as a whole). The four participating farms collectively operate over 1000 ha, with the largest farm operating over approximately 500 ha. With this, they all fall into the biggest 6.4% of farms in Brandenburg. The four farms have professional management and are strongly market-oriented. More detailed information on this case study can be obtained in Boenning & Knierim (2014).
Anti-Mafia Innovation network: from land to fork! Italy

The Italian case study focusses on the emerging rural innovation network in the so-called Land of Fires, an area in the Northern Campania region (Southern Italy) that is infamous for the socio-economic and environmental impacts of more than two decades of waste crisis. The network involves cooperatives who work on land which has been confiscated from the Mafia: environmental activists, associations, public and private actors (citizens and companies) fighting against dispossession and contamination of territories, and against Mafia culture. The study analysed the "economic heart" of this emerging network which is also a smaller formal network: the consortium of five social agricultural cooperatives called NCO (Nuova Cooperazione Organizzata) that was founded in 2012. They practise mostly organic agriculture, avoiding pesticides and inorganic fertilisers, adopting crop rotation systems to replace nutrients in the soil. They minimise and recycle the farm waste making compost for fertiliser. The cooperative also tries to regenerate and use local seeds and plants, sometimes in cooperation with a regional research institute, becoming both users and custodians of biodiversity in connection with local knowledge and the farming communities. The NCO cooperatives advance social inclusion, through the agricultural work of disadvantaged people (those with mental health problems, former prisoners, immigrants and the unemployed), with the ambition of becoming sources of "ethic economic wealth". In addition, they focus on direct selling by getting closer to consumers to build a short food supply chain. The innovative land use of NCO involves a cognitive and cultural re-orientation that assumes a purely non-instrumental relationship with the environmental and territorial resources, the labour force and with consumers.

In spite of the existing regional agricultural advisory services, which are still publicly funded, the network lacks specialised technical advice and extension services for organic farms, which the cooperatives mainly access through external sources and informal channels (other cooperatives and farmers). Other relevant sources for knowledge and information are downstream firms and organisations, such as plant and seed suppliers and private control bodies for organic certification. More detailed information on this case study can be obtained in Caggiano (2014).

The berry networks in Portugal

The Portuguese case studies included: the Cluster of Small Fruit (CSF) and the Drosophila Suzukii Monitoring (DSM) network. The first is a horizontal nationwide sectoral network established in 2013; its coordination structure comprises the main facilitators of knowledge sharing and diffusion processes. It is composed of both experienced and inexperienced producers and a diversified set of other actor such as private agricultural advice companies, independent consultants, several FBOs (cooperatives, farmers' groups and associations) and up and downstream industry firms, amongst others.

The DSM network, established in 2014, is a regionally located, hierarchical but informal network led by a coordinating body (Regional Agency of the Ministry of Agriculture) which also involves farmers and facilitators.

The CSF network involves the full range of actors in the berry production sector and is itself instrumental in organising the sector, specifically the knowledge and information supply to meet the current heavy demands of farmers and their organisations. It may be considered a relevant case study in the Portuguese AKIS context, not only because of its national and
sectoral importance, but also due to its unique position: on the one hand it shows how farm-based organisations (FBOs) and private advice can organise themselves in order to meet farmers' needs and demands and, on the other, it identifies these organisations' limitations in providing quality support to a novel and knowledge-intensive sector.

The second network, DSM, presents a model designed to create and store local-specific knowledge that is fundamental at both the regional and sectoral levels (when dealing with crop pest-monitoring) and one that engages farmers in the process of co-creating knowledge. The DSM is geographically a well-defined network, located in the central-northern region of Portugal. The network is co-ordinated by a public regional agency of the Agriculture Ministry and the members are farmers, mostly inexperienced berry producers, who were selected by the FBOs and private firms that they (the producers) are linked to. The private firms act as facilitators, identifying the farms which are suitably located for field experiments and the farmers who are actively exchanging knowledge as well as having the ability to implement and maintain the scientific experimental tests designed to detect the *Drosophila suzukii* (the insect pest responsible for devastating this crop) and to store and report the data collected. More detailed information on this case study can be obtained in Madureira et al. (2014).

**Monitor farms in Scotland, UK**

In the Scottish case study 'monitor farms' were investigated as an example of an agricultural innovation network. The Scottish Monitor Farms Programme is delivered by the Scottish Government in collaboration with delivery partners. Delivery partners include levy bodies (Quality Meat Scotland, DairyCo and Home Grown Cereal Authority), National Farmers' Unions Scotland and the Scottish Organic Producers Association. Between 2009 and 2013, 18 monitor farms were established by the Scottish Government and the delivery partners. To date a total of 40 monitor farms have been initiated in Scotland, funded mainly through the Scottish Government's Rural Development Programme Skills Development Scheme. The monitor farm strategy stated that improvements to knowledge transfer to the Scottish agricultural industry lay at the heart of the programme.

Different farmer types participate in the monitor farm network, representing the range of enterprises in the geographical area of the monitor farm, as well as young farmers and new-entrant farmers. Many participants were known to each other prior to the initiation of the network, from other groups or memberships, or from farming in the same area. The selection of topics covered in the monitor farm meetings is relatively farmer-led as they are determined by the management group made up of 5-8 participating farmers that want to become more involved.

There are many links between the monitor farm programme and existing knowledge and advisory services, not least due to the role of the programme facilitators (many of whom are agricultural advisors), and through the wider network including invited specialists, industry representatives and student/researcher attendees. The network provides an opportunity to bridge gaps in advisory services, for example, providing practical on-farm demonstrations. As the objective of the monitor farm network is to develop best practice through on-farm changes, the processes and dynamics developed to generate and exchange knowledge for co-innovation focus on communication, knowledge exchange and co-creation, for example through the informal discussion and sharing of ideas and experience between monitor farm participants. More detailed information on this case study can be obtained in Creaney et al. (2014).
Results

The networks configuration: structure, goals, actors and their interaction

Table 1 presents a comparative description regarding the main features defining the structure of the five studied networks. It illustrates their diversity with regard to the contexts of their origins and its establishment. It is noteworthy that even in those cases where the initiative for the network creation was top-down these tend to function through a bottom-up approach, with a prevalence of horizontal and a mix of formal and informal interactions (see Table 2).

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Leadership</td>
<td>Science-led network</td>
<td>Cooperative-led network</td>
<td>Farmers-led network</td>
<td>Facilitator-led network</td>
<td>Farmer and facilitator-led network</td>
</tr>
<tr>
<td>Funding</td>
<td>Public funding</td>
<td>Self-funded</td>
<td>Public</td>
<td>Self-funded</td>
<td>Public with industry contributions</td>
</tr>
</tbody>
</table>

Source: adapted from Madureira et al., 2015
Most of the networks are individual, one-off or even ad hoc initiatives, with the exception of the Monitor Farms programme in Scotland. This suggests that networks are still not regarded as essential collective learning, advisory and co-innovation tools for agriculture and rural
development, or that the official frames within which they sit do not fit the needs of the actors on the ground.

Figure 2 depicts, in a simplified way, the respective interactions of the main actors in the knowledge flows underpinning the various networks.

Figure 2 also illustrates the configuration of each of the studied networks, highlighting its boundaries, type and diversity of actors involved and their main interactions in terms of knowledge flows. The policy-induced innovation agricultural network in Brandenburg (‘Adapting seeds to climate change’) has well-defined boundaries due to its formality as a result of being a research-project based network, led by scientists and involving a lower number of participants. In contrast, the ‘Anti-Mafia innovation network’ is not a clearly bounded network, involving a multitude of actors, both in type and number that interact in a multi-directional way through formal and informal communication channels. The stability of the network is assured by the well-defined leadership structure defined by the cooperatives consortium that acts as the turntable of the multiple and diverse knowledge flows underlying the broader network. The main knowledge flows in the ‘Cluster of Small Fruits’ underline the presence and role of small-scale and inexperienced farmers. These farmers demand knowledge and information from the interaction opportunities provided by the network, either in an isolated manner or jointly with private and farmer-based producer groups, both formally and informally. This is not a bounded network, but involves knowledge flows into and out of the network, namely involving pioneer innovation-led farmers that demand knowledge from outside the cluster e.g. from R&D institutions with ICT resources. In this case, a core structure is fundamental to ensure the functioning and stability of the network, composed of four diverse but complementary actors: a sectoral farmer-based organisation, two R&D entities and an internationalisation facilitator organisation. The knowledge flows underlying the ‘Berry pest monitoring’ shape clearly this network. This is not surprising given that the main goal of this network is the co-creation and storage of explicit knowledge. The overall picture of knowledge flows in the ‘Monitor Farm’ networks relies on a diverse group of farmers and other actors gathering around the ‘monitor farm/farmer’.

**Influencing factors of the farmers’ enrolment and of the network stability**

The absence of fees as well as the informal nature of the enrolment into the network appear to be key aspects of the farmers’ enrolment in the networks. We noted that farmers are generally willing to bear travelling expenses and time opportunity costs, and appear to be satisfied with the gains of their participation, namely in the cases of Monitor Farms and the Portuguese berry networks. An additional factor relevant to the farmers’ enrolment is the existence of previous informal relational capital and trust (social capital), which also shows determinant to the network stability (Madureira et al., 2015).

The previous inter-personal and professional relationships and mutual understanding between the farmers and the scientists involved within the ‘Adapting seeds to climate change’ network was decisive for the enrolment and stability of the network (Boenning & Knierim, 2014). In the case of the ‘Anti-Mafia’ network, previous contacts, interactions and inter-personal relationships between the founder cooperatives have also shown to be helpful in building the trust needed to establish the consortium. In the broader network, led by the consortium, stability comes from shared values derived from anti-mafia attitudes and belief in a social alternative economic model to the sustainable development of the region of the ‘Land of Fires’ (Caggiano, 2014). The inter-personal relationships and trust amongst the pioneer berry
producers and strong ties with researchers and other actors (such as advisors and traders), has been a critical feature to enable coping with the tensions and imbalances present in this network. These are due to the participation of a large number of inexperienced farmers, with knowledge needs and demands, who are very dependent on the pioneers and their informal networks for support.

The ‘Monitor Farm’ networks in Scotland also provide evidence regarding how farmers value informal and neighbourhood connections. Previous personal and professional relationships and contacts enhance the adherence of farmers to the monitor farm (and respective farmer). The social aspects of participation appear to be of special value in this case, where the ‘free meal’ and opportunity to socialise with friends and acquaintances, as well as to enhance personal social networks, act as a determining enrolment factor (Creaney et al, 2014).

The value that farmers assign to previous informal relationships and to the opportunity to socialise with peers and other experienced professionals provided by the networks should be highlighted given that it can be shown to be a determinant feature in the success and effectiveness of learning and innovation within agricultural and rural networks.

A further important aspect related to the networks’ dynamics in terms of their social cohesiveness is how they address tensions, namely around cooperation versus competition, when the members (i.e. farmers) are competitors. In this case, previous relational and trust capital showed to be a decisive factor, although this tension can be surmounted by identifying and focussing on shared goals (Madureira et al., 2015).

**Network linkages with the R&D and advisory services infrastructure**

The linkages between the different studied networks and the respective national and/or regional R&D and advisory services infrastructure is summarised in Table 2.

**Table 2: Links between networks and knowledge and advisory infrastructure**

<table>
<thead>
<tr>
<th>Networks</th>
<th>Public Advisory Sector</th>
<th>Research and Education</th>
<th>Private Advisory sector</th>
<th>FBOs</th>
<th>NGO</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘Adapting seeds to climate change’, DE</td>
<td>○</td>
<td>o</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>‘Anti-Mafia’, IT</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>‘Cluster of Small Fruits’, PT</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td></td>
<td></td>
</tr>
<tr>
<td>‘Berry pest monitoring’, PT</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td></td>
<td></td>
</tr>
<tr>
<td>‘Monitor Farms’, Scotland</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Legend:**

○ Links  
○ Main links

*Source: Madureira et al., 2015*
The links identified in Table 2 underline the networks’ ability to mobilise and to integrate this infrastructure (R&D and advisory sector) in two alternative directions: (a) benefiting from it in situations where advisory services are present, as is the case with the Monitor Farms in Scotland and (b) benefiting advisory services by filling gaps resulting from the weakness or even absence of advisory infrastructures due to public services downsizing policies, such as is the case of the Portuguese berry networks and the ‘Adapting seeds to climate change’ network in Brandenburg region.

The role of place-based innovation networks for the creation of local knowledge (scientific and synthesised) is underlined by the cases of ‘Adapting seeds to climate change’ in Brandenburg region, the ‘Berry pest monitoring’ in the centre-north of Portugal and the ‘Monitor Farms’ in Scotland.

Cross-country comparison of the cases studies

All the networks involved the cooperation of a varied range of actors, providing examples of multi-actor networks which enhance the farmer’s innovation capacity in cooperation with other rural (and non-rural) actors through social interaction and collective learning. The studied networks were all, with the exception of the Italian case, focused on the agricultural sector. The ‘Anti-Mafia’ was a rural network involving and integrating a diversity of sectors, including social and health care, agriculture and ecological restoration.

None of the selected networks has received support from the respective country’s Rural Development Programmes (RDPs). The innovation network for developing climate change adapted seeds (in Germany) and the Monitor Farms in Scotland were funded through national funds. The Portuguese ‘Cluster of Small Fruits’ (CSF) network was funded by EU structural funds. The NCO cooperatives that constituted the core of the Anti-Mafia innovation network decided to invest in agriculture as a way to give economic sustainability to the network, by reducing its dependency on public funds for health and social services that are often delayed and discontinued. The Drosophila suzukii Monitoring (DSM) network case in Portugal was not funded by public or private funds, and depended on the voluntary time and work contributions of the involved actors (researchers, technicians, facilitators and farmers).

A common denominator across the networks studied, with the exception of the Italian case study, is that they all filled gaps in Agricultural Knowledge, Information and Innovation System (AKIS) in the regions and/or sectors in which they are situated. The network studied in the Italian case also filled a gap in the regional/local AKIS (advice for organic farms), although the reasons for the establishment of this network were rather different and broader in comparison with the other case studies. The four cases illustrated quite diverse network models reflecting the agricultural/rural diversity across Europe, the different AKIS at regional/national level, and the diversity of problems and potential solutions that the innovation agricultural/rural networks can address.

The comparison of case studies highlighted that multi-actors’ networks are actually able to deliver advisory services within innovative formats that overcome some of the limitations of the conventional advisory systems. They enable multi-topical advice, enhance the farmers’ role as creators, co-creators and converters of knowledge, and reduce the distances (geographical and cognitive) between farmers and other actors such as researchers and experts. It also showed that somewhat different network arrangements are possible to address similar problems/solutions. This diversity is due to contextual differences and the available options (e.g. with regards to funding).
Concluding remarks

The set of selected case studies illustrates a diversity of knowledge and innovation networks regarding their goals, structure, and the number of actors and the type of their interactions. However, they all show that multi-actors' networks are in fact an effective tool to bridge the actors from the research chain with the farmers, advisors and other rural stakeholders, by reducing cognitive distances between these heterogeneous actors and valuing tacit and local-based knowledge. How might these ties and interactions be reinforced? The evidence gathered suggests that there are aspects in the network’s configuration which influence the farmer’s decision to enrol and to develop the ability to learn and innovate in cooperation with other actors. These factors include the following:

- Bottom-up functioning, in spite of the more or less hierarchical structure of the network, bottom-up functioning has shown to be a ‘natural’ feature of these networks, explained by the way they work, with little degree of formalised ties and interactions, but focused on a well-defined and shared goal.

- The informality of the ties and the interactions is very much valued by their members and allows linking the network with a number of knowledge and information flows related to other formal and informal networks where the actors participate too, increasing the network performance in terms of farmers capacity building for learning and innovating.

- Networks need a good leadership power balance and this tends to rely on previous relational capital amongst the core members of the network, inter-personal and institutional trust, along with personal leadership abilities.

- The networks comprising a high number of actors, in particular when they are heterogeneous e.g. farming styles, cognitive abilities related with learning and innovation, or farming structures, need good facilitators who need to be persons (or entities represented by persons) able to facilitate actors’ involvement and their interaction.

The linkage between these knowledge and innovation multi-actor networks and the R&D and advisory service infrastructure, has shown they are often filling the gaps on the regional AKIS, derived from the disinvestment in many of the EU countries on applied research (e.g. the seed trial or the demonstration fields) and on the public advisory services (Knierim et al., 2015). However, they cannot replace these infrastructures and they actually depend on them. Networks filling these gaps, such as the ‘Adapting seeds to climate change’ in Brandenburg region or the Portuguese berry networks, depend on key actors linked to these infrastructures, evidencing that these are their underpinning support subsystem. The flexibility and informality demanded by the innovation networks is not compatible with using them to replace structures needing regular funding and continuity in their activities.

Acknowledgements

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References


New knowledge networks of small-scale farmers in Europe’s periphery

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Abstract: In this paper we assess the integration of new entrants to small-scale farming into agricultural knowledge and innovation systems (AKIS), in four study sites located on Europe’s periphery (Bulgaria, Poland, Portugal, and the United Kingdom). Utilising qualitative case studies undertaken in 2013, we assessed the knowledge acquired to inform three new activities being undertaken by study participants: agricultural production; subsidy access and regulatory compliance; and farm diversification (specifically agritourism). Findings were assessed in relation to network structure, demonstrating clear patterns in new knowledge access: formal ‘agricultural advisors’ identified in the case studies were sought primarily for codified managerial knowledge which was delivered through centralised networks. In contrast, production and diversification knowledge were exchanged through ‘distributed’ and ‘decentralised’ networks, where a range of actors were involved across varying geographical distances. Findings thus suggest that state-funded services for small-scale farmers are largely embedded in traditional, linear models of knowledge transfer, and confirm earlier research that small-scale farmers are under-serviced by formal advisory services. However, new entrants employ more flexible, multi-actor approaches to production and diversification, much of which was ‘free’ in terms of financial cost, but not necessarily freely available to those without substantive social capital lodged in communities of place and practice. In all four cases, we found that small-scale farmers utilise formal advisory services primarily for accessing subsidies (e.g. completing application forms), rather than acquiring production knowledge. The authors argue that by utilising the limited state funding allocated to advisory services for small-scale farmers primarily to enable these farmers to access subsidies, important opportunities for the ‘generation of space for innovation’ can be lost.

Key words: AKIS, farm advisory services, networks, new entrants, PRO AKIS

Introduction

Small farms play key roles in maintaining the environment, society (including employment) and culture (preserving traditions, manufacturing traditional products), as well as creating favourable conditions for animal welfare (European Parliament resolution of 4 February 2014 on the future of small agricultural holdings (2013/2096(INI), 2014). These contentions are supported by special provisions within the European Union’s Rural Development Programme (RDP) to promote farm development and business diversification (e.g. the Small Farmer Scheme and RDP funding to provide economic development advice to small-scale farmers, European Commission, 2013). Despite this recognised importance of small-scale farming, structural changes in European agriculture favour larger-scale farms (Zegar, 2012; European Commission, 2011). Smaller scale farms not only lack economies of scale, they are more...
likely to be occupied by older, less business-oriented farmers (Zagata & Sutherland, 2015) and frequently represent semi-subsistence farms (Davidova et al., 2013), which function primarily as buffers against poverty rather than as productive commercial businesses.

Widespread privatisation of agricultural advisory services across Europe in recent decades has further disadvantaged small-scale farms: as Kidd et al. (2000) point out, private advisory services may disproportionately serve those who can afford them (i.e. larger scale farms). In line with this, Labarthe & Laurent (2013) argue that reduction in public extension services across Europe has disproportionally impacted on small-scale farms, which are less visible as clients. A review of the Farm Advisory Services similarly found that the main beneficiaries were large-scale farms (European Commission, 2009). The Farm Advisory Service (FAS) review also found that in 14 member states, advice on Cross Compliance was the sole focus of the FAS (European Commission, 2009). The FAS review thus implies a transition towards advisory services focused on ‘managerial knowledge’ (i.e. the knowledge and skills to manage resources, grants, legislation and bureaucracy, Koutsouris, 2008), rather than adoption of new technologies. The report thus provides evidence that in many European countries the role of the FAS in ‘generating spaces for innovation’ is limited to enabling access to funding.

Although important, access to the FAS represents only one aspect of contemporary agricultural knowledge systems. Agricultural innovation is conceptualised as occurring through networks, including entrepreneurs, researchers, consultants, policy makers, suppliers, processing industries, retailers and customers. Recent research has emphasised that both local knowledge and scientific knowledge are important for achieving sustainability in agricultural systems (Curry & Kirwan, 2014; Kania & Kaplon, 2014; Labarthe & Laurent, 2013). Instead, innovation and up-take of new farming technologies or practices are widely accepted as resulting from iterative engagement in nonlinear knowledge networks or systems.

In this paper, we focus on newly established knowledge networks of small-scale farmers. Integration into new networks for the purpose of gaining knowledge suggests active intentions to change farming practices, adopting new or established innovations. To ensure the assessment of new knowledge networks, the research focused primarily on new entrants to small-scale farming. The research is structured to address the types of knowledge small-scale farmers access, the types of networks characterising these new networks and the role of formal advisory services in these networks. We demonstrate this through research on three major knowledge topics: commodity production; access to subsidies and business diversification knowledge (specifically agritourism).

**Conceptualising new knowledge networks**

The concept of ‘agricultural knowledge and information systems’ (AKIS) was developed and widely popularised in the 1980 and 1990s, comprising the idea that farmers exchange and produce knowledge in conjunction with a number of sources, which include research, agricultural advisors, and education/training and support services (Röling, 1988; Röling & Wagemakers, 1998). Röling & Endel (1991) defined AKIS as:

“The persons, networks and institutions, and the interfaces and linkages between them, which engage in or manage the generation, transformation, transmission,
storage, retrieval, integration, diffusion and utilisation of knowledge and information, and which potentially work synergistically to improve the goodness of fit between knowledge and environment, and the technology used in agriculture”.

In recent years the AKIS concept has been appropriated to address European policy concerns about innovation, and re-termed ‘agricultural knowledge and innovation systems’, reflecting an ideological shift towards innovation (Dockès et al., 2011). Within the overall AKIS concept, a number of different conceptualisations of information, knowledge, types of knowledge and innovation can be operationalised (i.e. the AKIS construct is overarching, rather than presenting an established conceptual approach). When assessing knowledge exchange and development, two general forms of knowledge are typically identified: tacit (implicit) and codified (explicit) knowledge, a distinction which can be traced back to Polanyi (1958). Implicit knowledge or ‘know how’ is acquired through practice and experience, and is not necessarily related to cognitive learning (e.g. riding a bicycle). In contrast, explicit or codified knowledge can be easily reported and documented (e.g. through scientific reports), although it may require translation into more adapted knowledge, suited to practical application (EU SCAR, 2012). Nonaka and Toyama (2003) identified four types of knowledge creation which ideally follow on from and build upon each other:

- Tacit or implicit knowledge is acquired through socialisation, which means that the learning person is directly and actively exposed to an environment that induces personal experiences (i.e. ‘hands-on learning’).
- Through communication about these experiences, tacit knowledge is articulated and becomes explicit – a step that is called externalisation.
- Sharing this explicit knowledge with knowledge from other people, systemising and integrating it, requires combination activities.
- Then, using the explicit and combined knowledge practically in new situations induces a fourth ‘embodying’ step, called internalisation, where the (new) knowledge becomes tacit or implicit at a higher level (Nonaka & Toyama, 2003)

As such, tacit knowledge most easily spreads within social networks, which enable the collective sharing of ideas and activities for common aims. In contrast, codified knowledge translates mental frameworks into symbols, and is therefore more easily made explicit (e.g. through textbooks and websites) (Knickel et al., 2008).

The different types of knowledge are associated with different types of network. Smedlund (2008) draws on Baran (1964) and Barabási (2002) to identify three primary types of networks, which link to different types of knowledge. Centralised networks, featuring a central node through which all knowledge flows, are most useful for ‘routine problem solving’ (e.g. explicit, standardised knowledge, such as advice on general regulatory issues). Codified knowledge is most likely to be transmitted in this type of network, representing ‘know why’ and ‘know what’. A central node can channel this information (e.g. an agricultural advisor), or individuals can access it directly, through transmittable sources such as books and websites. In contrast, ‘distributed networks’ are dense networks of ties where primarily tacit knowledge is exchanged. Distributed networks resemble ‘communities of practice’ or ‘networks of practice’ (e.g. peers who exchange personal knowledge to varying degrees). As such, these networks depend on ‘social capital’ – simply defined as “networks together with shared norms, values
and understandings that facilitate co-operation within or among groups” (OECD, 2001:41). The third type is decentralised networks, with multiple nodal points connecting diverse individuals. Decentralised networks thus involve knowledge from outside of peer groups to connect disparate groups and their associated knowledge. Smedlund (2008) associates this type of network with the acquisition of what he terms ‘potential knowledge’ (e.g. of future or cutting edge innovations). Gatekeepers link diverse groups; brokering these boundaries can be an important function. These types of networks are characterised as being in constant change and asymmetric, as the actors involved have considerable differences (e.g. business size). Klerkx & Proctor (2012), in their empirical application of Smedlund’s work, found that the distinctions are less distinct in practice.

Methods
In this paper, we assess the knowledge embedded in new farming networks in four contrasting case studies in Poland, Bulgaria, Portugal and the United Kingdom. The cases were selected as part of the PRO AKIS (Prospects for Farmer’s Support: Advisory Services in European AKIS) 7th Framework Project, funded by the European Commission. The selected case studies addressed a diverse range of small-scale farmers. They include new-entrants and semi-subsistence farmers in Plovdiv region, Bulgaria; small-scale farmers diversifying into agritourism in the Carpathian Mountains of Poland; newly established small-scale blueberry producers in the central-north region of Portugal; and new-entrants to crofting on the west coast of Scotland (UK). The four cases have in common the establishment of new knowledge networks1, as well as the small scale of the farms involved relative to national farming characteristics. We have not attempted to standardise a definition of small-scale farming, utilising instead the accepted definitions of small-scale farming in the study sites. As Davidova et al. (2013) note, there is no commonly accepted definition of a small-scale farm.

Table 1: Study participants

<table>
<thead>
<tr>
<th>Farming participants</th>
<th>Stakeholders/Key Informants</th>
<th>Age range of farmers</th>
<th>Farm size</th>
<th>Main Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulgaria</td>
<td>17</td>
<td>4</td>
<td>Under 40</td>
<td>3-6 ha</td>
</tr>
<tr>
<td>Poland</td>
<td>15</td>
<td>5</td>
<td>All ages</td>
<td>3-9 ha</td>
</tr>
<tr>
<td>Portugal</td>
<td>25</td>
<td>6</td>
<td>Under 40</td>
<td>Less than 1.5 ha</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>21</td>
<td>8</td>
<td>All ages</td>
<td>0-20 ha plus common grazing</td>
</tr>
</tbody>
</table>

Owing to the differences in land capability, the definition of small-scale farming applied in this research ranged from less than 1.5 ha in Portugal to less than 20 ha in the United Kingdom (not including access to common grazing of over one hundred ha in some cases). The case studies also represent different ‘types’ of small-scale farm: semi-subsistence farms were most common in the Bulgarian case, small-scale commercial farms particularly evident in the Portuguese case and to a degree in the other three countries, and hobby farming - more

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1 In the UK, Portuguese and Bulgarian cases, the farmers interviewed were new entrants. In the Polish case, the study was of existing farmers who had recently diversified into tourism provision i.e. new entrants to agritourism, rather than farming per se.
common in the UK case. Owing to the diversity of production systems across the four cases, not all case studies explored networks relating to all three topics. A joint analytical framework was developed collaboratively by the researchers to ensure that the interviews had sufficient similarity in terms of topics covered for comparative analysis. Findings were analysed qualitatively according to the analytical framework, and compiled into English-language reports which followed a standard template (www.proakis.eu). This paper is based on those reports.

Case studies
In all four cases, research was undertaken in regions where there are larger scale farms, but small-scale farms are common. In all of the cases, both public and private advisory services serve small-scale farms as a subset of the total farming population in the associated region. For further information on each individual case, see the PRO AKIS website (www.proakis.eu).

In Bulgaria, the case study focused on young people accessing RDP funding to establish new farms (typically small-scale vegetable or orchard production) in Plovdiv Region. Owing to the restrictions on new entrant supports (Measure 112), the study participants were all less than 40 years old with newly established farms and were undertaking farming on a full-time basis, primarily on rented land. The average size of the farms in the region is about 6.8 ha.

In Portugal, the case focused on new entrants who were taking up small-scale soft-fruit production (i.e. blueberries) in central northern Portugal. The crop was introduced to the region in the 1990s, with limited success. Efforts were renewed in the late 2000s, through initiatives developed by local governments to utilise RDP Measure 112 to address unemployment and land abandonment. Owing to the small geographical scale of most horticultural enterprises, to identify small-scale farms the Portuguese sample was restricted to small-scale blueberry producers with less than 1.5 hectares, earning less than 25,000 Euros/year from agricultural production, and who had established their farm post-2007, with
at least one harvest. These farmers market their produce collectively into international markets, certified by GlobalGAP.

In Poland, the research focused around advisory service provision to small-scale farms which were developing agritourism enterprises in the Carpathian Mountain region. The participants in the Polish case were located in three Carpathian provinces (Malopolska, Podkarpackie and Silesia) and selected to represent a range of agritourism providers which had been operating for between 3 and 16 years.

In the United Kingdom, the case study centred on new entrants to crofting, a traditional form of small-scale farming (typically involving sheep and cattle production, but also tourist accommodation and market gardening) on the islands of Skye, Harris and Lewis (Scotland). Participants could be of any age, but were selected on the basis that they had occupied a legally established croft for less than 12 years.

Characterising new knowledge networks
The research focused on knowledge networks associated with three topics: state grants and subsidies, commodity production, and diversification into agritourism. It is important to note that all of the farmers in the study accessed a number of different sources of knowledge. The associated networks evolved over time, typically starting with a single entry point, based on recommendations from family or neighbours. As such, the networks presented here overlap and have been simplified for presentation purposes.

Accessing grants and subsidies
Knowledge enabling access to subsidies can be termed ‘managerial’ knowledge (Koutsouris, 2008), in that it relates primarily to completion of administrative forms. Subsidies accessed included measures to support young farmers, subsistence farming, agri-ecological measures, diversification, local development and the single farm payment. Assistance with completing these applications was usually supplied on a one-to-one basis with a formal agricultural advisor, typically working either for the state advisory service or a private advisory company. In a few cases the applications were completed by NGOs (e.g. environmental charities assisting with applications for agri-environmental grants). For both private and public sector advisory services, the applicant typically had to pay a fee or percentage of the resultant grant to the advisor. The exception was Bulgaria, where public advisory services provide this assistance cost-free, but payment is required for use of private consultancy companies.

Knowledge of state subsidies represents ‘codified knowledge’, with the guidance notes and application forms publically available through websites. Owing to the perceived complexity of these applications, the small-scale farmers in this study typically opted to have experts complete their forms for them. This was despite the online availability of information and a high level of educational achievement; participants also reported working with advisors out of fear of making mistakes, not wishing to jeopardise an important source of farm income. The function of the advisory services thus becomes to ‘translate’ the codified knowledge available on state websites into usable form, which then led to successful applications. Form completion is offered as a service - the advisor simply completes the form using data garnered from consultations with the farmers involved and their own tacit knowledge; externalisation of this tacit knowledge and translation into a form usable by the farmer does not appear to occur -
the skill of form completion remains with the advisor. As such, the networks formed are centralised in nature, with advisors acting as central knowledge hubs. The farmers involved thus return annually for similar services.

Small-scale farmers have a choice of who to go to for assistance in accessing subsidies and grants (i.e. ‘know who’). For those establishing new farm holdings, this is often the first point of entry into formal knowledge systems; new farmers typically act on recommendations of family members and neighbours, who base their recommendation on the successfulness of their own past applications (i.e. ‘know who’ based on reputation for ‘who how’). Facilitating subsidy access was the primary use of state agricultural advisory services by study participants: state-funded advisors in Bulgaria, Poland and the UK reported spending the majority of their time on these tasks. In Portugal their role was minimal, owing to a very limited availability of state advisory services in general. In each of the countries, private advisors also offer these services, utilising different fee for service models. In Bulgaria and Portugal, fees for service are based on the success of the grant application – payment is proportionate to the amount of funding received, whereas in Scotland, there is a one-off fee for the application. In both cases, the fee for service creates an incentive to write a fundable application, rather than one which particularly suits the farm set-up or farmer’s skill, owing to the desire for customer retention. There is also an incentive to go with ‘tried and true’ options (i.e. a tendency not to innovate), as evaluators are more likely to fund established approaches.

Accessing production knowledge
In contrast to subsidy access, there is a wide variety of means to access production advice, including formal education, training courses, open days, work experience, magazines, books and through the internet. Study participants also accessed advice from public, private and NGO-funded agricultural advisors, agricultural pharmaceuticals stores, neighbouring farmers, family members with agricultural experience, accountants or accounting companies, seedlings importers, processors, scientific institutes, producer associations and non-governmental associations. This section presents findings from the Bulgarian, Portuguese and UK case studies.

By far the most common source of production knowledge in the Bulgarian and UK sites was friends and neighbours (i.e. tacit lay and local knowledge). As such, the knowledge was located primarily in distributed networks of dense interpersonal ties. Portugal was an exception because blueberry production is new to the region – there was therefore limited local knowledge on which to draw. In this case, the creation of an education and mentoring group (the ‘Small-Fruits Cluster’ (SFC)) by farm business organisations and profit and non-profit producers groups, translated and disseminated knowledge to new entrants. Because the blueberries were marketed jointly at national level, poor standards of production in the study site were negatively impacting on the overall reputation and quality of Portuguese blueberry production, marketed jointly through GlobalGAP; experienced farmers from southern Portugal were thus motivated to act to address this problem in central Portugal, forming and participating in a decentralised network.

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2 Although the former state-funded advisory services in the UK are now largely privatised, SAC in Scotland continues to receive a block grant from the Scottish Government to subsidise advisory service provision in remote rural areas.
In all three sites, provision of production advice was a secondary activity for state-funded advisory services. In both Portugal and Bulgaria, advice on production was part of the ‘package’ of services available to participants who had already achieved RDP funding. However, almost all of the Bulgarian respondents indicated that although they retained their relationships with their formal advisors for advice on business planning and project implementation, they were not using them for their production activities. In Portugal, the study participants indicated that they would have liked to access production advice from the state advisory sources (i.e., it was a trusted source) but this was no longer available. The quality of production advice provided by private consultants to the blueberry producers in the Portuguese case study was highly questioned, owing to their lack of practical experience: the advisors were perceived as invested in securing the success of the application, but were less concerned about choice of varietals or adapting the business plan to land capability, leading to substantial complaints by study participants. Instead, the SFC was specifically established to address the problem of poor quality production knowledge being transferred from private advisors to new entrant farmers. In Scotland, state-funded agricultural advisors were more likely to be identified as credible sources of knowledge relating to production, because many of the advisors were operating their own crofts. They thus achieved credibility through a combination of codified and tacit knowledge, although in some cases this tacit knowledge was not deemed sufficient to address location-specific production issues. When small-scale farmers did access advisory services for assistance with production, it was typically to acquire specific pieces of codified knowledge, such as soil analysis. State advisory services in Scotland and Bulgaria were also involved in facilitating the spread of tacit and codified knowledge through group events (e.g., farm open days). In Portugal, this function was fulfilled by farming organisations. As such, advisors were involved in knowledge brokering, enabling the externalisation of tacit knowledge through targeted combination activities.

A further issue for small-scale farmers was the cost of advice. Study participants reported that private consultancy companies are not often accessed by small farmers for production advice because it is perceived as expensive. Instead, input suppliers, such as agro-pharmacy stores, accounting companies, and import trade organisations are accessed. In Bulgaria, there is an agro-pharmacy store in almost every village and small-scale farmers use such stores not only for acquisition of the required inputs but also for consultancy on various diseases or pests on the plants they grow. These consultancies are generally cost-free, but linked to purchase of recommended inputs. As trained agronomists located in the local community, they combined tacit and codified knowledge, and were part of the farmers’ distributed networks.

This combination of tacit and codified knowledge was similarly sought out when accessing the expertise of friends and neighbours. A pattern of overlapping roles, or ‘hybrid knowledge’ amongst chosen local advisors was observed. For instance, recently some of the longer term Portuguese blueberry producers have become private advisors and/or project developers and may also be members of the board of a farmers’ association. Consequently, the same individual often acts as a facilitator, a supplier and a demander of knowledge and expertise within the network – thus engaging with multiple roles in the distributed network. In the UK site, local veterinarians who are also crofters can provide this combined knowledge. The distributed networks characteristic of production knowledge networks thus include a range of actors, primarily based on tacit knowledge but also including a degree of codified knowledge. However, this knowledge was not automatically available to everyone who wished to join the networks, particularly in the Scottish case; longer term crofters were not always willing to share
their expertise with newcomers. In these cases, social capital associated with long-standing family relationships was necessary to activate these connections.

Within this range of actors in the network, knowledge of recent scientific or technological advances is peripheral – relatively few innovations in production were introduced. The knowledge exchanged by farmers was primarily tacit (i.e. the ‘know how’ associated with animal husbandry and horticultural production). However, in some cases, farmers also sought codified knowledge directly from source material (e.g. blueberry producers searched for new varietals online).

**Accessing knowledge about farm diversification**

In the cases studied, provision of tourist accommodation was the most common form of diversification, but ‘agritourism’ can also include tourism packages, educational farms, and farms for children and seniors. We focus here on knowledge relating to developing tourist activities and marketing. Knowledge on these topics can be acquired through individual consultations, workshops, study trips, training, and cooperative networks. In this section, the data comes from the Poland and UK case studies.

The two cases represent opposite extremes in terms of organised state involvement. In Poland, the National Agricultural Advisory Centre – a governmental institution subject to the Minister of Agriculture and Rural Development - is responsible for collecting and processing knowledge, and then transferring it to advisory institutions that directly interact with farmers. The Branch of Agricultural Advisory Centre in Krakow has specific responsibility for both rural tourism and agritourism. Knowledge related to agritourism and innovative activities are transferred initially to specialists at provincial Agricultural Advisory Centres, as well as representatives of Agricultural Chambers, agritourism associations, and, since 2004 (when Poland joined the EU), with Local Action Groups. There is thus a largely centralised network within the Polish advisory system, which transfers knowledge between divisions and ultimately to farmers directly on an individual basis. However, the National Agricultural Advisory Centre also works to establish decentralised networks: every two years it brings together a wide range of organisations for an agritourism conference. There is also some evidence of decentralised networks facilitated by agritourism providers’ associations, which organise fairs, conferences and exhibitions. Distributed networks of agritourism providers do not appear to exist, partly because of the distance between agritourism operations but also because immediate neighbours would be in competition with each other. Instead, both tacit and codified knowledge are accessed through a combination of centralised and decentralised networks.

In contrast, knowledge exchange in the Scottish case is almost completely separated from the state-funded agricultural advisory system. The exceptions are a small number of developments which have been facilitated through the Scottish Rural Development Programme. Instead, tourism activities undertaken by farming participants are developed on a largely ad hoc basis, through decentralised networks, which include formal business development advice provided by rural development agencies, accountancy advice on tax, architectural services, group marketing through the Scottish Crofting Federation, and informal connections to agritourism providers in other regions. These can be providers in other parts of Scotland through the Scottish Crofting Enterprise website or connections within the previous locales of the new entrant crofters. Specific knowledge on diversifying into tourist
accommodation appears to be obtained partly through ‘trial and error’ (i.e. socialisation), whereby the accommodation is constructed and lessons subsequently learned through market experimentation. Respondents also frequently drew on networks and skills established before becoming crofters (ranging from joinery to previous tourist service provision). In terms of the networks accessed, these are numerous and relatively informal, in so much as it likely that each crofter involved in diversification has a different network which they interact with for knowledge exchange. As such, networks are decentralised.

Concluding discussion
The study confirms earlier findings that small-scale farmers are under-serviced by formal advisory services (Kidd et al., 2000; Labarthe & Laurent, 2013). When these formal advisory services do interact with small-scale farmers, it is primarily to enable access to government funding, through top-down service provision in centralised networks. As a result, there is limited scope for innovation in terms of the method of interaction, or the originality of the associated application. Findings are also consistent with Ingram (2008) and Sutherland et al., (2013) who argue that privatisation of advisory services puts pressure on advisors to develop grant proposals which are more suited to the farmers’ preferences than achieving the aims of the grant application. In addition, this one-to-one method, with the expertise retained by the advisor, reinforces historic top-down knowledge transfer patterns, which Smedlund (2008) argues are not suited to most forms of innovation.

In seeking production knowledge, the participants in this study often relied on ‘hybrid actors’: individuals with both codified and tacit knowledge. Although presented as cost-free, this knowledge typically comes at a price. Input suppliers, for instance, are typically trained agronomists, who have knowledge of what inputs are available and but offer advice oriented towards product sales. However, Sutherland et al., (2013) found that the commercial, NGO or private status of the source of advice was less important, in terms of credibility and trust, than the history of positive interactions with the advisor in question. Similarly, Kaberis & Koutsouris (2012) found that the trust could develop over time, particularly in situations where inputs were changing rapidly (e.g. new regulations and changing pesticide needs). Input suppliers offering biased production knowledge will not retain trust, although the subtleties between different potential recommendations may not be observed.

The selection of advisors – both formal and informal – thus appears based on a combination of personal relationships and access (both in terms of cost and physical proximity). Other local experts included retired veterinarians and former collective farm employees, who similarly combined tacit and codified knowledge. Although this advice was also cost-free it was not necessarily freely available, requiring social capital to access in some cases. Individuals require reasons to share their commercial business knowledge, particularly with potential competitors. In the Portuguese case, expert farmers were motivated to provide assistance to newcomers because their markets were threatened by the newcomers’ poor quality production. Scottish farmers were more reluctant to share their knowledge, until the new entrants demonstrated willingness to undertake experiential learning through group events (i.e. to engage in socialisation). Small-scale farmers themselves were sometimes hybrid actors, bringing considerable knowledge to farming from off-farm employment or training. This was particularly important for diversification of the farm business, enabling them to make the ‘bridging’ connections characteristic of decentralised networks. We suggest that there is scope...
for considerable further development of these resources within agricultural innovation systems, through providing training and opportunities for these recognised local leaders, and facilitating mentoring activities.

**Limitations**
The number of study participants involved with formal advisors represents the deliberate sampling strategy of the researchers, rather than a feature of small-scale farms in the study sites. Owing to the overall focus of the PRO AKIS project, participants were primarily those who had accessed formal advisory services (public, private or NGO funded). As such, the participants as a whole represent ‘active knowledge seekers’. However, the advisors interviewed for this study concurred that the majority of small-scale farmers in all four of the study sites had no engagement with state or private agricultural advisory services. We therefore assessed how those small-scale farmers who do engage with advisory services structure these interactions, in relation to other sources of knowledge. The cases are also very different. Although qualitative research by nature is not generalisable, identifying similar findings in cases located in four corners of Europe suggest that the issues identified are not limited to the case study sites.

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References


Stimulating innovation opportunities through shared and unique connections of intermediaries within advisory networks

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Abstract: Agricultural advisers are key intermediaries embedded within complex knowledge networks comprised of farmers and a range of private, industry and government stakeholders. Privatisation of extension increases opportunities for market based extension services while changing the role of government and creating new challenges for knowledge sharing within networks. While privatisation of extension has received considerable attention with respect to implications for public and private good, less consideration has been given to structural and relational implications for knowledge sharing. This study therefore considers the question ‘how is knowledge sharing enabled in privatised extension networks?’ To examine this question an empirically based case study was undertaken involving five industry extension advisers, referred to as Regional Extension Coordinators (RECs). This team was set up two years ago by Australia’s dairy industry peak body, Dairy Australia, to fill a gap in extension coordination and services left by the withdrawal of government extension services. Social network analysis in combination with qualitative data was used to identify the knowledge sharing relationships of RECs within their team as well as each REC’s individual extension network. Findings show that the composition of each Regional Extension Coordinator’s (REC’s) network reflects differences in their professional backgrounds, for example whether their previous roles were in government or agribusiness. Knowledge sharing opportunities for the REC team include creating opportunities to access each other’s unique contacts, identifying team strategies for working efficiently with contacts they have in common, and developing approaches for working more effectively with network contacts considered ‘not very enabling’.

Keywords: Adviser networks, relationships, knowledge sharing, Australian dairy extension

Introduction

Agriculture extension provides critical support for farm productivity and knowledge sharing (Faure, et al., 2012; Pragar et al., 2016). The public sector has traditionally been responsible for extension delivery due to assumed ‘public good’ value and benefit (Umali-Deininger, 1997). While extension has and continues to play a vital role in supporting adoption of innovation and technology, its economic and social value are difficult to measure in practice (ibid). Globally, neoliberal policy and a ‘user pays’ ideology have driven structural transformation of extension services in favour of pluralised, privatised, competitive market based options that reduce government investment (Klerkx, et al., 2006; Hunt et al., 2012; Cristóvão et al., 2012; Knuth & Knierim, 2013; Pragar et al., 2016).

The process and pace of transition from public to privatised extension has varied globally and by sector. The Australian dairy sector supported a combination of public and private extension for longer than many other farming sectors, however since 2014 Dairy Australia (DA) has taken greater responsibility for industry extension using a farmer levy funded delivery model referred to as the ‘regional interface’. This is now the structure through which resources are
invested in the leadership, planning, coordination and engagement activities to drive adoption of innovation on regional dairy farms (Dairy Australia – Adoption and Innovation Strategy Information Paper. July 2013, p 208). The ‘regional interface’ includes both public and private sector providers delivering extension services to ensure farmers have access to the information, tools, methods and capability needed to run successful dairy farm businesses and ensure the industry continues to be vibrant and successful (ibid). While economic concepts of public good, private good and market failure continue to be debated with respect to extension, there is limited attention given to implications of structural and relational reorganisation of extension services driven by business principles and specific terms of exchange. Attention to structural and relational opportunities and constraints in increasingly pluralised extension networks is important for addressing rising challenges of collaboration and coordination between extension actors representing multiple institutional contexts (Klerkx & Nettle, 2013). The coordination of privatised extension providers to serve the needs of a diverse range of farmers creates new facilitation and brokering challenges for advisers (Koutsoursis, 2012) and the need to understand how individuals and organizations within their extension networks are connected. This study is an empirical examination of structural and relational opportunities and constraints within a recently established, industry funded extension team whose role is to foster coordination of dairy extension delivery across the state of New South Wales, Australia. Using a mixed methods approach combining social network analysis and qualitative data, the case study of five members of the Dairy Australia Regional Extension Coordinator team (New South Wales) was carried out in 2016 based on the research question “how is knowledge sharing enabled in privatised extension networks?”

**Context: location and people**

**Location**

The study is focused on a team of five Regional Extension Coordinators working within dairy production regions of New South Wales (NSW) comprised of three coastal and two inland regions (see Figure 1). These dairy regions are geographically dispersed and situated in areas with fertile soils, flat to undulating land contour and good access to water.
The NSW dairy industry is currently based on approximately 500 farms with an average herd size of 280 cows. Annual milk production is over one billion litres of which 70% is consumed domestically. NSW produces 8% of Australia’s milk volume with a gross production value of almost $500 million (Kempton, 2015).

**Stakeholders in the New South Wales dairy extension network**

Stakeholders involved in New South Wales dairy extension network include extension providers, farmers, industry, agribusiness, government agencies, research and education institutions. Within this mix of stakeholders the role of extension providers has traditionally been to facilitate farmers’ access to knowledge, information and technologies that support more productive, efficient and sustainable farming practices (Faure, et al., 2012; Koutsouris, 2012). In this intermediary role extension providers need to interact widely with clients and other professionals to maintain their own knowledge competency. They must also have well developed relationship skills that enable others to capture learning opportunities.

Dairy Australia (DA) is a national industry-owned Rural Research and Development Corporation (RDC) accountable to its farmer members and to the Australian government. DA invests a combination of farmers’ levy and government funds across the dairy supply chain to ensure that the industry is profitable, sustainable and competitive. It operates regionally through eight Regional Development Programmes (RDPs) across Australia, including Dairy NSW. Each RDP is responsible for providing and coordinating regional extension, education and professional development services for dairy farmers and sub-regional Regional Development Groups RDGs. RDPs also provide funding for group projects which may involve discussion groups and local research trials. Each RDP has a regional manager and a team of
extension field staff who collaborate with farmers, government agencies, milk processors and a broad range of rural professionals (agribusiness, consultants and veterinarians).

Public sector interest in New South Wales extension policy and its delivery includes the Department of Primary Industries (DPI) (the government agency responsible for increasing the productivity and resilience of the agricultural sector through agricultural productivity research across livestock, plants and natural resource management areas) and Local Land Services (LLS) that operate in eleven sub regions of New South Wales (to provide farmers, land managers and communities with technical and advisory knowledge on a range of rural topics and issues). Public sector institutions with education and research interest in extension include vocational training institutes (Technical and Further Education (TAFE)), universities and the Commonwealth Scientific and Industrial Research Organisation. (CSIRO).

Private sector interests in extension include agribusiness (suppliers of milking equipment, animal breeders, seed, fertiliser, general farm supplies, livestock agents, technicians), consultants (providers of general farm management advice as well as specialists in agronomy, nutrition and irrigation), financiers (banks and accountants), veterinarians, milk companies and milk supply field officers. Declining government investment in research, development, education and extension is currently shifting responsibility for these functions to the private sector (Kempton, 2015).

Conceptual framework

**Extension background in Australian**

Up until the 1990’s public sector provision of agriculture extension developed alongside research capacity and together made a critical contribution to Australian agriculture. Extension services were considered to be ‘of major importance to (farms achieving) higher production and lower costs (Williams, 1968 quoted in Hunt, 2012: 14). Prior to the 1990’s extension was regarded as a credible and valued profession supported by academic training and research (ibid). Provision of more pluralised forms of extension was also encouraged such as public/private partnerships and fully privatised consultancy (ibid). After 1990 rapid structural changes implemented by government devolved research responsibility to industry based Rural Development Corporations. This coincided with the ‘retreat’ of government from provision of public sector extension and capacity and skills development of extension professionals resulting in ‘weakened extension capability’ and ‘disconnection in the RD&E feedback loop’ (ibid:16).

Structural changes in favor of privatised extension services have major implications for extension professionals and access to knowledge support by the agriculture sector. Traditionally, free publically offered extension was provided outside the constraints of user-pays market driven principles and largely involved one to one relationships between advisers and farmers. Privatisation now means that advisory relationships are based on business and market principles of exchange. Employees in hierarchical government structures are increasingly at ‘arms-length’ from farmers and undertake development and research rather than extension roles. To make sense of such changes for the knowledge creation and sharing functions of extension, Adler et al.’s (2008) framework (see Table 1) distinguishes between the implications of community, hierarchy and markets’ principles according to social mechanisms, control imposed, goal alignment, exchange of resources, terms of exchange and extent to which terms of exchange are explicit or not. The framework highlights that
hierarchical principles, which are traditionally applied to public provision of extension, are underpinned by control embedded in authority and are effective for sharing codified knowledge but weak for sharing new or tacit knowledge (typical of adoption challenges involving complex agricultural innovation). Market principles are underpinned by user-pays, price competition and opportunities to appropriate value. Incentives to create new knowledge are dependent on its commercial value as well as demand generated by consumers willing and able to pay for it. Community principles are underpinned by mutual trust that fosters knowledge sharing and facilitates learning in situations involving risk and uncertainty (and therefore of increasing importance within agriculture decision making).

Table 1: Framework of community, hierarchy and market principles (Source: Adler et al., 2008)

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<tr>
<th>Terms of exchange specific or diffuse:</th>
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<th>Explicit</th>
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<tr>
<td>Terms of exchange made explicit:</td>
<td>Diffuse¹</td>
<td>Diffuse/specific</td>
<td>Specific²</td>
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For extension providers the increasing influence of market and hierarchical principles impacts on the structures and institutions they are now working in in ways that not only impact on their relationships with farmers but also on the maintenance of informal collegial interactions. Coordination across new business structures introduces new challenges relating to consistency and quality of knowledge products and services and increases opportunities for conflict of interest as advisers compete for a limited pool of clients.

While structural change due to privatisation of extension is a ‘given’ under prevailing economic and political contexts it brings structural and relational consequences that are difficult to measure using standard empirical tools. Understanding how advisers are experiencing privatisation within their professional networks is an opportunity for both policy makers and industry strategists to consider some of the critical consequences.

Social capital

For the purposes of this paper Lin’s ‘structural perspective on social capital’ (1999, 2001) is used to understand how location, position and the effects of both weak (open) and strong (close/closed) relational ties affect social network relationships. Lin suggests that ‘social

¹ Generalised reciprocity refers to unspecified exchange but an expectation of future exchange or return of favours.
² Specific reciprocity refers to exchange of agreed resources.
capital refers to resources embedded in a social structure that are accessed and/or mobilised in purposive actions’ (2001:29). This definition highlights three critical elements – firstly resources may potentially be shared that have either material or symbolic value (including for example physical farm inputs, information, knowledge and money\(^3\)). Secondly these resources are embedded within and must be accessed through social structures\(^4\) (for example farm management expertise is available from advisers who may be self-employed or employed within organisations, have been highly trained in universities and have acquired practice based experience through social interactions with farmers and other professionals). Thirdly, social capital is mobilised for a purpose (for example farmers seek advice to ensure their farm businesses are profitable). Mobilisation of social capital may be instrumentally motivated (to gain social capital) or expressively motivated (to maintain social capital) (Lin, 2001). Structural constraints and agency of actors determine whether opportunities for mobilising social capital can be realised (ibid). This view of social capital focuses on how resources are valued, accessed and mobilised in social networks including what resources are deemed relevant and where they can be found. For example strongly connected network members who trust each other and interact frequently are well positioned to give and receive resources. Conversely weakly connected network members with limited access to resources are at risk of missing opportunities to develop the potential of their livelihoods and wellbeing. The gradation of strong to weak ties aligns with concepts of bonding, bridging and linking (High et al., 2005; Fisher, 2013) used to differentiate opportunities for sharing resources horizontally and vertically in a given social context. Bridging social capital is associated with brokers, or intermediaries such as extension providers, whose role is to connect otherwise unconnected individuals or groups in order to access valuable resources such as information and knowledge (Howells, 2006).

**Access and mobilization of information and knowledge sharing through collaboration**

Adler and Heckscher (2005) argue that the prevailing ascendancy of market principles in economics and policy gives rise to individualism that is contrary to the maintenance of communal norms of interdependence and trust that underpin collaboration. Within an extension network, farmers, advisers, service professionals (amongst others) regularly exchange technical, economic, environmental and social information and knowledge that directly impacts on the efficiency, profitability and sustainability of farming. While provided by the public sector the sharing of knowledge by extension advisers was typically an open process. Advisers working across different farms freely shared their knowledge of what new practices worked or not. This provided opportunities to influence rates of adoption as well as learn from others’ mistakes. Privatisation of extension knowledge reduces opportunities for open sharing of both knowledge and experience as this becomes a private asset and a source of competitive advantage (Hunt, 2012).

**Methodology**

Social network analysis (SNA) is a method for describing the structure of relationships within groups, communities and organisations (Cross & Parker, 2004; King & Nettle, 2013). Formal and informal relationships are represented visually in social network models (sociograms) using lines (edges) to show a relationship between nodes (vertices or graph points) according to a specific relationship of interest (between individuals and/or organisations). A relational connection provides the potential for resources, both tangible and intangible, to be shared (Wasserman & Faust, 1994; de Nooy et al., 2005). Social networks are formed for many

\(^3\) Lin (1982, 1999) refers to resources as including wealth, power and status.

\(^4\) Social structure is determined by positions, authority, rules and agents (ibid).
reasons (Wasserman & Faust, 1994; Scott, 2013) and are based on an explicit relational question relevant for a specific purpose. Findings cannot be generalised beyond the implications relative to this question. SNA data is presented in sociograms (network maps) in which each connection (node) is situated as a graph coordinate in two dimensional space.

For this study the boundary of the empirical case was formed by relationships of five members of the Dairy NSW REC team and who they regarded as their ‘top 30’ contacts.

The relational questions used to identify network ties were:

‘In your extension capacity, who are the most important 30 people you talk to in the dairy industry (not including people who work in your same organisation)? Followed by:

‘What organization do they belong to?’

The contacts named by each REC were combined to create a network model for this extension team. To assure confidentiality each contact’s name and relationship was ascribed a numerical value. The data was processed with SNA software, Pajek. Data was also collected about frequency of interaction with each contact and perceptions of whether each contact is ‘enabling’ or ‘not very enabling’ of collaboration. The social network of all five REC’s resulted in a network of 98 nodes and formed a core-periphery structure (see Figure 1). The network model includes 17 core nodes representing contacts shared by at least three REC’s. Before finalising the network models, feedback was sought from each REC as to whether the draft SNA models ‘made sense’ to ensure that the data was of sufficient quality for the next stage of analysis.

Findings

The Dairy NSW Regional Extension Coordinators’ network

A social network model based on extension relationships of five members of the Dairy NSW REC team is shown in Figure 1. It forms a core/periphery structure based on 98 nodes. The five respondents are marked with letters (nodes within the small circles) and their contact nodes (alters) are indicated with numbers. Nodes shared by at least three RECs are located in the network core while nodes that are unique for each REC are located in the network periphery. Nodes shared by only two RECs are located between the core and the periphery. Eleven role groups were identified in the network and are indicated by colour (see Key for Figure 1 roles).

The network ‘core’

The core contains 17 nodes who represent critical extension knowledge capability and influence within this network. The core includes seven farmers, four milk company field officers, three government employees, two consultants and one educator. Of these the most highly connected are nodes 41, 26, 60, 10, 19 and 34 who include three government employees, one farmer, one consultant and one milk company field officer. The connectivity patterns of these network members suggest they are network ‘stars’ (Cross & Parker, 2004). Network ‘stars’, or central connectors, are people highly sought out by other network members.

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5 Nodes: 41,26,60,10,19,34 (Core star nodes); S,G,J,M,R (RECs); 83,55,62,30,86,84,20,80,69,16,50 (Core nodes potential stars and/or brokers)
for their expertise, experience and skills. Their presence provides credibility and status for the wider network and they are critical for enabling information and knowledge to flow efficiently and effectively to other network members (ibid). Most network ‘stars’, although not all, are well known and highly visible to other network members.

Figure 1: Core/periphery network model of ‘top 30 extension’ contacts for the NSW REC team (December 2015). Core nodes within the central back circle are shared by at least three RECs. Blue circles between the core and the periphery indicate nodes shared by only 2 RECs. Unique connections for each REC are shown on the black outer periphery circle.

Key for role groups in Figure 1 (numbers refer to how many of each role group are present in the network)

<table>
<thead>
<tr>
<th>Role Group</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>DA REC</td>
<td>5</td>
</tr>
<tr>
<td>Researchers</td>
<td>5</td>
</tr>
<tr>
<td>Farmers</td>
<td>26</td>
</tr>
<tr>
<td>Veterinarians</td>
<td>3</td>
</tr>
<tr>
<td>Government DPI, LLS (21)</td>
<td></td>
</tr>
<tr>
<td>Educators, TAFE (2)</td>
<td></td>
</tr>
<tr>
<td>Milk Company representatives (14)</td>
<td></td>
</tr>
<tr>
<td>Technicians (2)</td>
<td></td>
</tr>
<tr>
<td>Consultants (10)</td>
<td></td>
</tr>
<tr>
<td>Industry Advocacy (1)</td>
<td></td>
</tr>
<tr>
<td>Agribusiness (8)</td>
<td></td>
</tr>
<tr>
<td>Other (1)</td>
<td></td>
</tr>
</tbody>
</table>
The other eleven core members include six farmers, three milk company field officers, one consultant and one educator. While not as highly connected as the ‘stars’ they are centrally positioned and provide network connectivity and intermediation opportunities for the network. Their location in the network enables them to coordinate and control the flow of information and knowledge with individuals or groups that may otherwise not have access to the network’s resources.

**Shared contacts between the core and the periphery**

Between the network core and periphery connections shared by only two REC’s are shown in blue circles (see Figure 1). Not all RECs share nodes with other RECs but this appears more likely between those whose work regions are in closest physical proximity (e.g. REC R and G; REC J and S). REC M, who has the greatest number of ties (8) shared with other RECs, is a state-wide specialist available to advise on land, water and carbon and is therefore working across all dairy regions. The highest number of shared nodes between RECs outside the core is four. Shared contacts are mainly consultants, farmers, government employees and milk company representatives who are sources of information and advice for the RECs.

**Unique network contacts.**

The dairy industry of NSW is geographically wide spread which means that RECs are working long distances from each other. Unique connections for each REC are shown on the peripheral circle in Figure 1. RECs’ unique ties represent 40% of all network contacts and are based on contacts within their work regions. Their unique contacts are highest with farmers (30%), then local government employees (24%), milk company representatives (15%) and consultants (11%). RECs’ connections with these four role groups comprise 80% of all network connections. The role distribution of unique connections for each REC is shown in Table 2. The similar contact patterns of REC J, G and S is because they each hold dairy extension coordinator roles but in different locations. REC R is the overall team leader with responsibility for strategic issues and team oversight rather than on farm extension delivery. Both REC R and M work across all regions and their leadership roles require connections to researchers which are reflected in their ‘top 30’ contacts. The significant proportion of REC J’s unique contacts with agribusiness reflects his previous employment in this sector. Sharing unique network contacts between team members provides opportunities to develop expertise and knowledge.

**Table 2. Roles of unique contacts**

<table>
<thead>
<tr>
<th>Network Role</th>
<th>REC R</th>
<th>REC M</th>
<th>REC J</th>
<th>REC G</th>
<th>REC S</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consultant</td>
<td>6</td>
<td>5</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>17 (11%)</td>
</tr>
<tr>
<td>Milk Officer</td>
<td>2</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>7</td>
<td>22 (15%)</td>
</tr>
<tr>
<td>Farmer</td>
<td>10</td>
<td>9</td>
<td>8</td>
<td>10</td>
<td>7</td>
<td>44 (30%)</td>
</tr>
<tr>
<td>Educator</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>3 (2%)</td>
</tr>
<tr>
<td>Government</td>
<td>8</td>
<td>8</td>
<td>6</td>
<td>5</td>
<td>9</td>
<td>36 (24%)</td>
</tr>
<tr>
<td>Industry</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6 (4%)</td>
</tr>
<tr>
<td>Researcher</td>
<td>2</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td>5 (3%)</td>
</tr>
<tr>
<td>Agribusiness</td>
<td></td>
<td></td>
<td>8</td>
<td>1</td>
<td></td>
<td>9 (6%)</td>
</tr>
<tr>
<td>Bankers/Accountants</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vets</td>
<td></td>
<td>2</td>
<td></td>
<td>1</td>
<td></td>
<td>3 (2%)</td>
</tr>
</tbody>
</table>
Network access and mobilisation of resources

The success of extension work is dependent on access to information and knowledge resources. Perceptions and experience of others’ willingness to collaborate is an indication of their confidence that interactions within those relationships will facilitate access to knowledge and information that allows them to achieve extension goals and tasks.

Perceptions of collaboration

RECs were asked to indicate whether they perceived each of their ‘top 30’ contacts to be ‘enabling’ or ‘not very enabling’ of collaboration based on their perceptions of approachability, willingness to share information and confidence in their working relationship. The results for the combined 98 contacts named in the NSW REC network model are shown in Table 3. The majority of extension contacts (86%) were perceived to be ‘enabling’ with respect to sharing information and knowledge. Eighteen individuals in the network were identified as ‘not very enabling’, including nine government employees, three milk company field officers, one agribusiness representative and one farmer. Notably, three of the ‘star’ nodes (one each from government, a milk company and a consultant) were perceived as ‘not very enabling’. Three other core nodes were also perceived as being ‘not very enabling’ (one farmer, one milk company field officer and one consultant). A perception of ‘not very enabling’ may indicate that workload and time constraints limit ability to be responsive or that conflict of interest or commitment exists. Importantly, a total of 6 of the 17 core nodes were perceived as ‘not very enabling’ (35%) which is a concern for this network as the significance of connectivity with RE’s suggests that they are influential and have gatekeeping roles with respect to enabling access to critical knowledge resources.

Table 3: REC’s perceptions of collaboration with their network contacts

<table>
<thead>
<tr>
<th>Perception of collaboration</th>
<th>REC R</th>
<th>REC M</th>
<th>REC J</th>
<th>REC G</th>
<th>REC S</th>
<th>Total number of ties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enabling</td>
<td>27</td>
<td>23</td>
<td>29</td>
<td>23</td>
<td>28</td>
<td>130 (86%)</td>
</tr>
<tr>
<td>Not very enabling</td>
<td>3</td>
<td>7</td>
<td>1</td>
<td>7</td>
<td>2</td>
<td>20 (14%)</td>
</tr>
<tr>
<td>Ties per REC</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>150</td>
</tr>
</tbody>
</table>

Differences in perceptions vary between each REC (REC J only perceives one ‘top 30’ contact not to be enabling whereas REC M and G each perceive 7 of their ‘top 30’ contacts to be not very enabling and in combination account for 14 of the 20 ‘not very enabling’ perceptions). Differences in perception may be due to a range of professional and personal factors including personality, relationship history and duration, institutional, epistemological and other
differences. Further examination of why particular individuals were perceived to be ‘not very enabling’ was outside the scope of this study. However, all but one individual perceived in this way was identified as belonging to organisational structures based on hierarchical or market principles (i.e. government, processors and consultancies).

**Frequency of interactions**
Frequency of interaction provides opportunities to develop relationships, trust and rapport. RECs were asked whether they interact with each of their ‘top 30’ contacts weekly, monthly or six monthly. Interaction frequency is summarised in Table 4. The average across all RECs indicates that 60% of their extension contacts occurs monthly, however this varies for each REC. Interaction patterns for REC R, J and G are similar, however REC M has the highest weekly interaction (10) and REC 5 the lowest weekly interact (1). It is likely that each REC develops their contact frequency pattern in relation to their own knowledge needs related to their role and location. The analysis is not intended to imply that there is an ‘ideal’ pattern of interaction common to all RECs but to highlight similarities and differences within the team.

**Table 4: Frequency of interaction**

<table>
<thead>
<tr>
<th>Frequency of interaction</th>
<th>REC R</th>
<th>REC M</th>
<th>REC J</th>
<th>REC G</th>
<th>REC S</th>
<th>Total number of ties</th>
<th>Average for the REC team</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekly</td>
<td>4</td>
<td>10</td>
<td>6</td>
<td>7</td>
<td>1</td>
<td>28</td>
<td>5.6 (20%)</td>
</tr>
<tr>
<td>Monthly</td>
<td>21</td>
<td>19</td>
<td>16</td>
<td>19</td>
<td>15</td>
<td>90</td>
<td>18 (60%)</td>
</tr>
<tr>
<td>6 monthly</td>
<td>5</td>
<td>1</td>
<td>8</td>
<td>4</td>
<td>14</td>
<td>32</td>
<td>6.4 (10%)</td>
</tr>
<tr>
<td>Ties per REC</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>150</td>
<td></td>
</tr>
</tbody>
</table>

Despite implications of social capital theory that more frequent interaction is likely to strengthen relationships (and social capital is created), the RECs reported 27 ‘enabling’ relationships involving 6 monthly interactions. This suggests that some collaborative relationships are likely to be based on linking social capital and do not require highly frequent interactions based on bonding social capital.

**Discussion**
The study’s findings provide insights about structural and relational opportunities and constraints for the five REC team members and their ‘top 30’ professional contacts with respect to knowledge sharing. Firstly the RECs shared and unique connections identify 98 different individuals and organisations with whom the team share knowledge. Opportunities to develop the relational resources of the team and each individual member can be enabled by explicitly understanding why members access shared connections as well as why each REC maintains relationships with their unique ‘top 30’ connections. For example the SNA model identifies 17 ‘core’ contacts shared by at least three RECs, seven of whom are highly connected ‘stars’ (Cross & Parker, 2004), although some were perceived as being ‘not very enabling’ of collaboration, particularly from government or consultancies. Whether perceived as ‘enabling’ or ‘not very enabling’ of collaboration, network ‘stars’ are typically in high demand and time-poor and their capacity to maintain relationships is affected accordingly. For the REC team it may be possible to connect more effectively with such people through scheduling regular group meetings with them, or by nominating a team member to act as an intermediary on behalf of the team. Another opportunity to tap into the collective relational resources of the team could be for each REC to share their unique contacts with each other, particularly those
who may bring specialised knowledge to the team. For example, REC J has unique contact with agribusiness contacts that may provide access to specialised knowledge held by the commercial sector. In addition only two RECs named researchers and no REC named financial contacts in their ‘top 30’ contacts, despite both role groups representing critical knowledge resources for extension networks. The knowledge capacity of the REC team and each member could be developed by exploring how to better connect with both these groups. The team can use the SNA as a tool to identify other relational opportunities and constraints based on their knowledge of each other and their sector not necessarily apparent to anyone outside the team. RECs are aware that there are some people within their networks who create relational barriers (gatekeepers) that require time and effort to manage; a solution is sometimes to work around them. They are also aware that developing new relationships as well as maintaining existing relationships is time consuming and it is easier to focus on people they are comfortable with.

“There are core contacts who are gatekeepers. They are necessary but challenging people in which bridges are continually in need of repair and strategies are needed to work around them. RECs are also limited in the time they have available to seek new contacts, especially those who work part-time, and each REC’s network is flavored by the ‘comfortable’ relationships – people easy to work with and in areas of familiarity” (REC).

As well as the relational insights discussed above, SNA offers a way of understanding the structural effects of a pluralised extension network. The framework presented in Table 1 (based on Adler et al., 2008 and Lin, 2001) uses notions of community, hierarchy and market to categorise institutional differences between network actors. Each network member identified by the REC team was allocated to a community, hierarchy or market category according to the dominant structural principle of their activity (see Table 5 and using the 14 different roles groups identified for the SNA). Although farmers operate commercial businesses in Table 5 they are identified as representing community structures based on the willingness to share knowledge with each other (between farmers and in discussion groups) as well as their interdependence for economies of scale in milk production and processing.

The top two rows of Table 5 indicate types of extension resources represented by each actor such as knowledge and information, strategic leadership, databases, practice based knowledge and experience. The lower three rows draw on the REC’s perceptions of collaboration and frequency of interaction with their contacts to consider how the different actors may influence access and mobilisation of resources.
Table 5: Summary of knowledge resources and availability in the NSW REC network (numbers in brackets indicate how many organisations and individuals were identified in the network)

<table>
<thead>
<tr>
<th>Extension network resources</th>
<th>Network actor</th>
<th>Structural principle 1 Community</th>
<th>Structural principle 1 Hierarchy</th>
<th>Structural principle 1 Market</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge and information</td>
<td>Organisations</td>
<td>Farmers advocacy groups (2)</td>
<td>Government – DPI LLS (4) Dairy Australia TAFE (3) University (2)</td>
<td>Consultancy – sole practice, group practice (10) Vet practice (3) Milk companies (6) Agribusiness (9)</td>
</tr>
<tr>
<td>Strategic leadership</td>
<td></td>
<td>Farmer discussion groups (7)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Research Databases</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knowledge and information</td>
<td>Individuals</td>
<td>Farmers (26) Industry advocate (1)</td>
<td>Researchers (5) Government employees (21) DA RECs (5) Educators (2)</td>
<td>Vets (3) Technicians (2) Milk company field officers (15) Agribusiness reps (8)</td>
</tr>
<tr>
<td>Practice knowledge and</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>experience</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Access and mobilisation of</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>extension resources</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived collaboration</td>
<td>Not very enabling</td>
<td>Government employees 38%</td>
<td>Consultants 45% Milk company field officers 20%</td>
<td></td>
</tr>
<tr>
<td>Perceived collaboration</td>
<td>Enabling</td>
<td>Farmers 96%</td>
<td>Government employees 62% Researchers 100% Farmers 4%</td>
<td></td>
</tr>
<tr>
<td>(opportunity to mobilise</td>
<td></td>
<td></td>
<td>Consultants 55% Milk company field officers 80% Agribusiness reps 90%</td>
<td></td>
</tr>
<tr>
<td>information and knowledge</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>resources</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency of access</td>
<td>Frequency of interaction</td>
<td>3/5 REC’s in weekly contact with farmers All RECs in monthly contact with farmers</td>
<td>All RECs in weekly contact with government employees;2 RECs in weekly contact with researchers</td>
<td>3/5 in weekly contact with consultants; 2/5 in weekly contact with consultants; 1/5 in weekly contact with agribusiness</td>
</tr>
</tbody>
</table>

RECs’ perceptions of whether their network contacts are ‘enabling’ or ‘not every enabling’ of collaboration (as a proxy for knowledge sharing) are based in structures of both hierarchical and market institutions. In contrast 96% of RECs’ interactions with farmers aligned with community based principles are perceived to be ‘enabling’ of collaboration. Structures based on community principles draw on trust and unspecified terms of resource exchange (Lin, 2001) in contrast to those based on market principles and specific exchange of resources (Adler et al., 2008). The distribution of network members of the REC network in Table 5 shows that community structures are represented by 9 farmer groups and 27 farmers; hierarchal structures are represented by 27 organizations and 37 individuals; and market structures are represented by 11 entities and 33 individuals. The implications of this mix and distribution of institutional structures require further longitudinal study to assess changes over time and the impacts on managing and coordinating relationships to facilitate and maintain effective and
efficient knowledge sharing. Tracking such changes is important for policy makers as well as extension providers for supporting decisions relating to distribution of resources in the public interest as well as industry goals.

Conclusions
The purpose of this study was to understand the structural and relational implications for knowledge sharing in a recently privatised extension network and what this means for coordination across a wider, pluralised network. Findings show that the composition of each Regional Extension Coordinator’s (REC’s) network reflects differences in their professional backgrounds, for example whether their previous roles were in government or agribusiness. Knowledge sharing opportunities for the REC team include creating opportunities to access each other’s unique contacts, identifying team strategies for working efficiently with contacts they have in common and developing approaches for working more effectively with network contacts considered ‘not very enabling’. Community, hierarchy and market based institutions are all represented in the REC team knowledge sharing contacts, however contacts from government (hierarchy) and consulting (market) sectors are most likely to be perceived as ‘not very enabling’ of collaboration. Further work is needed to understand the basis of these perceptions and what bridging strategies may ensure that these institutions remain open to ongoing shared innovation opportunities.

The SNA offers a benchmark for ongoing longitudinal comparison of the changing balance of roles represented in the RECs’ ‘top30’ network contacts. While it is suggested here that the team’s network is currently weak in research and financial knowledge, future changes in farming practice and the need for greater environmental accountability may require different forms of expertise to be available to the network. Further understanding is needed about how to manage and coordinate extension across a changing, pluralised balance of community, hierarchical and market institutions. The geographically dispersed REC team will continue to face ongoing relational and structural challenges as well as coordination challenges. They can use their understanding of the strengths and weakness of knowledge sharing in both their team and individual networks to capture opportunities to access and mobilise knowledge as well as maintain and build social capital and capture opportunities for innovation.

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References


Variable collaborative learning spaces in the quest for agricultural sustainability in New Zealand

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Abstract: Participatory research is advocated for fostering multi-stakeholder engagement and learning necessary for advancing sustainability. This work examines how participatory projects develop collaborative learning to advance agricultural sustainability. It presents findings from empirical evidence from six micro-level horticultural innovation projects in New Zealand where farmers and scientists engaged in public/private funded partnerships. Analysis revealed institutions, partner relationships and learning were critical and highly inter-related dynamics of participatory research projects. This paper focuses on the creation of learning spaces in these projects that ideally should support and sustain change to more sustainable practices. The research revealed a ‘collaborative learning space’ influenced by the strength of partner relationships and institutions that shape how actors engage in participatory research. This paper visualises the variability of the collaborative learning space among the six projects and reveals the importance of this space where innovations can be co-developed and learning is emergent, adaptive and dynamic.

Keywords: Participatory research, learning spaces, agricultural innovation, agricultural sustainability

Introduction

Nearly thirty years after the publication of the Brundtland Report (WECD, 1987), which sought global consensus around sustainability, the implementation of sustainability remains a highly fraught and contested endeavour. Within agriculture there remains an urgent need to effectively address the environmental impacts of agricultural practices. This requires effective responses at all levels, including at the micro-level - the “multi-party collaboration processes in which representatives from different stakeholder groups interact” (Medema et al., 2014, p.27).

Participatory approaches in agriculture are approaches to research that see farmers and scientists collaborate in projects to address a shared problem using both local and scientific knowledge. They are argued to be a suitable platform for facilitating change towards sustainability as they encourage multi-stakeholder engagement, collaboration, learning and collective action (Neef & Neubert, 2011; Pretty, 1995; Reed, 2008). Policy and funding agencies increasingly support the use of participatory approaches to both promote sustainable agriculture and increase adoption of sustainable innovations (Ison, Roling & Watson, 2007; Pahl-Wostl, 2002).

Despite wide support for participatory research there remains limited understanding of how participatory research can stimulate meaningful change towards sustainability in the rural sector. Furthermore the integration of scientific and local knowledge in research projects is often difficult to achieve (Allan et al., 2013; Neef & Neubert, 2011). This raises questions about the effectiveness of participatory research for advancing sustainability. This paper uses empirical data from six micro-level innovation projects in New Zealand, where farmers and
scientists engaged in public/private partnerships to explore how participatory research fosters learning environments to advance sustainability.

**Participatory research in agriculture**

Post Normal Science (Funtowitz & Ravetz, 1994) demands new approaches to research to address not just the technological requirements of environmental issues but also their socio-ecological complexities. In this environment, science is seen to be more democratic and socially accountable as it embodies multiple perspectives from inside and outside science and technology in decision-making (Gibbons, 1999; Lubchenco, 1998). Within this context, participatory research is put forward as an effective approach for multi-stakeholder engagement to address sustainability and to promote rural change, as it is inherently collaborative and inclusive by seeking to bring a wide base of expertise to both identify problems and co-develop solutions (Leeuwis, 2004; Pretty et al., 2010; Reed, 2008; Vanclay & Lawrence, 1995).

Participatory research challenges traditional ways of undertaking agricultural research and extension that favoured linear top-down approaches that saw agricultural scientists determine priorities, develop technologies and then transfer the knowledge to leading farmers through extension workers (Leeuwis, 2004). Participatory approaches no longer see science as the only legitimate knowledge for to do so denies the socially constructed nature of knowledge production. Participatory scholars call for divergent stakeholders to create shared understanding of problems and co-produce knowledge and solutions (Baars, 2011).

To advance sustainable agriculture, collaborative multi-stakeholder engagement and learning in ‘transdisciplinary’ participatory partnerships should challenge assumptions and values of both farming and science practice to facilitate new ways of thinking through a process of cumulative and incremental learning (Keen et al., 2005; Roling & Wagemakers, 1998). Success however, must not be solely measured by quantitative indicators as this risks allowing a participation dogma to dominate, where success is solely measured by numbers rather than by the development of meaningful and lasting change (Vanclay, 2011; Ziegler & Ott, 2011).

In participatory research, learning should become an emergent property of the collaboration (Ison, 2005). The knowledge that is obtained from practical experience and collaborative experimentation is then built into solutions (Blackmore, 2007), with decision-making being collectively framed through dialogue (Leeuwis & Aarts, 2011). Leeuwis and Aarts (2011, p.27) call the environment where people interact “a space for change” and highlight how this space is necessary for stimulating innovation in complex systems. They argue that these spaces mobilise divergent “discourses, representations and storylines” that fluctuate between the dominant thinking and new ways of knowing and doing.

The literature is emphatic that participatory projects should focus on the capacity of actors to learn together to enable problems and solutions to be co-constructed. Such ‘constructivist’ notions of learning are not focused on didactic approaches to teaching or persuading people to simply adopt an innovation. Instead they seek to bring about transformations in people’s perceptions and assumptions (Keen et al., 2005; Mezirow, 1994) that ideally leads to a questioning of the underlying assumptions that drive current practice, which can generate new ways of knowing and doing. It is this type of learning that is regarded as essential for addressing the complexity of sustainability (Keen et al., 2005; Lachlan, 2013).
Participatory approaches inherently require traditional power structures, with scientists as experts giving ‘top-down’ advice to farmers as passive recipients, to be replaced by more equitable partnerships. While power sharing is regarded as a fundamental principle of participatory approaches, processes are often still affected by power structures. Kothari (2001) argues that an unquestioning approach to participatory endeavours can overlook the socially embedded nature of knowledge production and actually reinforce power differentials. Agencies adopting participatory approaches are criticised when superficial approaches to participation ignore the socio-political context of stakeholder interactions (Kothari, 2001; Pretty, 1995).

Redistribution of power structures will require fundamental changes to institutions that have historically afforded western science a privileged position in agricultural research and extension (Fergus & Romney, 2005) and shape how scientists behave and practise science (Klerkx & Leeuwis, 2009; Ziegler & Ott, 2011). Indeed new approaches to research will challenge how scientists view themselves and science’s role in research (Rodriguez et al., 2008).

Community, funding and policy actors may however perceive participatory initiatives as vague. Participatory researchers often struggle with the requirements of funding agencies which rely on evaluation measures more suited to the traditional top-down approaches to research and extension (Webber & Ison, 1995). Furthermore, among policy agencies there may be a primary expectation that participatory approaches will increase the acceptance of stakeholder adoption of innovations and government policy. Barr and Carey (2003) contend that the language of contemporary policy remains embedded in the Innovation Diffusion Model (Rogers, 1962), which sees innovation as inherently good for farmers (Ison, 2005), and assumes farmers will eventually adopt. Bruges and Smith (2007) even question the appropriateness of using participatory approaches to achieve policy goals that promote change towards sustainable agriculture.

Investigating participatory projects
New Zealand’s farming and science landscape provides a rich context to examine how effectively participatory projects facilitate learning environments to advance agricultural sustainability. While farming remains a dominant force in New Zealand’s economy (PCE, 2004), as with other countries its rural communities face increasing pressure to address concerns about the detrimental environmental impacts of farming practices, with growing concern that the agricultural sector is underperforming in improving its environmental performance (PCE, 2004).

New Zealand policy and funding agencies have increasingly challenged scientists to build greater capability for participatory approaches into science research. Since the restructuring of New Zealand’s science sector and the dissolution of publicly funded agricultural extension in the 1990s, many micro-level public / private ‘participatory’ partnerships have emerged to address sustainability.

The six micro-level projects investigated in this research supported engagement between science and farming actors in research partnerships and therefore were all generally consistent with the participatory paradigm. However, with no clear blueprint on how a participatory approach should be applied, implementation is variable. All were situated in the horticultural and arable sectors and located as shown in Figure 1. Five projects were partially
funded by the government’s Sustainable Farming Fund (SFF) with matching contributions from project farming partners. One project, Crop Science for Maori, was fully funded by the government’s public science fund. Table 1 provides a synopsis of each project’s objectives, while Table 2 outlines the characteristics of the farming groups and sectors, as revealed from project documentation. While all projects involved scientists and farmers working together to advance sustainability, their distinct differences provide valuable comparisons to assess learning in participatory projects.

Figure 1. Geographical location of projects
## Table 1. Synopsis of project objectives, actors and project initiator

<table>
<thead>
<tr>
<th>Project / Actors / Initiator</th>
<th>Objectives</th>
</tr>
</thead>
</table>
| **Crop Science for Māori**   | - Identify how Māori communities could transition from extensive agriculture to intensive organic horticulture.  
                                - Establish a reciprocal learning network providing scientific, education, and extension services to enable ECOP Trust to develop and implement ‘best’ organic vegetable farming practices. |
| (5 year project with 1 year extension) |                                                                                                                                          |
| **Actors:** Scientists & the East Coast Organic Producers (ECOP) Trust  
**Initiator:** jointly initiated by community and scientists |                                                                                                                                          |
| **Squash Rot**               | - Assess factors that influenced the extent of storage rot in squash (buttercup) fruit lines.  
                                - To develop a model of weather influences on squash growth and yield to assist with defining multi-factor influences on fruit yield and maturity. |
| (3 year project)             |                                                                                                                                          |
| **Actors:** Scientists & Squash Industry Group (Horticulture NZ), squash farmers & pack-house owners.  
**Initiator:** Scientists |                                                                                                                                          |
| **Potato Aphid Project**     | - Develop a pest management strategy to delay or prevent aphid insecticide resistance in potatoes to maintain options for pest control and potato quality.  
                                - Determine ‘best practice’ for the control of aphids and viruses in potato crops, and provide growers up to date information on aphid flights and infestation. |
| (3 year project)             |                                                                                                                                          |
| **Actors:** Scientists & Potatoes New Zealand (Horticulture NZ) & farmers  
**Initiator:** Scientists |                                                                                                                                          |
| **Walnut Blight Project**    | - Optimise the timing of copper-based sprays and understand and transfer best practice blight management to growers.  
                                - Develop an environmentally benign agent for blight control to reduce reliance on copper-based sprays. |
| (3 year project)             |                                                                                                                                          |
| **Actors:** Scientists & Walnut farmers from the Walnut Industry Group (WIG)  
**Initiator:** Farming Group (WIG) |                                                                                                                                          |
| **The Wheat Calculator**     | - Examine and quantify the effects of arable and vegetable growing practices on nitrate leaching.  
                                - Development of “user-friendly” software - the Wheat Calculator, to provide information on how wheat cultivars respond to nitrogen loadings and irrigation.  
                                - Increase farmer profitability by increasing yields & reducing farm inputs & improving environmental outcomes by limiting the effects of nitrate leaching. |
| (3 year project)             |                                                                                                                                          |
| **Actors:** Scientists & Foundation for Arable Research (FAR) & farmers  
**Initiator:** jointly initiated by FAR & scientists |                                                                                                                                          |
<p>| <strong>Precision Agriculture Projects</strong> |                                                                                                                                          |
|                             | - Co-ordinate on-farm research &amp; development.                                                                                               |</p>
<table>
<thead>
<tr>
<th>Farming Group</th>
<th>Farming group / Sector characteristics</th>
</tr>
</thead>
</table>
| **Crop Science for Māori** | - East Cape Region: economically deprived and geographically isolated.  
- ECOP Trust sought to improve the health, social, cultural, economic and ecological wellbeing on the East Cape by promoting cultural values.  
- ECOP Trust membership was very small – approximately 6-10 growers.  
- Community had limited understanding of science as a development tool.  
- Boundaries of influence limit knowledge sharing between communities.  
- Communally owned land makes development capital hard to secure. |
| East Coast Organic Producers (ECOP) |  |
| **Squash Rot** | - Group funded by grower levy, supported full time employee.  
- Product group of grower body (Horticulture NZ) with strong policy focus.  
- Complex industry value chain.  
- 5-6 corporate growers largely control the squash value chain.  
- Competitive industry players; price sensitive market. |
| Squash Industry group |  |
| **Potato Aphid Project** | - Group funded by grower levy, supported full time employee.  
- Product group of grower body (Horticulture NZ) with strong policy focus.  
- Complex, competitive value chain with three sectors: seed, process, table.  
- In the seed sector (where the project was targeted) profit margins are small.  
- Seed potatoes are rarely grown as a sole crop.  
- Most farmers’ contract grow for seed potato merchants. |
| Potatoes NZ |  |
| **Walnut Blight Project** | - Small emerging industry progressing towards commercial production.  
- Consists largely of part-time growers, many are scientists and other highly skilled professionals along with older retired couples.  
- Industry group formed by farmers to represent growers & access funding.  
- Voluntary membership, so dependent on grant success for group’s knowledge generation – no paid staff.  
- Long association with Lincoln University and access to trial orchard. |
| Walnut industry Group (WIG) |  |
| **The Wheat Calculator** | - FAR funded by grower levy, supported several full time employees.  
- FAR supports research and technology transfer in the arable sector.  
- Facilities located next to major science institutes. |
Results
An examination of how knowledge production occurred in each project revealed how projects fostered a discursive learning space for actors to engage, share, collaborate and co-develop. When the six projects were viewed through this knowledge production lens, they could be divided into three groups as discussed in below.

Linear knowledge production (scientist-initiated)
Although all projects employed a participatory methodology, linear processes were evident in two projects - the Potato Aphid and Squash Rot projects. Interestingly, both were scientist-initiated and farming actors were principally observers of the project’s research, rather than active research participants. Project steering committees managed both projects and farming actors largely ensured that the field research undertaken by the scientists aligned with farming operations. With minimal farmer engagement in fieldwork and a primary focus on data collection to answer ‘science’ questions, the development of a collaborative learning space was limited.

Methodology
The research used a case study approach (Yin, 2009) to gather empirical evidence from the six projects to explore how participatory research in micro-level agricultural projects created learning environments. Multiple sources of evidence were gathered from 84 stakeholder interviews (which were recorded and transcribed), eight participant observations and a review of project documentation and media articles. Interview participants included project actors including farmers, research scientists and farming group employees. In addition interviews were undertaken with actors from the wider agricultural innovation system.

Four of the projects had finished so were examined retrospectively, and two projects were examined while in progress. A large and rich corpus of data was collected and analysed to code, order and structure the data. Two ‘cycles’ of coding were applied guided by Saldana’s (2013) approach to analytical coding. In the first cycle, “holistic coding” (Saldana, 2013, p.142) was undertaken as a ‘grand tour’ to gain a first impression of the data corpus. This was followed by in-depth second cycle coding which led to 20 coding categories being identified. These grouped into three themes: the institutional context for innovation; partnerships and learning. This paper focuses on the ‘learning’ theme.

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The empirical evidence from the Squash Rot and Potato Aphid projects showed that when farmers are largely isolated from the fieldwork, a project is unable to foster a meaningful discursive space where partners can share, communicate, negotiate and build trust, to learn together and co-develop innovations. Project committees allowed partner input, but interactions typically focused on operational matters. While this may be useful for aligning operational and research components, it does not foster active engagement in a ‘learning by doing’ approach that is integral to effective participatory research (Douthwaite et al., 2003). The linear approach to knowledge production in these projects largely reflects the Transfer of Technology (TOT) approach to research and extension.

**Collaborative knowledge production (farming-group initiated)**

In the Walnut and Precision Agriculture projects, farmers and scientists collaboratively engaged. Both projects were established on partnerships initiated by the farming groups. Farmers in these groups (some of who were scientists) drew on both explicit codified and tacit knowledge to address issues. They valued science input and sought engagement with particular specialists, however they sought outcomes relevant to their farming business and expected this relevance to be evident in the project design. To maintain relevance field trials were managed by the farming group.

LandWISE and WIG saw themselves as innovators. The groups employed a ‘learning by doing’ approach and they actively facilitated field gatherings with members, sometimes only involving scientists as advisors or analysts of data collected by farmers. These small self-organised discursive spaces enabled farmers to share and co-produce knowledge. However, they drew on scientific expertise as needed to more deeply understand the complexities of the systems in which they farmed. They saw the science / farmer relationship as a synergy between what Ingram (2008) calls the ‘know-how’ of the farmer and the ‘know-why’ of the scientist.

While WIG and LandWISE maintained positive long-term relationships with scientists, they created a new power dynamic that directly challenged traditional linear approaches to research and extension. Despite positive partner relationships this new power dynamic challenged scientists’ desire for a robust and rigorous methodology to agricultural investigations. As a result, research in collaborative spaces led by these farming groups blurred traditional agricultural research boundaries.

**Negotiated knowledge production (joint scientist and farming group initiated)**

Negotiated learning spaces, where partners jostled for position, occurred where partners needed to become familiar with each other’s expectations before they could effectively collaborate. This occurred in the Crop Science for Maori and Wheat Calculator projects, which were jointly initiated by farming and science actors. Partners needed to establish a foundation of trust on which to build a learning space. For effective dialogue to occur, relationships needed to firstly be humanised (Yankelovich, 1999). This was most notable in the Crop Science for Maori project which operated in remote Maori communities. Here scientists needed to respect, learn and understand how to operate in a community with strong cultural values and limited understanding of science as a development tool. This required scientists to temper personal and organisational expectations about project timeframes and create greater flexibility in project delivery.
In the Crop Science for Maori project the positive relationships which developed over time provided the enabling factors for collaborative learning that sought to incorporate both Mātauranga Māori (Māori knowledge) and western science knowledge into project learning. The community wanted science knowledge to complement not replace their traditional knowledge. Only when trust was established could learning extend beyond a singular focus on kumara (Maori potato) crop production into issues such as market access which led to workshops where chefs provided tastings of specialty kumara dishes and scientists worked with the community to organise two food festivals to showcase their organic produce.

In the more conventional partnership of the Wheat Calculator project, science and farming actors were familiar with engaging and farming actors had more understanding of science. Trust building was still required however to overcome an early misalignment of partner priorities that led to a power struggle between partners. This exhibited as a clash between the scientists’ requirement for evidence-based findings that valued outputs that were robust and statistically rigorous, and the lived experience of farmers who sought knowledge that was relevant to farming practice. To become an effective learning space, actors needed to understand each other and to collaboratively create a shared vision.

Discussion
The examination of how knowledge was produced in the projects revealed that learning spaces were created most effectively in projects that fostered collaboration and where knowledge was co-produced. This environment created a ‘collaborative learning space’. Section 1 explores project characteristics that impeded or fostered a collaborative learning space, while Section 2 visualises how effectively the learning in the projects advanced sustainability.

1. Creating a ‘collaborative learning space’
The creation of a collaborative learning space is essential for fostering knowledge co-production that drives innovation and change. Knowledge co-production is created when collaboration, trust-building and negotiation between partners is fostered in this supportive learning space. Without active collaboration in projects, linear knowledge production occurs. Trust building is critical where relationships need to overcome initial power differentials and struggles as collaborative learning challenges institutions that attempt to maintain existing power relationships.

Boundary crossers, who connect actors from different sectors (Veitch et al., 2007) were often used to unlock the learning space. Farming groups who had a strong research focus, (LandWISE, WIG and FAR), took on this critical ‘connection’ role between science and farming actors and also fostered farmer to farmer learning. Their open and collegial cultures and structural arrangements supported collaborative engagement.

The empirical evidence revealed characteristics that impede and foster a collaborative learning space. Table 3 outlines the characteristics that impede collaborative learning while Table 4 outlines those that fostered the development of a collaborative learning space.
## Table 3. Project characteristics that impeded collaborative learning spaces

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Examples of empirical support from research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary focus on science / crop research not learning processes</td>
<td>Squash project focused on fieldwork for scientists to be able to develop a rot predictor tool. Potato Aphid project focused on gathering field data for scientists to develop a resistance management strategy. Crop Science for Maori project focused on <em>kumara</em> production, which under-estimated market requirements and led to a huge quantity of large sized <em>kumara</em> that the market did not value.</td>
</tr>
<tr>
<td>Scientifically complicated research ‘shoe-horned’ into participatory projects</td>
<td>Squash Rot project fieldwork was technically complicated and so provided few opportunities for collaboration.</td>
</tr>
<tr>
<td>Segmented roles for actors – Scientists responsible for the research while farmers take a passive role in project research</td>
<td>In the Squash and Potato Aphid projects scientists undertook the fieldwork. Farmers’ input was confined to project logistics to ensure science fieldwork aligned with farming operation.</td>
</tr>
<tr>
<td>Only formal arrangements for collaboration</td>
<td>In the Squash Rot and Potato Aphid projects, steering committees provided the primary site for partner engagement and discussion in the project.</td>
</tr>
<tr>
<td>Didactic teaching methods employed</td>
<td>In the Crop Science for Māori project scientists began with classroom-based teaching. The community resisted this ‘teaching’ approach to engagement.</td>
</tr>
<tr>
<td>Project knowledge production does not align with farming practice</td>
<td>The Wheat Calculator software initially did not reflect the way farmers managed their crop.</td>
</tr>
<tr>
<td>Organisational infrastructure does not support innovation</td>
<td>Information from field trials assessing aphid numbers was too slowly uploaded to the Potato Aphid project website. Potato Aphid’s ‘bowl traps’ presented problems for farmers’ aphid identification. Weather stations in the Crop Science for Māori project were technically cumbersome or inappropriate. Geographical isolation of the East Cape impeded regular collaboration between actors due to distance to field sites.</td>
</tr>
<tr>
<td>Institutions are not supportive of collaborative innovation and co-production</td>
<td>Industry / community institutional cultures in Potato Aphid, Squash Rot and Crop Science for Māori projects limited collaboration among community participants, e.g. limited sphere of influence across Maori communities. Scientists’ perception of farmers as receivers of science knowledge (challenged by farming group in the Wheat Calculator project)</td>
</tr>
<tr>
<td>Characteristic</td>
<td>Examples of empirical support from research</td>
</tr>
<tr>
<td>------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Learning by doing approach</td>
<td>Farmer experimentation played a significant part in farmers’ understanding of their environment e.g. LandWISE, and WIG farmers actively engaged in field experimentation; WIG’s benchmarking orchard work set protocols for blight management. LandWISE’s farmer-led trials allowed farmers to manage soil quality and to adapt and apply the learning to their farm conditions.</td>
</tr>
<tr>
<td>Co-development of innovation through learning by interacting and/or learning by using (Hekkert et al., 2007)</td>
<td>Active engagement with scientists to share knowledge: WIG and LandWISE contracted scientists to engage in field activities with farmers or advise on farmers’ trials. In the Crop Science for Māori project, growers and scientists co-developed knowledge so science knowledge complemented not replaced their traditional/local knowledge e.g. the production of a kumara growing calendar showed how local and science knowledge could be integrated into project learning and outputs.</td>
</tr>
</tbody>
</table>
2. Visualising collaborative learning for sustainability

To visualise and compare how effectively the six projects fostered learning spaces to address agricultural sustainability, a number of important characteristics with the potential to enable collaborative learning for sustainability were identified from the empirical evidence. These were tabulated to allow each characteristic to be compared across projects and each project to be compared across characteristics.

Each characteristic was qualitatively ranked for each project, as enabling learning (green); disabling learning (red) or being indifferent (orange). Figure 2 visually presents the characteristic ranks for each project. To increase the discrimination for each characteristic, cells of mixed colours indicate a project characteristic that was heterogeneous, to reflect variable actor responses for that characteristic.

Columns have been arranged across the figure in descending order of projects that enable learning. Rows were then similarly ordered in descending order of learning enablement across the six projects. This ordering concentrated those projects and characteristics with the greatest learning enablement in the top left corner of the figure, and those with the greatest learning constraints in the bottom right of the figure.

It can be seen that following the rearrangement of the table as described, the projects have grouped into a 2 x 2 x 2 pattern which coincides both with the groupings of who initiated the project, and also the type of learning space (linear, collaborative or negotiated) that was created. Farming group-initiated projects (which created collaborative knowledge production) had the greatest degree of learning enablement followed by shared partnerships (negotiated knowledge production) where learning enablement was heterogeneous across almost every characteristic and science-initiated projects which largely disabled collaborative learning. Within the science-initiated projects a few characteristics were heterogeneous but none fully enabled collaborative learning.

Comparing these characteristics across the investigated projects provides insight into the effectiveness of individual projects and of projects collectively in realising and most importantly optimising learning for sustainability in the collaborative learning space. Of particular importance in Figure 2 are the learning attributes that contain characteristics that should be evident in innovation projects addressing agricultural sustainability. Co-development and trans-disciplinarity indicate evidence of an enabling learning environment for innovation (Curry et al., 2012; Wieczorek & Hekkert, 2012). Temporal and spatial dimensions recognise the need for innovations to address long-term issues and recognise differing scales. The longevity of project learning has also been explored to see if the outcomes from collaborative learning are sustained in farming communities beyond the funded period of a project, a characteristic argued to be important in sustainability projects and usually indicative of institutional capacity building at the local level (Pretty, 1995). The comparative analysis of the six projects shows the collaborative learning space to be highly variable.
Figure 2. Visualising project realisation of learning for sustainability

<table>
<thead>
<tr>
<th>Project Attributes</th>
<th>Farming Initiated</th>
<th>Shared Initiated</th>
<th>Science Initiated</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Precision Agriculture</td>
<td>Walnut Blight</td>
<td>Wheat Calculator</td>
</tr>
<tr>
<td>Farming relevance of objectives</td>
<td>Enabling</td>
<td>Neutral</td>
<td>Disabling</td>
</tr>
<tr>
<td>Collaborative project governance</td>
<td>Enabling</td>
<td>Neutral</td>
<td>Neutral</td>
</tr>
<tr>
<td>Mindset of actors to participatory research</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
</tr>
<tr>
<td>Positive actor relationships</td>
<td>Enabling</td>
<td>Neutral</td>
<td>Neutral</td>
</tr>
<tr>
<td>Networking and feedback loops</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Institutional support for participatory research</td>
<td>Enabling</td>
<td>Neutral</td>
<td>Neutral</td>
</tr>
<tr>
<td>Farming partner funding security for science research</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Partners co-develop</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
</tr>
<tr>
<td>Learning sustained beyond project</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
</tr>
<tr>
<td>Temporal scale of sustainability learning acknowledged</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
</tr>
<tr>
<td>Transdisciplinarity</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
</tr>
<tr>
<td>Spatial scale of sustainability learning acknowledged</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
</tr>
</tbody>
</table>
Conclusion

This research shows that actor engagement and learning to address sustainability is a complex social process. As a result the creation of a ‘collaborative learning space’ in micro-level agricultural projects is highly variable. The development of this learning space is critical as the complexities of sustainability will necessarily require integrating different perspectives and knowledges to facilitate questioning of the assumptions and values that drive current practice.

Where changes to agricultural practices are sought as an outcome, actors need to actively engage in a collaborative learning space. In this research this collaboration most effectively occurred in informal peer networks where participants collaboratively engaged in a discursive learning space. Such transdisciplinary environments acknowledge the constructed nature of agricultural knowledge.

When participatory projects create opportunities for multiple stakeholders to collaboratively learn, issues can become apparent, negotiated and resolved. Reframing current understanding of participatory research and conceptualising it as a collaborative learning space provides the opportunity for knowledge to be co-developed where learning can be emergent, adaptive and dynamic.
References


How agroecological farmers develop their own practices: a grid to describe the objects and mechanisms of learning

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Abstract: The agroecological transition - defined here as a transition toward practices based on the management of ecological processes - requires innovations involving a wide range of stakeholders, from farmers to scientists or intermediaries. An extensive literature has shown that agroecological farmers' practices cannot be exclusively based on the application and adaptation of general recipes to the specific context of their farms. For intermediaries, supporting farmers' calls for opening innovation spaces in which they can develop their own practices and generate innovative agroecological knowledge rooted in their peculiar agroecosystem. As a consequence, we argue that it is important to better understand how this knowledge is developed. The ways in which farmers learn, however, remain poorly investigated at the individual level. The major role of experience in learning leads us to build on Kolb's pragmatist theory and to consider the individual learning process as a continuous interplay between a farmer's experience and his or her capacity for action. The purpose of this paper is to propose an analytical grid to describe the mechanisms connecting the farmer's experience and his pragmatic judgements. To do so, we focused on the case of conservation agriculture. We conducted five semi-structured interviews with experienced farmers and analysed them qualitatively. The resulting grid exposes an array of learning mechanisms as well as the objects they may be linked with. This analytical grid may, in the future, be applied to a wider sample of farmers, as a means to better grasp the possible diversity of their learning processes. A deeper understanding of these processes would then help intermediaries to identify which types of support are the most adequate for farmers engaged in the agroecological transition.

Keywords: Agroecology, conservation agriculture, experiential learning, pragmatic judgement

Introduction

Agroecological practices, defined here as production practices based on the management of ecological processes, need to take into account the complexity of these processes as well as their very local characteristics, as minor variations in soil composition, microfauna communities and so on may affect the results of a given practice. Consequently, farmers cannot simply apply general recipes produced by agronomists at a large scale, with only minor adaptations to the ecological specificities of their farm. On the contrary, it has been argued extensively (Altieri, 2002) that agroecological practices need to be developed by farmers in close relationship with their own local context (which includes both the ecological environment and the specificities of the production system). In other words, this questions the system of knowledge transfer, where intermediaries would have the role of expert in charge of educating farmers and giving them the technical solutions ready to be applied.

An agroecological farmer's knowledge must be, at least partly, very specific to his local conditions (Richardson, 2005; Knapp & Fernandez-Gimenez, 2009). However, even though recognising the importance of farmers' knowledge seems crucial in the agroecological transition, this knowledge cannot be directly 'transferred and applied', from one farmer to another. Knowledge exchange between farmers has been shown to provide great benefits to
the participants (Millar & Curtis, 1997; Ingram, 2010), but more as a way to promote the circulation of ideas that still have to be tested, adapted and so on. Therefore, understanding not only what agroecological farmers learn, but also how they learn it, seems especially interesting. Such an understanding could indeed help intermediaries (Koutsouris, 2014) in supporting farmers willing to engage in agroecological practices, by highlighting ways to foster the development of adequate solutions by the farmers themselves.

Theoretical background: understanding the learning processes as a way to support farmers in their own transition

Various studies have explored farmers’ knowledge in a large range of production systems, from traditional smallholders in poorer countries to larger conventional farms, from fruit and vegetable producers to cattle breeders (Thomas & Twyman, 2004; Richardson, 2005; Knapp & Fernandez-Gimenez, 2009). According to Girard (2014), these works can be classified into four categories, depending on their goal regarding farmers’ knowledge: use farmers’ knowledge as an inspiration for innovation, evaluate the current state of farmers’ knowledge to improve it, promote knowledge exchange between farmers and document farmers’ knowledge to support its role in development. In addition to these four types of use of farmers’ knowledge, other authors developed ways to describe more precisely this knowledge; Toffolini, et al. (2014), proposed a grid to describe the different forms and characteristics of knowledge used by farmers in their daily activities. Although such works shed light on what farmers’ knowledge is and how it can be used, they leave aside the question of how farmers come to develop such knowledge.

Farmers’ learning in particular situations

Other works have approached the way farmers learn, but focusing on particular ‘learning situations’. Drawing on the pragmatist distinction between a context and a situation, we here consider a learning situation as a “set of conditions taking part in the development of an individual’s capacities” (Zask, 2008). Moreover, this ‘set of conditions’ is taken here in a restricted sense, to indicate a situation fairly limited over time. A learning situation could thus be an interaction with a scientist, a meeting of a knowledge exchange group among peers and so on.

Some studies explored the learning situations involving an ‘expert’, such as a more experienced farmer or a technician. For instance, Labarthe (2009) investigated the role of agricultural extension services in farmers’ learning, and showed how the complex relationships between public and private agricultural extension stakeholders may hamper real support for farmers’ learning. In a different setting, Chrétien (2015) examined the transmission of organic farms and described the specificities of the learning processes involved in the interactions between the newcomer and the leaving farmer. Another set of studies concentrated on learning situations involving knowledge exchange groups. Building on two case-studies of Australian breeders, Millar and Curtis (1997) suggested that farmers may undervalue their own knowledge, and that exchange among peers may help them gain awareness of their own knowledge, as well as facilitate the construction of common understanding between farmers and scientists. Along the same lines, McGreevy (2012) examined the synergies and blocking points in the knowledge exchanges between incoming organic farmers and local family farmers in upland Japan.

Finally, some authors have focused on learning situations corresponding to farmers’ experiments. Lyon (1996) explores how English farmers “research and learn” and compares
this process with scientific methodology, arguing that these two types of experiments are
driven by different goals, and should thus be regarded as complementary. More recently, quite
a few studies have further documented farmers’ experiments in diverse production systems
(Milestad et al., 2010; Kummer et al., 2012).

These studies have described and analysed a diversity of learning situations for farmers, but
in a somewhat fragmented way in the sense that these varied situations (exchanging with
peers, experimenting, etc) are explored independently from one another.

Learning across multiple learning situations
Farmers experiment and exchange with peers and experts on a regular basis. These different
learning situations must in some way interact with one another, and their combinations may
produce a variety of outcomes. Consequently, we argue that it is especially interesting to
understand the learning process as a whole across multiple learning situations.

In the past few years, some authors have started to adopt such an approach. Kilpatrick and
Johns (2003), among others, showed that a random sample of Australian farmers display a
diversity of ‘learning patterns’, each including a variety of learning mechanisms such as
seeking information from experts, observing a practice chosen by a peer, etc. Ingram (2010)
explored the learning processes of farmers practicing reduced tillage, and described them
according to two main dimensions, namely “on-farm learning, the technical dimension” and
“social learning, the social dimension”, thus providing some thoughts on how to combine
different learning situations. More recently, Chantre et al. (2014) identified “configurations of
learning conditions” for farmers who try to reduce their use of fertilisers and pesticides: in other
words, they described how farmers articulate experience and information gathering, and more
specifically how they integrate inputs from resource persons along three phases of learning -
warning sign, experiencing and evaluating.

In this paper we aim to build on these works to investigate the learning processes of farmers,
but in the more specific case of agroecology. As discussed earlier, such practices rely on very
local knowledge and require farmers to learn in a context of uncertainty and lack of information.
As a consequence, the learning process of farmers who practise agroecology may present
specificities that have not yet been analysed.

Conceptual framework and goal of this study
Experience is clearly highlighted in these studies of diverse farming systems as a major aspect
of learning. Moreover, in the context of agroecology, practices are deeply rooted in a particular
environment, which leads us to consider that an agroecological farmer’s continuous
experience may play an especially important role in his learning process. We thus chose to
Contrary to the view that learning can be seen as a simple transfer of knowledge from a
knowledgeable person to a learner (a point of view which has been largely criticised, see
Freire, 1970), this theory considers the experience lived by a person as the very basis of this
person’s learning. As a consequence, we here consider learning as a continuous interplay
between a farmer’s experience and his or her pragmatic judgement (Pastré, 2005), as
presented in the figure below. By ‘pragmatic judgements’, we here mean the diversity of
“concepts that organise actions” (Pastré, 2005), which can include decision rules at a very
specific level and more general principles of action.
Figure 1. Learning as a continuous interplay between a farmer’s experience and his pragmatic judgement. The concentric circles represent the diversity of pragmatic judgements. The continuous interactions between experience and pragmatic judgements are shown as thicker light grey arrows, while the thinner dark grey arrows represent inputs from peers, scientific sources, etc., which may affect these interactions.

A farmer’s experience is the basis of his elaboration of a pragmatic judgement, which in turn affects what experience is lived. Interactions with peers or experts, and gathering of information from a diversity of documents, also contribute to this process. Consequently, even though we chose to base our study on experiential learning theory, we fully acknowledge that learning does not happen solely in one’s field, in a strictly individual way; we only choose to focus on personal experience and the way external sources of knowledge are incorporated in experiential learning, rather than focusing on knowledge dynamics among members of a group for instance.

The succession over time of these interactions between experience and pragmatic judgement is what we here call the learning process; meanwhile, we use the term learning mechanism to refer to the way in which each of these interactions may happen: the learning process is a sequence of learning mechanisms. Because learning mechanisms may not necessarily be the same depending on what the farmer is learning, we also use the notion of object of learning to refer to the object learned about. To understand the learning processes of farmers practising agroecology, we suggest that a first step may be to describe the diversity of learning mechanisms and learning objects –moreover, we will here restrict the learning objects to those directly related to agroecological production practices.

Consequently, the goal of this paper is to propose two grids to describe the mechanisms and objects of learning in the case of farmers experienced in terms of agroecological practices.

Methodology

The case study: conservation agriculture

Conservation agriculture is commonly dated back to the 1930s, when the ecological and human catastrophe of the ‘dust bowl’ in the American midwest prompted scientists and farmers to develop a set of practices aiming at reducing soil erosion risks, while also improving the
agronomic properties of the soil (although similar practices, also linked with soil erosion, were likely happening as early as the late 19th century –Birkas et al., 2004). The term is used mostly for field crops, and it is based on three main principles: reduced tillage; permanent soil cover and more complex cultural successions (De Tourdonnet et al., 2013; Pittelkow et al., 2014). Each of these principles covers a large diversity of possible practices:

- reduced tillage may include a gradient from shallower ploughing to no ploughing at all, use of tools that crack the soil without disturbing its structure, direct seeding...

- permanent soil cover may be accomplished through the use of mulch, ramial chipped wood, diverse cover crops...

- more complex cultural successions can include varied crops with a diversity of nutrient needs, root systems, symbiotic capacity (in the case of legumes especially)...

However, all these practices are directed toward similar goals. For instance, reducing the perturbation of the soil and protecting it through the use of covers globally aims at enabling soil biodiversity to develop and ensure the recycling of organic matter as well as the structuration of the soil itself (Farooq & Siddique, 2015). In other words, conservation agriculture principles aim at fostering ecological processes that provide a benefit for the agricultural system: in this sense it can be considered as an example of agroecological practices as previously defined.

Sample and data collection: semi-structured interviews with 5 south-western French farmers

Conservation agriculture is a particularly promising example of agroecological practices in south-western France, since soil erosion is especially high in that region (GIS Sol., 2011): we consequently chose to base our study in this area. We interviewed 5 farmers (all men), members of a local conservation agriculture association - AOC Sols (“Association Occitane de Conservation des Sols”, http://aocsols.free.fr/) who had practised reduced tillage, permanent soil cover and complex cultural successions for at least 6 years. We chose this time frame because of previous studies (Pittelkow et al., 2014) which indicated that the transition towards conservation agriculture usually includes a deterioration of the soil conditions around the third year, and that it takes about 5 years for the benefits of the practices to be effective.

Our qualitative data was gathered through face-to-face semi-structured interviews, always conducted by the same person. Because we had no a priori hypothesis to be tested, these interviews were largely exploratory, and were thus conducted in a rather loose way to follow the line of thought of the farmer and enable new topics to emerge (Blanchet & Gotman, 1986). However, even though a certain freedom was given to the interviewee, we made sure that the three main aspects of conservation agriculture (reduced tilling practices, soil cover and crop succession) were discussed at some point, as well as the relationships and knowledge exchange with other farmers, scientists and extension agents.

Data analysis: qualitative structuration of interviews through inductive coding

The interviews were integrally transcribed and a qualitative analysis of content was then performed using the Nvivo® software. We constructed separately the grids of the mechanisms and objects of learning; for the grid of objects of learning, we proceeded as follows.
Taking one interview after the other, in random order, we coded the objects of learning in the inductive way characteristic of “conventional coding” (Hsieh & Shannon, 2005). Our strategy was close to grounded theory (Glaser & Strauss, 2009), and consequently there was no previously defined list of nodes to be used.

Each time the interviewee talked about something he learned, we coded this excerpt of the text with a short expression describing ‘what the farmer learned about’. We used words that were as close as possible to the farmers, while also trying to choose an expression not too specific to one particular excerpt, so that it could be re-used to code other parts of interviews dealing with the same object. We observed that saturation (or the absence of apparition of any new object) was reached around the end of the fourth interview.

The data thus structured into smaller units through coding was then used for “gradual construction of a system of categories” (Langley, 1999), encompassing the various discourses of interviewed farmers. Because the categories of mechanisms and objects of learning had to be sufficiently general to include elements of discourse from different farmers, we could not keep strictly to the words used by each interviewee. Consequently, the labels of the categories of objects and mechanisms of learning are often scientific terms, chosen because they were large enough to encompass the diverse specific expressions used by different farmers.

The same method was then applied again to the 5 interviews to obtain the grid of mechanisms of learning.

Results

Objects of learning of farmers experienced in conservation agriculture

Figure 2 represents in a systemic way the major objects of learning emerging from our interviews. We distinguished three kinds of objects of learning: biological objects (such as pests or cover crops); relationships between biological objects (such as the effect of some crops on weeds) and relationships between a practice and a biological object (such as the effect of tillage on soil micro-fauna). These diverse objects of learning revolve around three large themes which are the three main aspects managed by the farmers, namely soil, cultivated biodiversity and non-cultivated biodiversity.

The farmers interviewed expressed learning about both the physico-chemical and the biological characteristics of the soil. The physico-chemical properties encompass elements regarding the structure and the composition of the soil: soil structure includes the characteristics of the soil layers at a given time as well as the propensity to erosion. Soil composition covers chemical content and micro-geological characteristics. The physico-chemical characteristics of the soil are deeply affected by agricultural practices, and farmers repeatedly talked about the observed effects of different tillage practices on soil structure (e.g. compaction of the soil and reduced water retention). The biological properties of the soil – its micro-fauna and micro-flora - were also frequently evoked, as well as their response to practices such as tillage.

We decided to divide the second theme – non-cultivated biodiversity - according to the roles farmers said it played for them, which led to three categories: harmful biodiversity, helpful biodiversity, and neutral biodiversity:
Harmful biodiversity includes pathogens, pests and weeds, all of which affect, and are affected by, the cultivated biodiversity, i.e. crops. The effects of crops on weeds may happen through a diversity of ecological processes managed by farmers, such as competition (with the planting of a cover crop to make it harder for weeds to start growing) or allelopathy ("Because oat […] hampers weeds a lot. You have barley, oat, but oat is maybe one of the most...It has allelopathic virtues, or I don't know what, that are quite exceptional"). The choice of crops may also affect pathogens and pests by disrupting their life cycles and depriving them of a suitable habitat.

Helpful biodiversity includes species that present an intrinsic advantage for agricultural production (for instance, any bacteria or worms participating in organic matter recycling), and species that are used by the farmer as indicators (e.g. birds used as a way of knowing whether or not insects are present).

We call neutral the biodiversity which does not, according to the farmers, explicitly play a direct role in the production system.

Regarding the third theme, cultivated biodiversity, farmers mentioned learning about seed selection and the effect of climate on crops. The effects of cultivated biodiversity on soil structure often appeared in farmers’ discourse, for instance through the use of cover crops to mitigate against soil erosion, or the choice of specific crops such as sorghum to alleviate soil compaction.
Figure 2: Objects of learning of farmers experienced in conservation agriculture. The three rectangles indicate the main themes of learning, while the circles represent biological objects included in those themes. The thinner grey arrows represent relationships between biological objects, while the larger arrows represent the effect of a practice on biological object.
Learning mechanisms of farmers experienced in conservation agriculture

Table 1 presents the mechanisms of learning emerging from our interviews. We organised them into five categories corresponding to different steps in the learning process: these possible steps are not always present for each farmer, nor do they represent a logical sequence which is necessarily followed. They are merely larger categories which we defined to cluster more specific learning mechanisms.

Get an idea for a new practice. This may happen on one’s own, or it may result from exchanges with peers, either directly (i.e. getting the idea from another farmer) or indirectly (i.e. on the basis of exchanges with peers, getting inspiration to personally conceive a new practice). It may also come from scientific sources, again, directly or indirectly.

Implement a new practice. Farmers talked about implementing new practices at a variety of spatial scales (e.g., trying a cover crop on a smaller area first, or on a whole field at once) and time scales (e.g. trying direct seeding of corn in just one year, or trying it over several years to see whether or not the specific climatic conditions of the first year made a difference). New practices may also be implemented more or less progressively: some farmers try stopping tillage altogether, whereas others go through gradual change from a 50cm ploughing to 30cm and then 15cm and so on, assessing the results as they proceed.

A farmer may implement a new practice in a more or less planned way, and we have identified three types of experiment: planned experiments, that are willingly foreseen and conducted by a farmer; opportunistic experiments, that happen when some mishap puts a farmer in an unexpected situation, prompting him to try something new which he would not otherwise have tried, and fortuitous experiments, that are not decided on by a farmer but happen anyway (e.g. when a mistake leads to interesting results). As this last category is wholly unplanned, it can happen simultaneously to a group of peers, but it cannot include any scientific input, hence the exclusion of the ‘scientific inputs’ column in the Table 1.

A farmer may implement a new practice on his own, but exchanges with peers may also affect how he decides to go about experimenting. Scientific documents or extension agents may also provide methodological inputs to plan an experimental design.

Monitor the state of the system. Farmers may monitor their system or parts of it in a qualitative or quantitative way, at different frequencies and spatial scales, with a variety of indicators (coming from scientific sources, co-developed with peers and/or personally developed).

The analysis of such monitoring may also be more or less formal (from a very rough guess to a computer-aided statistical analysis including a diversity of independent variables).

Get standards/points of comparison. Farmers form an idea of what their system or parts of it should be like and what its performances should be, either on their own or based on exchanges with peers - leading to the construction of a common ideal, comparison with other farmers’ systems and/or scientific standards.

Assign a certain degree of validity to a principle. Farmers expressed to different degrees their needs to understand the cause of an observed phenomenon in order to consider it as generally true. Such an explanation may come directly from peers or scientific sources, or be more indirectly inspired by such sources.
Table 1. Learning mechanisms of farmers experienced in conservation agriculture. The left-side column indicates the main possible steps of the learning process and the upper line presents the different sources that a farmer may mobilise when going through these different steps.

<table>
<thead>
<tr>
<th>Personal experience</th>
<th>Peers’ inputs</th>
<th>Scientific inputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Get an idea of a new practice</td>
<td>Conceive a new possible practice</td>
<td>Find an idea of a new practice from a scientific source, by getting inspiration from peers’ practices</td>
</tr>
<tr>
<td>Implement a new practice</td>
<td>Choose a time scale</td>
<td>Choose a spatial scale</td>
</tr>
<tr>
<td></td>
<td>Experiment in a planned way</td>
<td>Choose a degree of intensity of change</td>
</tr>
<tr>
<td></td>
<td>Experiment in an opportunistic way</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Experiment in a fortuitous way</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Implement a new practice individually</td>
<td>Implement a new practice collectively</td>
</tr>
<tr>
<td></td>
<td>Rely on scientific methods to conceive an experimental design</td>
<td>Be reassured of a decision already taken thanks to a scientific input</td>
</tr>
<tr>
<td>Monitor the state of the system</td>
<td>Monitor the system in a quantitative or qualitative way</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Monitor a specific experiment, or monitor the system in a more general way</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Choose a frequency and spatial scale for monitoring activities</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Find indicators for the information desired</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Analyse the information obtained through monitoring in a more or less formal, quantitative way</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Choose a time and spatial scale for analysing the information obtained through monitoring</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Take into account independent variables</td>
<td></td>
</tr>
<tr>
<td>Get standards</td>
<td>Reject peers’ standards</td>
<td>Compare own system with peers’ systems</td>
</tr>
<tr>
<td></td>
<td>Construct and share common ideals</td>
<td>Judge the state of the system with respect to scientific standards</td>
</tr>
<tr>
<td>Elaborate a principle of action</td>
<td>Confirm or disprove information coming from a scientific source</td>
<td>Confirm or disprove information coming from a personal observation</td>
</tr>
<tr>
<td></td>
<td>Confirm or disprove information coming from peers</td>
<td>Confirm or disprove information coming from a scientific source</td>
</tr>
<tr>
<td></td>
<td>Put together different personal experiences</td>
<td>Confirm or disprove information coming from peers</td>
</tr>
</tbody>
</table>
Discussion

These results show an extensive diversity of objects and mechanisms of learning for farmers experienced in conservation agriculture practices. However, we do not claim that these grids are exhaustive; quite the contrary, we suggest that they should be taken as a starting point to better qualify the full diversity of objects and mechanisms of learning. Although our sample already presented fairly diverse approaches to learning, it is important to note that because our interviews were conducted with farmers belonging to the same conservation agriculture association and same geographical area, it is possible that part of their discourse is more homogeneous than it would otherwise be. As a result, we are currently interviewing a broader sample of farmers, taken out of this specific context, to complete the grids. In addition, in order to better approach the learning mechanisms and objects which may not be easily verbalised, our further work will include more observation and interviews in the fields.

It will also be interesting to explore the relationships between objects and mechanisms of learning. Indeed, our interviews suggest that a diversity of learning mechanisms may be linked with one same object, but these relationships remain to be clarified. In particular, if some mechanisms are more specifically mobilised by farmers to learn about a given object, then knowing this could help intermediaries to better tailor their actions towards farmers to support them in learning to develop their own practices. These grids may also be used as a first step to investigate the interconnection of the learning mechanisms and their succession over time, or in other words, the learning process as a whole. The learning process may also involve changes in the objects of learning, and further work will help identify the modalities of such changes, i.e., how a succession of learning mechanisms related to one object may result in another sequence of learning mechanisms linked with another object.

We focused here on objects of learning directly related to production practices (biological objects, relationships between biological objects and effect of a practice on a biological object),
however learning may also occur for other types of objects. More specifically, we suggest that developing agroecological practices such as conservation agriculture may induce a change in pragmatic judgements about objects such as oneself, one’s role in society as a manager of natural resources, one’s desired relationship with nature etc. These objects and their role in the learning process as a whole could be envisioned through the theory of double-loop learning (Argyris, 1982): learning about objects directly related to production practices could be considered as first-loop learning, which may in turn induce a second-loop learning dealing with those broader objects. Such a learning process seemed to appear in our interviews, for instance when a farmer explained how learning to change his seeding techniques (from a conventional method to direct seeding) made him reconsider the whole technical orientation of his system and try to develop new methods based on ecological processes through, for example, a diversification of crops.

Understanding in more detail how learning happens for farmers experienced in agroecology is crucial to better tailor extension services and agricultural support generally. If we can identify more clearly which kind of evidence (a scientific explanation of the phenomenon, an observable example at a neighbours…) are required by farmers to consider something as a rule of action, then it may be easier for intermediaries to efficiently search for and expose such evidence. Having a clearer idea of the objects that farmers feel a need to think about, and how they relate these objects to each other, may also help in defining the focus of extension services.

Conclusion
Our study enabled us to present a diversity of objects and mechanisms of learning for farmers experienced in conservation agriculture and to propose organised, although non exhaustive, sets of these objects and mechanisms. This analytical framework may be used as a starting point towards a more comprehensive characterisation of the multiple-loop learning processes of agroecological farmers. The learning processes may well be very varied so any promising research path would need to highlight some steadier aspects, or try to establish a typology of learning styles, based on an understanding of the learning process as a whole, for farmers experienced in agroecological practices. A deeper understanding of the diversity of learning processes may then be mobilised by intermediaries to better tailor their support for farmers engaged in agroecological practices.
References


Farming system transformation as transition to sustainability: a Greek quality wines case study

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Abstract: This study aims at analysing the gradual transformation of a low input and bulk wine producing system into a quality system. This transformation is examined in Santorini Island in Greece during the last three decades, in a highly contested natural landscape. The conceptual framework draws from the ‘transition to sustainability’ approach, in particular the theoretical apparatus of the multi-level perspective (MLP). Spaces for innovations as well as threats for this transformation have been created by a series of ‘socio-technical landscape’ pressures, along with processes internal to the ‘niche’, the links between the niche and the ‘regime’, as well as multi-regime interactions. Public intervention in the form of both regulatory and incentive provision policy measures had a considerable impact on creating space for these reconfigurations and innovative forms of organisation. A series of conflicts have been identified, as well as a polarisation in the power game. Despite significant efforts for co-ordination among local stakeholders, there’s a need for more permanent forms of co-operation such as an innovation platform. The interests vested are important hence the necessity of an institution acting as a mediator seems to be apparent.

Key-Words: Transition to sustainability, space for innovation, quality wines, Greece

Introduction
Various challenges and change in agri-food systems have increasingly been analysed from the ‘transition to sustainability’ perspective over the last 10-15 years (Hinrichs, 2014). In a similar vein, following a systems approach, innovation is considered as a successful combination of new technical devices and practices, new knowledge and new social institutions and forms of organisation (Smits & Kuhlmann, 2004).

Deliberate efforts for the development of a quality wine sector in Greece date back to the early 1960’s. An early system of labeling was introduced in 1970’s, and after Greece’s accession into the EEC/EU in 1981 quality in the wine sector has been promoted within the overall European regulatory framework.

More recently, the Greek wine sector is characterised by both declining production volume and quality upgrading. While the total wine production has decreased by 23%, between the 2004-2009 and 2010-2015 periods (i.e. before and during the current crisis), wines without any quality certification have been reduced by 36.4% while quality wines have increased by 83.2% (MRDF, 2016). Thus, between these periods the share of all quality wines has more than doubled (from 11.3% to 26.8%) whereas in early 1990’s quality wines contributed 6% to the total wine produce of the country.
The wines of Santorini island have always been the spearhead in these efforts. Santorini’s wines entered a new era after they received their own Appellation of Origin, especially after 1981 (see below). Nowadays, high quality wine production aiming at the global market is an integral part of the local production system. In the course of transforming this system, a series of innovations have been introduced and established, including the use of new technological and biological means, as well as changes in specific farming practices.

It has to be noted that following a complex adaptive system approach, development in tourist areas can be understood as a multilevel, co-evolutionary process, involving diversification in tourist products which requires, inter alia, networking activities among actors and various niche innovations (Hartman, 2016).

This study aims at analysing the gradual transformation of a low input and bulk wine producing system into a quality system. This transformation is examined in Santorini island in Greece during the last three decades, in a highly contested natural landscape. The conceptual framework draws from the ‘transition to sustainability’ approach, in particular the theoretical apparatus of the multi-level perspective (MLP). Spaces for innovations as well as threats for the transformation examined here are explored in the context of a series of ‘socio-technical landscape’ pressures along with processes at the ‘niche’ level. The study is based on material mainly collected in the context of the EU-7th Framework Programme FARMPATH (“Farming Transitions: Pathways towards Regional Sustainability of Agriculture in Europe”), as well as in previous research on the same area.

Data within the FARMPATH project were collected through open-ended interviews with 20 stakeholders, including the local Department of Agriculture, the local co-op representatives, wine makers and representatives of national collective bodies of wine makers. Previous research addressed the topic of the island’s landscape and was carried out through discussions with local key informants (wine makers, agronomists, co-op representatives, etc.).

The paper consists of six parts. The second part comprises the conceptual framework, with the third part giving an account of the construction of space for innovation in the framework of the emerging transformation. The key role of policies is examined in the fourth part and a series of conflicts, synergies, open issues and the need for mediation are discussed in the fifth. The paper concludes in the final section.

**Conceptual Framework**

The substantial transformation of socio-technical systems to more sustainable modes of production and consumption, i.e. their ‘transition to sustainability’, has taken a prominent place in the academic literature over the last 10-15 years. The multi-level perspective (MLP) has been the main theoretical framework for this research, using the analytical categories of regime, landscape and niche (Geels, 2011). MLP contends that transition comes about as a result of pressures from the broader ‘landscape’, combined with the propagation of innovations that have been nurtured at ‘niches’ (Konefal, 2015).

In this context, an agri-food regime can be conceptualised as a configuration of co-evolving technical, social (actors and networks involved) and institutional (prevailing values, knowledge systems and policy measures) elements (Ingram, 2015). On the other hand, the socio-technical landscape is perceived as an exogenous environment that affects both the regime
and the niches by exerting pressures, which can create tensions and offer opportunities for change (Geels & Schot, 2007).

Of major importance to any transition are the processes taking place within a niche, i.e. a ‘nursery’ in which various novelties can be tested and developed (Kemp et al., 1998). With the active contribution of local actors and networks, these niche innovations, after their initial development, could be successfully linked to the regime, thus setting in motion broader transformative changes at the regime level. On the other hand, from a systems perspective, a multitude of stakeholders and networks are involved in an innovation process, while innovations include new social and organisational arrangements (Leeuwis & Aarts, 2011). In exploring the potential of ‘space for innovation’, the processes of development of a niche are of prime importance, especially the articulation of expectations and visions, as well as the building of social networks and the enrolment of more actors (see also Schot & Geels, 2008).

Moreover, transition is a process with an ‘uncertain’ outcome, which usually involves frictions, tensions and competing views on the direction of change. As innovations are being introduced in a niche and break through into the agri-food regime, both the internal structure of the regime and inter-regime relations are rearranged. Thus, serious contradictions as well as a series of unresolved issues (e.g. from multi-regime interactions) may emerge, which may hamper the overall momentum of the transition under study.

By using this framework, the actual and/or the potential role of mediation can be identified, which could be beneficial to the innovation process by closing system gaps, facilitating network formation and managing the innovation process (Kilelu et al., 2011).

**Space for innovation in an emerging transition**

**Socio-technical landscape pressures**

During the last three decades, the time frame of our paper, there have been two main driving forces conveying various pressures upon the local regime.

Firstly, tourism development (since the early 1980s), which mainly affected space and labour, the most contested dimensions of the local regimes. The emerging tourism industry of the island was in dire need of both of these elements. As land has always been a scarce resource and the ownerships were small and highly fragmented, the increased demand for land, for the construction of hotels and other tourism enterprises, resulted in a considerable increase in land prices, including agricultural land. At the same time, attractive salaries were offered to the local labour force in both tourism and construction, therefore absorbing obscured unemployment and reduced out-migration.

However, within the process of expansion and growth of the tourism industry worldwide, global changes such as improved transport infrastructure and lifestyle changes, as well as saturation of certain market segments, caused the emergence of strong trends within the tourism industry towards the provision of differentiated and diversified tourism services. New forms such as ecotourism, cruises, wine tourism or combinations of these emerged during the 1990s and gained an impetus. Big hotels and mega-installations were not sought after any more, hence the demand for land became more eclectic; smaller pieces of land and the landscape became an asset. In parallel, the transition processes in Eastern European economies and elsewhere
during the 1990s created a large pool of available labour. These changes seem to have had an impact on both the local land and labour markets.

An additional sociotechnical landscape pressure has been the development of a worldwide market for quality wines in which globalisation is manifested through a strong tendency towards homogenisation of the taste and the creation of ‘international wines’ (Nositer, 2010). Based on sales and exports data, the market for quality wines can be seen to have expanded rapidly during the last decades. Thus, various changes have occurred in order to facilitate a new way of co-ordination of the wine production stakeholders so as to deal with the various external threats or opportunities concerning wine production (Barbera & Audifredi, 2012).

The globally widespread perception of ‘localness’ and provenance as an element of quality, especially for wine, has been a further socio-technical landscape feature that seems to have played an important role in the changes that occurred in Santorini wineries. There are quite a few elements that suggest that geographical indications (GI) provide a considerable added value to wine, e.g. a price differentiation for GI wines (EC, 2012). However, the role of ‘terroir’ as a decisive factor of quality, is not as incontestable a fact as one might expect (Josling, 2006). Especially in the case of quality wines, the debate is ongoing re issues of grape (variety) vs. terroir or the uniformity of ‘international’ wines as opposed to the diversity of local wines (Nositer, 2010; Negro et al., 2007; Anderson, 2009; Patchell, 2011; Lugeri et al., 2011).

**The regimes under transformation and the new driving forces**

In the case of Santorini, the two interconnected regimes - tourism and agriculture (mainly wine production) - can be better described by analysing the synergies and conflicts created during the co-evolution of both regimes in the three last decades.

Santorini has been known for wine production and trade since the 5th millennium BC. Almost 100 years ago (1920) vineyards covered 3,500 hectares., accounting for 84% of the cultivated land (Kourakou-Dragona, 1995). A gradual decline over the years (down to 2,250 hectares in 1970 and 1,492 hectares in 1997) was accelerated by a massive earthquake in 1956 followed by the augmentation of tourism in the 1980’s (Drosou, 2005). Since then, the area covered by vineyards seems to have stabilised.

Twenty-five indigenous grape varieties, adapted to the hot, dry climate, harsh winds and volcanic soils, are grown on the island. Santorini also remains one of the few places in Europe with its original un-grafted vines, as the volcanic geology made its grape varieties immune to Phylloxera (Kourakou-Dragona, 1995). Two practices, manifestations of the adaption to the local environmental circumstances, constitute a crucial element for the landscape of the island. The first is the self-propagation of the vines, which makes mechanisation and the use of equipment almost impossible. The second concerns two peculiar pruning practices which, in parallel, require skilled pruners and increase costs.

The wine produced was sold, mainly in the form of bulk, to the nearby islands as well as to the mainland, through informal networks of internal immigrants. The local co-operative afforded the only sizeable bottling unit and an elementary marketing mechanism.

As aforementioned, during the early 1980s Santorini started to become an increasingly attractive tourism destination. The process followed a pattern common in Greece: a disorderly establishment of small size tourist installations, starting from the littoral and gradually expanding to other areas. The view, the volcano, sunset, beach and the nightlife were the
main (if not the only) features of Santorini’s tourism industry. The linkages established with other local agricultural products besides wine (e.g. small tomatoes, fava etc.) were virtually non-existent.

The small size of the numerous tourist activities did not however lessen the pressures towards agricultural land uses. An equally important impact was the increased option-cost of the labour, especially concerning local youth. Adopting a flexible strategy, households divided available labour, with the older members dealing with the vineyards and the younger occupied in construction and tourism. The small size of businesses in both regimes permitted the smooth flow of labour between the two. Nevertheless, the proportion of labour dedicated to agriculture shows a continuous decline during the last three decades. The jobs created in construction also seem to decline after a significant increase during the 1990s, while tourism accounts for an increased proportion of the labour force of the island.

The adaptive strategies followed did not however mean that the pressures on agricultural land use and labour ceased to increase. They resulted in an impressive sprawl of urban uses, with increased land prices having detrimental effects on the rural and the volcanic landscapes as well as on the built environment of the island. Gradually, the flourishing tourism businesses attracted further external investment, as well as real estate. Cheaper external labour also became available on the island creating increased competition for local labour.

Emergence of the niche
During the 1980s, one of the largest wine making companies, based in Northern Greece, started its first attempts towards quality wine production in Santorini in collaboration with local bulk wine producers and the co-operative. At the same time they experimented with traditional techniques used in the area such as the use of canava, i.e. human-made grottos used for the aging of the wine.

This decision seemed to have been influenced by four factors: a generational change within the company; the availability of new technological innovations, especially for the processing of the grapes; funding through either national or EU structural subsidies; and, finally, the coincidence with the increase in arrivals of tourists on the island. All factors acting synergistically seem to have triggered the initiation of the niche, starting with the construction, in 1989, of a modern winery and an information centre in which visitors could taste and purchase wine (Boutaris Winery, 2016). Later on (1992) the local co-op, accounting for 2,500 vine cultivators, created an independent facility with considerable success (Santo Wines, 2016). In this respect, two regime actors played a crucial role in the initiation of the niche; they offered it legitimacy and resources as well as considerable momentum (Geels, 2011).

These two efforts, apart from being successful initiatives, paved the way for a new wave of wine makers. They were mainly younger people with origins on the island, who up to the 1980s were migrating for studies or/and work. These returning ‘new entrants’, came to the island having already established professional, personal and political as well as social network linkages during their previous occupations. Apart from vision and contacts, some of the new wine makers also owned agricultural land and in some cases installations as well as having a family tradition in wine making.
A substantial co-ordination of efforts of individual wine makers can be identified in the efforts for joint presentations to international fairs and exhibitions and participation in contests as well as establishing linkages to mainstream and influential specialised press. Another key co-ordination effort is a ‘voluntary commitment contract’ that all wineries of the island signed with the ‘National Inter-Professional Organisation of Vine and Wine’, whereby they are bound not to follow unfair competition practices as well as to protect the fame of the product. Apart from the multiplication of involved actors, the niche has therefore set in motion the creation of new networks and a remarkable networking activity.

In the tourism regime, in parallel to the emergence of the niche, the global trend towards alternative forms of tourism highlighted the environment and ‘localness’ as important elements of diversification; this trend coincided with the ‘saturation’ of the conventional local tourism market in Santorini, providing local wineries with an opportunity for synergies. Currently, there are more than a dozen wineries offering wine services to tourists as well as direct sales. Wine tours are offered during the whole of the tourist season, some by specialised agencies. The niche thus contributed to the creation of strong links between the two regimes.

The key role of policies

The island of Santorini was one of the first places in which the Greek state tried to design and implement policy measures to promote quality wines. The first ‘Appelation of Origin’ for Santorini’s wines was legislated by the EEC in 1970 as a result of a Greek request, based on the findings of a number of oenological studies (conducted by the Greek Ministry of Agriculture in 1962), concerning the ecosystem of the island and three native vine varieties (Kourakou-Dragona, 1995). The next decisive step was taken in 1981 – when Greece accessed the EEC – with a Santorini wine labeled as ‘VQPRD’ in the EEC market following requests by the Greek state. This designation triggered the whole formation of the niche in Santorini, along with the above mentioned developments in the ‘regime’ and ‘landscape’ levels1.

A second policy has been the support of investments provided by national and EU funds. Technological innovations in wine making have been available since the late 1970’s (Colman, 2008). What this policy made possible was the access of wine makers to these innovative techniques by significantly contributing to investment costs. The small size of the vineyards in Santorini would render the quest for investment capital for novel techniques and equipment in wine making a rather difficult exercise; especially when one refers to small specialised businesses, with limited possibilities for expansion in size.

In addition, within the EU rural development policy framework, two incentive policy measures have been implemented during the last two decades. The older one, in force since the 1990s, concerns the support of the small islands of the Aegean sea. Acknowledging the accessibility problems as well as the increased production and marketing costs of agriculture in the islands, the EU provides financial support to the active islander farmers. Furthermore, farming on islands is considered of great importance for the maintenance of a high level of environmental protection. Hence, within this specific policy measure, a scheme for the maintenance of traditional crops cultivated on the islands of the Aegean archipelago is also included.

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1 Quality criteria linked to provenance have been applied to European wines long before the 1991 launching of the first food quality regulations for Protected Denomination of Origin (PDO), Protected Geographical indication (PGI) and Traditional Speciality Guaranteed (TSG).
Vineyards as well as a number of other traditional crops of Santorini are included in the list of the crops supported. Almost all of the active farmers in Santorini receive this support (Vlahos & Louloudis, 2011).

More targeted is an agri-environmental measure aimed at the maintenance of the traditional agricultural landscape of Santorini, whereby farmers are compensated in order to continue pruning and propagating the vines using the traditional and costly techniques as well as to leave uncultivated parts in each parcel. More than half of the island’s area and farmers participate in this measure. Both measures seem to have been a clear success in terms of acceptance. However, the environmental impacts of the measures are not as clear, especially when the pressures to change land use have their origins in driving forces external to agriculture, as is the case of urban expansion (Vlahos & Louloudis, 2011). Neither policy seemed to be very effective, especially in the areas where urban pressures are intense. These areas, due to the spatial expansion of tourism through the creation of urban continua and the dispersion of housing, could be considered as having attributes similar to those of the urban fringe, where the effectiveness of rural development and/or agricultural policies is highly questioned (see also OECD, 2009).

**Alliances, conflicts, synergies and the need for mediation**

As was expected, changes were not adopted without resistance; innovation not being a neutral notion. The changes that took place affected all the links of the wine value chain (starting from the primary production process), causing rearrangements and new types of co-ordination among actors and stakeholders.

In order to comply with the new cultivation methods required for the production of ‘international wines’ (since the mid-1990s), two changes occurred:

Firstly, the need for land parcels to be planted with only one variety to facilitate harvesting vs. the traditional way of mixing different grape varieties which made it impossible to co-ordinate harvesting even within one holding. This, however, meant that farmers had to restructure their vineyards investing resources and time (i.e. incurring an entry cost), in order to participate in the quality production project;

Secondly, early harvesting (middle to the end of August) is essential for securing quality. But this created a serious conflict in the intra-household division of labour, since the demand for labour in the vineyards coincided with the peak of the tourism season. Traditionally, late harvesting (early-mid September), meant that the members of the household occupied in tourism could also contribute to the task (Vlahos & Louloudis, 2011). The conflictual relationship of the two regimes, i.e. tourism and agriculture, was thus further aggravated. The possibility of establishing a synergistic effect by using the contested resource, i.e. labour, in different time periods was precluded by the change to the agricultural calendar imposed by the striving for quality.

The high number of grape producers and the relatively limited number of wine makers resulted in a power asymmetry. Farmers, being in a relatively weaker position, had to bear all the burdens of the two changes in order to maintain the access to market for their produce. This caused the partial alienation of the farmers from the “miracle of the Santorini vineyard”. Increased prices were not assured due to the intervention of the co-operative, functioning as
the last resort buyer for the grapes. This reflected on the farmers’ sense of ownership for the GI system.

However, the main conflict among the two regimes has been over land use. As mentioned above, tourism has been a fierce competitor for land use (Vlahos & Louloudis, 2011). The changes to the landscape of the island have been dramatic. The detrimental impacts have not been limited to the agricultural landscape. Urban continua have been formed, in serious detriment to the volcanic as well as the vulnerable small-scale urban landscape. The deceleration in the construction of hotels and recreation facilities has been followed by a second wave of pressures, that of luxury summer holiday homes. Real estate investors have taken advantage of the deficient land planning national regulatory framework and shifted their efforts towards this market.

Additionally, agricultural land is unprotected. Efforts undertaken by the Ministry of Rural Development and Food to protect either highly productive land, or areas characterised as ‘High Nature Value’ and territories that form important agricultural landscapes, have remained at the stage of statements of principles and noble intentions (MRDF, 2011).

The effects of the financial crisis have also been devastating in terms of policy measures intended to protect the environment through regulation (WWF, 2012). There is only one regulatory tool, that of local land planning, that can be used in order to restrict the expansion of housing. Indeed, there have been two regulatory interventions concerning the agricultural landscape in Santorini, but they are restricted to the most attractive (in real estate terms) areas, hence rather limited. There is, however, a proposal for a complete and structured regulation of land use, through a land use plan for the whole island. Its approval has been pending since 1995, although all stakeholders in the area seem eager for its approval.

The adoption of changes on the part of wine makers on the island relate to technological innovations, especially in the processing part of the value chain. Their primary objective has been access to the market, especially in the increasingly interesting and quality augmenting wine market. When access to the market was achieved, they strived towards maintaining their competitive edge through quality. In this attempt, the changing circumstances of international markets have not been a stabilising factor. Two competing approaches are taking place; one that is pursuing the homogenisation of taste and advocates the prevalence of grape variety as a quality attribute, whilst the other supports the value of diversity of tastes and the importance of terroir, i.e. a unique combination of environmental, agronomic and human factors, particular for each wine producing area.

The adoption of the first approach, calls for the ‘correction’ of certain characteristics of the wines that are not ‘desirable’ by the actors that are important in the construction of the ‘ideal’ wine (Nositer, 2010). Extending the idea of full adaptation to the needs of a globalised market, some of the wine makers decided to change the pruning and propagation system in their owned land and asked their providers to make this change, if they were to buy from them. Thus, the innovations voluntarily adopted by wine makers, called for obligatory changes on the primary production side, since they were deemed necessary in order to comply with this ‘ideal’ of quality. A new problem was thus created as the changes in the pruning practices and propagation methods affected a landscape much valued, not only by experts or environmentalists but also by tourists, having become an essential part of the “Santorini” experience and hence an asset for the island and the tourism regime.
Despite some co-ordination efforts among wine makers, the lack of co-ordination between vine growers and wine makers seems to have resulted to a further debilitation of their position in the land use regulation policy arena. When they have joined forces however positive outcomes have emerged in the policy field. An indicative example of the potential benefits of co-ordination is the response to a policy measure, potentially detrimental for the island if implemented. As a part of the 2007 reform of the Common Market Organisation for Wine the grubbing up of vines was promoted but the breadth of its implementation was left at the discretion of the Member State. A co-ordinated effort by the co-op, individual wine makers and the local authorities annulled the application of this specific policy provision in Santorini, alleging that vineyards are a scarce economic and environmental resource that have to be protected. However, this effort was on rather an ad-hoc basis, pointing to the need for more permanent forms of co-operation such as an innovation platform (Heemsesrk et al., 2011).

In this respect, the question raised is ‘what the role of an intermediary could be’. In a situation where innovation is accepted and implemented but creates conflict and the stakes are significant, the importance a mediator seems to be apparent.

In the case of wine quality, the existence of a quality convention (PDO wine), initiated by the EU but embedded in the local society, implicates local actors in an active protection of a collective good, i.e. fame. Unfortunately, no such convention for the landscape was perceived, much less adopted, by local stakeholders. On the other hand, it can be argued that the active participation in and support of quality schemes, established by public institutions, increases the degree of adherence of local actors to the maintenance of quality regulation within the public sphere and does not subjugate it to a self-regulated market system in the form of either private certification schemes or informal institutions (such as the specialised press), that are of capital importance in the international arena (NYT, 2015).

An analysis of the conflicts that emerged reveals a polarisation in the power game. The first pole comprises the new innovative ‘international’ wineries. They have as their main objective competitiveness and growth and the need to be adjustable to the changing demands of a very volatile market. They perceive the denomination of origin as merely another element of their marketing strategy which they consequently force their providers, the farmers, to adopt. They are fierce protectors of agricultural land use and supporters of changes deemed necessary in order to comply with standards, even if such changes have a detrimental effect on the landscape and the environment in general.

On the other side lie the co-operative and its allies, the majority of the farmers, whose main preoccupation is the stability of their households. In this respect, pluriactivity is an important element of their survival strategy, while the fame of Santorini wine is considered as a collective, valuable good. Tourism for them is not just an outlet for their wine production but an asset for earning additional income, either through employment in or the establishment of a tourism related business; therefore, the protection of the landscape is essential. But on the other hand, they are not willing to forego the option to exploit their most valuable asset, the land, just because they have not seized the opportunity during the tourism boom.

The two poles have sought allies at national level both in the sector and in public administration cadres. The individual wine makers have formed a professional network (Santorini Wine Producers Association), while participating in the national network of private wineries, i.e. the
Greek Wine Association. On the other hand, the local co-op participates in the third tier wine co-operative organisation (KEOSOE).

In that local ‘power landscape’ the role of institutions has been to a certain degree that of allies to be secured. The aforementioned polarisation has influenced local and regional elections as well as policy implementation.

Conclusions
The aim of this paper has been to analyse the emergence of a quality niche in the Greek wine sector with reference to Santorini island. The analysis reveals that the triggering point for the initiation of the niche has been the activation of two central actors of the wine sector (one external and one local) which, in turn, attracted numerous new wine makers and set in motion some networking (marketing) activities.

Deliberate efforts of both the Greek state and the EU have also played a crucial role through the establishment of a regulatory policy framework for the promotion of quality in the wine sector. Additionally, since the mid-1980’s, investment aids provided through EU Regulations have made a decisive contribution to the establishment of new, modern wineries in Santorini as well as the modernisation of existing wineries.

Changes in the relevant international arenas (i.e. tourism and wine) had direct and almost immediate effects on the local economy and society. Therefore, landscape trends and pressures, processes internal to the niche, the links between the niche and the regime, as well as multi-regime interactions all created a fertile substrate for the germination of innovations. Furthermore, it can be argued that the existence of a quality convention (PDO wine), initiated by the EU but embedded in the local society, indicates an increased degree of social consensus and involves local actors in the active protection of a collective good, i.e. fame. Unfortunately, no such convention for the landscape was perceived, much less adopted, by local stakeholders.

The analysis of the conflicts that emerged revealed a polarisation in the power game, with two poles having different priorities and perceptions about ‘quality’. The first pole comprises the new innovative ‘international’ wineries aiming at extroversion and competitiveness and thus at continuous innovation as relates to growth. This pole supports the protection of the agricultural land but not of the traditional landscape of the island. The second pole comprises the co-operative and the majority of the farmers and aims at stability (household reproduction). This pole supports the protection of the traditional production methods and the landscape since these are crucial aspects for both tourism and their wines. In this sense, it can be argued that the second pole, given its own contradiction and trade-offs, seems more supportive to sustainability.

Finally, the case examined provides significant evidence of the potential benefits of co-ordination among local stakeholders, which has, however, been on rather an ad-hoc basis, thus pointing to the need for more permanent forms of co-operation such as an innovation platform. In a situation where innovation is accepted and implemented but creates conflicts and, on the other hand, the stakes are significant, the importance of an institution acting as a mediator seems apparent. Additionally, in the case of Santorini co-ordinating efforts and network activities have taken place in the absence of ‘professional’ mediators such as brokers.
or facilitators. This corroborates the claim that the informal everyday communicative interactions among stakeholders are as important as the communicative efforts of professionals (Leeuwis & Aarts, 2011). However, network building and dealing with the dynamics of power and conflict are two of the processes that can be substantially supported by communication/intermediation professionals.
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Alternative medicine in dairy breeding: the key role of atypical veterinarians

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Abstract: There is a scientific debate on the impact of the increase in private stakeholders in agricultural extension services. Some social scientists consider that concurrence goes against investment in new techniques. In the past however many agricultural innovations have been promoted by private stakeholders, for example in organic farming and conservation agriculture. The European Union currently encourages the farming sector to reduce antibiotic use in order to avoid antibiotic resistance in human medicines. As a result, farmers show great interest in alternative medicines, such as those promoted by atypical veterinarians: homeopathy, aromatherapy, plant and manual medicines. Our communication focuses on a collective of homeopathic veterinarians, “GIE Zone Verte” (ZV) which is dedicated to farmers’ training and advisory services, mainly for organic breeders. Our analysis aims to understand why and how they are committed to the diffusion of alternative approaches in animal health management. Our survey consists of (i) interviews with these professionals and also with dairy farmers, technicians and trainers and (ii) observations made during training sessions on animal health and meetings of farmers’ groups. We show that members of ZV are part of a professional segment of atypical veterinarians, who defend an alternative vision of veterinary medicine. Farmer autonomy and animal health equilibrium are the key concepts of their training, but they are still seen as the experts by the farmers. In conclusion, we discuss their interaction with training organisers and their role in breeding innovation processes.

Keywords: Animal health, veterinary profession, alternative medicine, training, organic farming, autonomy

Introduction

Many rural social scientists are dealing with a major transformation of agricultural extension services, i.e. the increase in private stakeholders such as firms or self-employed workers (Kidd et al., 2000; Laurent et al., 2006; Rivera & Zijp, 2002). Yet withdrawal of state support for adapting farms to new health and environmental norms is viewed as a problem by some researchers (Compagnone et al., 2015). They consider that competition between these stakeholders is working against the farmers’ interests, as the firms that employ them invest more in marketing than in knowledge. Moreover, they assert that advice given by private stakeholders such as technical salesmen is biased as they have products to sell. Nevertheless, many agricultural innovations have been promoted by private stakeholders in close relationship with atypical farmers, for example in organic farming (Hellec &Blouet, 2012) or in conservation agriculture (Coughenour, 2003). For these two new ways of farming, state extension organisations and state scientific research institutions have overlooked techniques coming from the grass roots. The European Union is currently encouraging the farming sector to reduce antibiotic use, in order to avoid antibiotic resistance in human medicines. As a
consequence, breeders are showing great interest in alternative medicines that have long been promoted by atypical veterinarians who are specialised in homeopathy, aromatherapy, herbal or manual medicine.

This article focuses on a French association of homeopathic veterinarians called “Groupement d’Intérêt Économique Zone Verte” (ZV). We will analyse their role in experimenting and spreading alternative animal health management methods in cattle and dairy farms in France. Our approach consisted of (i) interviews with two veterinarians and ten farmers; (ii) observations of three training courses and one meeting organised by ZV, and of five meetings of the Animal Health Commission of the French Organic Farming Technical Institute (ITAB). Interviews with farmers were carried out in tandem by a sociologist and an animal science researcher, in order to analyse animal health, feeding and production management and to assess the influence of social and professional networks on this management. Interviews with other agricultural stakeholders focused on their professional activities and their relationships with farmers and other technicians and advisors, who are either rivals or partners. Here we present the results of the first step of our survey. Further interviews and observations of training courses will be carried out.

Our theoretical framework is based on the interactionist approach to professions (Hughes, 1984), which studies the dynamics of social groups which control a specific domain of human activity, such as medical doctors or lawyers. According to this scientific approach professional groups are in constant movement. They are faced with internal forces such as disagreement amongst profession members as to their mission and the way of achieving it; they are also faced with external forces such as competition with other social groups that have similar activities, or relations with the public, which stabilise or destabilise them (Abbott, 1988). Veterinarians in France form a professional group as they have a monopoly of many activities such as making health diagnoses on animals and prescribing medicines. As for other medical professions, their monopoly is based on professional knowledge and skills. Moreover, in France, veterinarians have a mandate to purchase public health missions like controlling epizootic diseases (Bonnaud & Fortané, 2015).

In this article, we will show that there is a dissident group within the veterinarian profession, which is striving to find another way to cure farm animals. Their curative methods are to a certain extent opposed to current veterinarian knowledge and skills. Moreover, their methods entail a different relationship with farmers that is less focused on emergency interventions and more on advising and training. This goes together with the sharing of activities and expertise domain between veterinarians and farmers regarding animal health management. Farmers working with atypical veterinarians are supposed to be more working more autonomously to cure their herds, but we will demonstrate that they still need the external view of animal health professionals.
In the first part of this article we analyse the place of ZV members within the atypical veterinary collective. In the second part we describe activities carried out by ZV veterinarians, their vision of good animal health and the position they adopt with farmers and other livestock farming advisors.

**Alternative veterinarians, a professional segment with blurred lines**

At present, ZV consists of ten homeopathic veterinarians (five men and five women) who are spread all over French territory. Some of these veterinarians have additional specialisations e.g. manual medicine, aromatherapy, herbal medicine, bio-geology and cheese making. The ZV headquarters, with its secretariat of two people, is located in the Doubs in eastern France. The constitution of this group is directly linked to the rise of organic farming in France and with the networking carried out by the Organic Farming Technical Institute (ITAB). As we will show, ITAB does indeed participate in structuring the professional segment (Bucher & Strauss, 1961) of veterinarians engaged in promoting and implementing alternative approaches to animal health management on livestock farms.

**From Symphytum to the “GIE Zone Verte”**

The veterinarians who founded ZV initially met together within the ITAB, during technical days on livestock farming at the end of the 1990s. These days brought together many rural veterinarians who specialised in alternative approaches to health. About ten of these veterinarians chose to found an association, Symphytum, in order to meet together regularly and discuss their practices. During one Symphytum meeting, one of the participants, Doctor Giboudeau, presented the OBSALIM® method which he had developed with ruminant livestock farmers in his region during the 1990s. This method aims at identifying food problems in the cows based on the observation of various signs: condition of the coat, the eyes, the muzzle, the state of the dung, etc. The original aspect of this method is the place given to the observation of the animals, as the observation points selected take their inspiration from homeopathy. It differs from the methods used to calculate the animals' diets, which are based on average needs according to the type of animal.

Within Symphytum several veterinarians were very interested in the OBSALIM® method and collaborated to adapt it to other species of ruminants as well as cattle, such as sheep and goats. Once the principles of the method had been stabilised, they chose to form a group, the economic interest group “Zone Verte”, in order to diffuse this method to livestock farmers. The creation of the ZV in 2002 indirectly caused the closure of the Symphytum association.

ITAB is today the principal meeting place of alternative veterinarians. The ITAB livestock committee consists of veterinarians, including a ZV member, researchers, livestock farmers and livestock advisors. Its role is to define the priority actions to be carried out in organic livestock farming. More widely, many alternative rural veterinarians regularly attend a variety of events organised by the ITAB, such as technical days and research and development meetings, or meet within the framework of research and development projects coordinated by the technical organisation.

This participation in various ITAB activities can be explained by the fact that organic farmers are a special audience for alternative veterinarians, who work with conventional livestock farmers too. Organic farming specifications impose limits on antibiotic treatments and require the use of alternative products as a first recourse. These specifications answer the more
general principles of organic farming, which aims at a high level of animal health and welfare (Vaarst & Alroe, 2012) and which are shared by these atypical veterinarians.

**Atypical veterinarians for alternative animal health techniques**

Behind a great diversity of profiles and activities, points of similarity can be observed between the veterinarians working with the ITAB, in particular the fact that they mobilise knowledge of a different kind from that of conventional rural veterinarians. Most of them have a specialisation in homeopathy, aromatherapy or herbal medicine. However these therapeutic approaches are not taught in French veterinary schools. Homeopathy in particular is not taught to veterinary students because its effectiveness has not been proven by medical scientific institutions. So the alternative veterinarians turned towards the human medicine colleges or the homeopathy center in Liège, in Belgium, for training in homeopathy, or towards human pharmaceutical faculties and specialised works to be trained in the therapeutic use of plants. The use of plants is presented as ‘natural’ and ‘traditional’ medicine by the professionals who use them, as opposed to medication produced by synthetic chemistry.

The veterinarians within ITAB also show great interest in preventive approaches associated with feeding and grazing management. A large number of them refer to ecopathology, an approach to the health of herds which appeared during the 1970s and which centred on the risk factors related to rearing conditions and called the industrialisation of agriculture into question (Fortané, in press). Most of these professionals work in private practices. Some work within the framework of annual contracts with livestock farmer groups, thus ensuring closer monitoring of the health of herds (Combettes et al., 2012). Finally, most of them regularly run training schemes for farmers, advisors and agricultural technicians.

Their relationship with farmers is different from that of the other rural veterinarians. The rural veterinarians mainly intervene as emergency doctors, to look after seriously ill or injured animals and to date give very little advice (Duval, 2016). In addition, conventional rural veterinarians market the medication used by farmers, combining prescription and delivery. Some alternative veterinarians have developed a considerable business selling therapeutic products, but others refuse to do this. This is the case with ZV members, who do not market medication from synthetic chemistry. They do not sell any homeopathic or plant-based products either, even though they may recommend them.

**Collective actions of atypical veterinarians**

Atypical veterinarians form a professional segment within the veterinary profession in so far as they advocate another way of looking after animals, based on knowledge of a different kind from that taught in veterinary schools. They also engage in collective actions disputing public political measures involving their profession. Two subjects in particular have been the subject of controversies in which ITAB has taken part: obligatory vaccination against Blue Tongue Virus (BTV) and the use of therapeutic plant-based products.

Obligatory vaccination against BTV was adopted in France in 2008, to stop extension of this epizooty in sheep and cattle farms. This disease does not pose any risks for human health, but it generates economic losses for farmers. Regulations for its prevention aim above all to benefit the international cattle trade. ITAB has committed itself alongside other organisations, such as the ZV or the National Organic Farming Union (FNAB), against the obligation to
vaccinate against BTV and for freedom of choice for farmers (Ollivier, 2013). On its website\(^1\), ITAB goes directly to the arguments advanced by the ZV veterinarians: the effectiveness of vaccination is not proven; this technique carries risks, as it weakens some animals; and the dangerous nature of the additives used. Other homeopathic veterinarians also call vaccination as preventive medicine into question. This position goes against the basis of the veterinary profession in France. As shown by Delphine Berdah (2012), for a long time veterinarians had competition from farriers and traditional healers. They acquired expertise by joining the Pasteurian movement and by obtaining the monopoly of livestock vaccination for the control and eradication of zoonoses.

The second subject for collective action of atypical veterinarians is the use of plant-based products in veterinary medicine. Current French regulations, which come directly from European regulations, prohibit the use of many plant-based products for therapeutic purposes. Either these products must be regarded as medication, and therefore obtain marketing authorisation (which is a long and extremely expensive procedure for complex molecules), or they must be assimilated with food supplements and thus not be prescribed for medical care. Today ITAB coordinates the debates and actions to be put in place to obtain legal recognition of care products based on plants, as has been done for crops. But this is coming up against a State requirement concerning proof of the absence of risks to human health. Homeopathy however benefits from a lighter marketing authorisation procedure in human and animal medicine.

So ZV veterinarians are integrated into a wider collective of rural veterinarians using alternative animal care techniques. It is a vaguely defined professional segment for which ITAB is a special meeting place. We will now describe the work of the members of this group to show how their different conception of health is taught to livestock farmers.

**Teaching farmers to manage animal health differently**

The majority of ZV members no longer work in an independent practice; so their work consists exclusively of training ruminant livestock farmers and of providing individual advice. As we have indicated, they have a positioning with respect to farmers that is very different from that of conventional rural veterinarians. Their intention (Lémery, 1994) with livestock farmers, i.e. the project to transform livestock farming which underlies their training activities, can be summarised in two key concepts: farmer’s autonomy and herd equilibrium. These concepts are fundamental to their teaching, both in its content and in its form.

**Training and transmitting**

From the very beginning ZV has been extremely active. Its training programs have appeared to be in line with the needs of some farmers and in particular farmers who have converted to organic farming. ZV was created at the very time when the number of organic livestock farms was growing rapidly, after public policies began to support their development in France. ZV also met great success with livestock farmers near their head office in the east of France. Most of these farmers produce milk for making cheeses with protected designations of origin, so they have to respect specifications. These specifications are different from organic farming specifications as they do not impose a limit on antibiotic treatments, but a maximum use of pasture.

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\(^1\) The actions carried out by the ITAB for the recognition of plant-based products in veterinary medicine are presented on their website: [http://www.itab.asso.fr/itab/sante-animale.php](http://www.itab.asso.fr/itab/sante-animale.php)
Whether for organic livestock farmers, or for farmers in the Franche-Comté, training officers (who are in charge of organising training programs) have played a key role in the success of ZV, since they select the educators. In the sub-regions of the Doubs and the Jura in particular, training officers in charge of livestock management chose to develop training on alternatives in animal health, in agreement with their partner farmers.

The technical content of the training given by ZV varies according to what is requested: general training which brings together the principles of OBSALIM®, the principles of homeopathy and recommendations concerning feeding and grazing management, or more specialised training programs in a precise field or method. The training courses always structure the time in the classroom and the time on the farm. Some of them, like training in manual medicine, involve interventions on animals. Educators and ZV members share the same objective, which is to make livestock farmers more autonomous in animal health management to enable them to acquire the knowledge and know-how required to look after their animals themselves. This autonomy also answers a need for organic livestock farmers and all those who want to turn to alternative methods, because conventional rural veterinarians are not trained in these approaches.

In addition, ZV teaching allows farmers to appropriate a dimension of livestock farming work which is not often mentioned: the emotional ties with the animals (Porcher, 2003). Farmers particularly appreciate the emphasis placed on animal observation by OBSALIM® method. As one of them said, these are things that he used to do “unconsciously”. However the fact of putting into words a normal, not to say banal activity, enables them to step back and take a new look at their practices. They are able to discuss a whole area of their work which is hardly ever mentioned, as livestock farming work is often primarily discussed via statistical data representing technical and economic performances.

**Achieving herd equilibrium**

ZV veterinarians are positioned around a particular vision of animal health, considered as a balance to be achieved. According to them, the animal must live in balance with pathogens and with parasites. The aim of herd health management is not to eradicate the disease but to strengthen the animal’s immunity to enable it to confront these pathogens and parasites.

This way of considering animal health and disease is different from that of conventional rural veterinarians. Let us take the example of parasite management. When they graze, cattle encounter parasites which infest their digestive system. ZV members consider that by exposing the animals to parasites gradually, from a very young age, they are able to acquire sufficient immunity and thus cohabit with these parasites. This supposes quite specific grazing management from a very early age: reserving fields with low parasite pressure for the young animals; changing the animals’ grazing lands sufficiently often and avoiding overgrazing. Conventional rural veterinarians generally recommend systematic treatments, which aim at eradicating the parasites in the animal’s stomach. By doing this they do not call herd management methods into question and confine themselves to a medicinal approach.

The same type of argument is used to justify refusal of vaccination against BTV. In the documents published on their website[^2], ZV members urge farmers “to learn how to live with BTV” and “to tolerate the natural infection of the animals to allow them to build up lifelong

natural immunity” (natural immunity which would be different from what they name “vaccine immunity”).

ZV training also focuses on animal feeding as they regard it as the main factor to prevent animal health problems. Here their recommendations are not in opposition with current animal science knowledge, but they know more about animal feeding than other rural veterinarians, who have learned to cure sick animals but not so much about prevention and nutrition. So ZV encourage farmers to care at the rumination process and to enhance it. For example, they recommend giving animals roughage first, and feed concentrates after, once roughage has been totally eaten. They also advise farmers to let feeders empty between morning and evening feeds, so that the herd ruminates properly. According to ZV veterinarians, most farmers feed their animals too much to optimise milk and meat production, but this creates rumen malfunction and part of the feed is not digested but just ruined. To achieve a balance between production objectives and a high level of animal health, ZV veterinarians encourage farmers to produce hay with lots of fibre.

Trainers or “gurus”?
We have already pointed out that autonomy is a central concept for ZV members. By following training schemes on animal health questions, farmers are seeking to be less dependent on the different external professionals who come to their farm to advise them about livestock farming. By implementing some simple recommendations from OBSALIM® training programs, such as first distributing roughage, the farmers can quickly see results. However, not all of them systematically implement the veterinarians’ recommendations. But they are still greatly influenced by a technical presentation which goes against what they were taught before.

But this autonomy acquired by livestock farmers appears ambiguous: admittedly they keep their distance from the usual advisors and the conventional rural veterinarian, but by doing this they refer almost systematically to what the ZV veterinarians say. Even if the farmers do not implement all their recommendations, they are treated as experts – some organic farming advisors even call them “gurus”. In fact, during the training programs that we have observed, some veterinarians structure political and technical discourse. Sometimes they are virulent in saying that the pharmaceutical industry controls the animal health sector, accusing conventional rural veterinarians of being too involved in this industry because they market their products directly. By these criticisms they try to detach the livestock farmers from their usual advisors in order to attach them (Goulet & Vinck, 2012) to their vision of veterinary medicine, opposing conventional and other alternative approaches to animal health management.

Disagreements therefore appeared between certain ZV members concerning training methods. This led to the withdrawal of one of the founder members, the very person who developed OBSALIM® method. He reproached some of his colleagues for not teaching this method correctly and for only giving farmers ready-made recipes, or even excessively dogmatic principles of herd management. For Doctor Giboudeau, OBSALIM® is above all a method of diagnosing the state of the herd, which has to enable problems concerning animal feed and their digestive capacities to be detected precisely. This veterinarian therefore chose to recreate a company devoted to OBSALIM® and to form a network of advisors capable of teaching it. These advisors are invited to create groups of farmers who regularly experiment with the method together, with what they call “hair rally” ("rallyes poils" in French). For a whole morning, farmers visit each of their farms and share their observations on the state of the herd. By working together in this way they aim to enhance their observation abilities.
Another point of disagreement has also appeared concerning training in homeopathy. For some homeopathic veterinarians, the farmer cannot make a correct homeopathic diagnosis because he only observes his own animals. The veterinarian sees far more animals on different farms, so he has in mind an important number of clinical cases which helps him to make the right diagnosis for a new sick animal. What is in question here is the work division between veterinarians and farmers. Some veterinarians consider that homeopathic diagnosis can only be made by specialised professionals. During our fieldwork, we have observed that no farmer was able to cure their herd with homeopathic methods alone. They usually used one or two remedies for some specific problems. Some of them systematically refer to a homeopathic veterinarian to choose the best remedy; indeed there is a pay phone service in ZV for such medical consultations. We have noted the same phenomena for manual medicine: farmers prefer to use the services of an osteopath rather than intervening themselves on their herds, even if they have undertaken training courses in that domain. Finally, farmers who participate in ZV trainings become more autonomous in animal observation and early detection of animal health imbalance, but they still depend on specialists to cure sick animals.

Conclusion

Today, alternative veterinarians, and in particular those of the ZV collective studied in this article, play a key role in the field of animal health management innovation. They promote another way to cure animals at the farm level, through training and advisement activities. They also take actions at a national level in order to change state regulation, for example by contesting obligatory vaccination.

ZV veterinarians however do involve other stakeholders to bring about changes in animal health management. Indeed, an innovation process is not the result of a sole stakeholder action, but is supported by a social network whose structure has to be characterised (Coughenor, 2003; Compagnone & Hellec, 2015). Behind atypical - and charismatic - veterinarians, there are discreet but essential stakeholders that we call mediators and who facilitate farmers’ access to new methods of animal observation and animal health management. Indeed, ZV training activities depend on training officers’ actions, as ZV is not a training centre itself. In Franche-Comté, training officers are employed by agricultural training centres, which are independent of chambers of agriculture and of farming unions; this is a reason why they were able to bring in atypical veterinarians. In other regions, ZV veterinarians are mainly contacted by alternative farming associations, like organic farming associations. So training officers play a major mediation role as they choose trainers and decide what kind of new methods and techniques to disseminate or not to farmers.

Farmers themselves are, of course, major stakeholders in the innovation process as they are final decision takers of innovation adoption. We showed that ZV training success is partly explained by the focus made on an effective tie with animals. Farmers get interested in methods that help them to observe their animals more accurately. Training courses are however only the first step in animal health management changes and it is difficult to say to what extent these changes are implemented on herds. We observe that some farmers form groups that meet regularly to enhance their observation abilities while some farmers turn to homeopathic veterinarians for advice and medical diagnosis, but all breeders keep on working with their close rural veterinarian for emergency intervention or antibiotic prescription when necessary. Whereas atypical veterinarians insist on a division between current and alternative medical methods, farmers utilise both to manage animal health on their farm.
There has still been very little study of the use made by farmers of lessons received during training courses. The question of hybridisation between various forms of knowledge still remains: between knowledge used by conventional veterinary medicine which has been validated by institutional science and other types of knowledge promoted by alternative veterinarians who concentrate more on observation, sensitivity and experience.

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Social and technical influences that enable and constrain adoption of genetic improvement by commercial lamb producers.

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Abstract: Productivity is important for improving the long term profitability and competitiveness of commercial lamb producers and the Australian lamb industry. Productivity can be achieved in part through improved genetics and as such it is considered a key profit driver for sheep producers. Yet improved genetics, such as breeding value technologies are still not completely accepted or adopted and the uptake of this technology is seen to be slower compared to other animal industries. The value of genetic improvement to productivity and profit has been repeatedly proven and demonstrated in scientific studies and yet the question that is still not well understood or investigated is why some commercial producers do not see and acknowledge the potential benefits. With genetic technology rapidly expanding, becoming more sophisticated and possibly more complex, there is now a greater need to recognise how producers make sense of breeding values and how social influences impact upon behaviour and beliefs or the meaning given to actions. Drawing on qualitative social research methodology and an agricultural innovation systems framework this study will explore the organisational roles and interactions of supply chain actors to address the following question ‘How do social and technical arrangements within the Victorian lamb industry support or hinder adoption of genetic improvement by commercial lamb producers? Data collection and preliminary analysis to inform the research started in 2015. A number of focus groups with commercial lamb producers and semi structured interviews with industry representatives form the basis of early learnings around actor roles, beliefs, confidence, knowledge exchange and interactions.

Keywords: Agricultural innovation systems, breeding values, confidence, interactions, knowledge exchange

Introduction
The intended focus of this paper is to explore the interaction, knowledge exchange and presence of enabling situations between farmers and intermediaries that lead to innovation within the Victorian lamb industry in the state of Victoria Australia.

Research attention and a greater understanding of the roles that innovation brokers and facilitators perform in agricultural innovation is an area that requires further exploration (Klerkx & Leeuwis, 2009). These groups of either individual actors or organisations embedded within networks fulfil vital roles in relation to innovation processes as they facilitate access to knowledge, new technologies, provide interpretation and help overcome information gaps. They are seen to act as a bridge between the science providers who generate and supply knowledge and those actors who convert codified knowledge into practice such as farmers.
In Australia the role and function of advisory services that perform in the intermediary space are of increasing interest as the role is slowly being removed from state funded extension providers into the hands of the private sector. For example the Victorian lamb industry is an extensive and diverse farming system that has traditionally been serviced by a high level of state government funded public advisors. With reduced state investment, there has been a noticeable increase in the engagement of private intermediary roles to facilitate knowledge exchange, form new networks and accelerate innovation. The impacts of this change and the nature of intermediaries with regards to innovation processes has however received limited study and requires further examination, particularly in the Australian context.

Information pertaining to the role and function of intermediaries within this paper is informed from the wider research focus investigating the ‘social and technical influences that enable and constrain adoption of genetic improvement by commercial lamb producers, in the state of Victoria Australia’. The Agricultural Innovation Systems (AIS) framework is being used to help guide a comprehensive and systematic approach to explore the organisational roles and interactions of supply chain actors in new, innovative and holistic ways that have not been undertaken in the Australian lamb industry.

The data and discussion presented are based on in-depth interviews carried out with a wide range of actors embedded in the lamb supply chain. The paper is divided into a number of sections. Background outlines the background and industry context that gave rise to the research study and questions. This is followed by the conceptual framework being used to guide the study. The methodology section is followed by one which summarises preliminary findings from the study while the final section considers the key findings emerging from the data around the presence of enabling situations between farmers and intermediaries that lead to innovation within the Victorian lamb industry.

**Background**

Breeding decisions are important complex management decisions made within a farming enterprise. They influence future flock performance and farm profitability and as Kaine and Niall (2003, p. 2) reported are ‘too important to be left to chance or whim’. It is an important complex management decision that should be better understood according to (Rowe, 2010) as the choice of sire made for every joining has a large and permanent impact on production and profitability that compounds over generations.

Research completed in the Australian wool and dairy sectors currently provide the most insights into how Australian livestock producers make breeding decisions and perceive genetic improvement, in particular the value of breeding value technology within their farming systems. The information while valuable cannot be fully extrapolated across the Australian lamb industry however, as different breeding strategies and supply chain systems exist. Furthermore these studies tend to focus on the decision making processes of the end user or farmer. The role and function of intermediaries upon innovation processes within this context has received less attention and yet they play an important role facilitating access to information, technologies and networks that support more efficient, productive and profitable farming practices.

The following sections outline the industry context and conceptual framework in which the research is being undertaken.
**Australian lamb industry overview**

Victoria is Australia's largest lamb producing state accounting for 42 per cent of national lamb production (VDPI, 2010), making it a significant contributor to Australia’s red meat industry which is valued at around $15.7 billion (Kroker, 2013). With new emerging markets, particularly in Asia and others in the developing world (Ridley, 2013), many future opportunities are foreseen for the lamb industry (Kroker, 2013; Sheep CRC; VDEPI, 2014).

Rowe (2010) argues that the future profitability of the lamb industry depends on producers attaining high rates of productivity gain and producing quality products valued by consumers, both of which can be achieved through improved genetic selection and ‘best’ management practices. Genetic improvement technologies which play a key role in increasing the productivity, profitability and market competitiveness (Islam et al., 2013; Sheep CRC) of the Australian lamb industry have been accessible now for many decades. However the uptake of genetic improvement innovations to assist with selective breeding has been relatively low compared to other animal industries such as the dairy, poultry and pig sectors (Islam et al., 2013). Both research and industry bodies in Australia advocate room for improvement (Rogan et al., 2011; Sheep CRC; Williams, 2010). With industry benefits to be made from the implementation of genetic improvement via the use of quantitative genetics, industry bodies undertook a large collaborative Research, Development and Extension (RD&E) initiative in the late 1980s to make lamb a competitive marketable product both domestically and globally (Banks, 2012). The current industry focus is to identify barriers to the uptake of genetic technologies and overcome these through better communication, training and skills development strategies (Rogan et al., 2011) so as to achieve accelerated rates of genetic gain in those traits of economic importance for Australian sheep producers (AWI, 2013; Rogan et al., 2011).

Animal selection has played a key role in breeding better animals for generations. Today's farmers continue to selectively breed as animals are still capable of rapid improvement or modification due to genetic variation (Hayes et al., 2013). Animal selection traditionally occurs by ‘eye’, that is a visual inspection of the animal’s body, health, pedigree and environment (Holloway et al., 2011; Islam et al., 2013). Over time, continuous selection for desirable traits generally leads to improvements in productivity and performance. Show ring success, that is exhibiting an animal to a judge, can also play a part in the selection process (Banks, 2012). However as Banks (2012, p. 54) points out, in the lamb sector at least ‘the characteristics used in judging both live sheep and carcasses bore little or no direct relationship to profitable meat production’.

Scientific advances throughout the past quarter of a century however have provided an alternative way to breed animals for increased productivity, determining genetic merit (the genes responsible for productivity and passed onto progeny) with a calculated figure called estimated breeding values or EBVs. Estimated breeding values (EBVs) are a numerical value that indicates how strong or weak the genes are for various economically important production traits, such as growth rate. The use of EBVs in breeding decisions has been shown to increase animal performance across a range of species (Islam et al., 2013) and has had a positive impact in the Australian sheep industry generally acknowledged by science and industry (Barnett, 2006).

LAMBPLAN, launched in 1989, is the Australian national system for describing genetic merit of animals in the sheep industry (Banks, 1990; Williams, 2010). LAMBPLAN works to
genetically improve the ‘terminal’ and ‘maternal’ sheep breeds that operate under the sheep meat banner. Terminal breeds produce lambs that go directly to slaughter, while maternal breeds are used to breed the next terminal lamb. Since the introduction of LAMBPLAN there has been significant, albeit variable, genetic progress across the major breeds in the Australian sheep industry (Barnett, 2006; Swan et al., 2009).

Breeding programs that implemented EBV selection produced by LAMBPLAN are credited with increasing the size of slaughter lambs and their carcase weight (EDGE network, 2003). Banks (2012) reports that between 1993 and 2006 carcase weight increased sixteen percent from 17.64 kilograms to 20.53 kilograms while fat content decreased.

LAMBPLAN research, information and tools around breeding value technologies, better known as Australian sheep breeding values (ASBVs), has commonly been disseminated over the years through the development of extension programs and delivered through public and private providers. The adoption and utilisation of research however is dependent on the perceived benefits being accepted and adopted by the end-user (Corner-Thomas et al., 2013). Extension programs such as EDGE network, Making More from Sheep and the recent RamSelect workshops promote and encourage ram breeders and commercial sheep producers to adopt genetic improvement technologies to assist with the selection of rams that will breed the best progeny for them with ‘more wool’, or ‘more meat’ or ‘more lambs’ through buying in the right set of genes for production, quality and disease resistance. Furthermore network programs such as BestWool BestLamb run by Agriculture Victoria (Victoria, Australia) are used by research organisations as conduits to transfer and diffuse knowledge about breeding value technology and the benefits of adoption throughout its farmer and group network.

Genetic improvement technologies, specifically breeding values, are however still not universally accepted or adopted within the sheep industry, a message conveyed and shared by Australian and international research (Kaine et al., 2002; Morris & Holloway, 2014; Swan et al., 2009; Williams, 2010). The science nonetheless has been proven to work and repeatedly demonstrated in scientific studies and practical on-farm demonstrations (Morris & Holloway, 2014; Ramsey, 2012; Williams, 2010).

Other studies contribute insights into how livestock producers perceive genetic improvement. Yet few are in the Australian context and inform enquiry across the whole supply chain in a comprehensive, systematic way such as Agricultural innovation systems. The use of AIS permits a much richer view and diagnosis of enablers, influences and constraints across an innovation system and as such is being used to guide this research.

The conceptual framework: Agricultural innovation system

This research adopts the Agricultural Innovation Systems (AIS) framework as it provides a systematic and comprehensive framework to analyse and categorise technical and

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1 The body of slaughtered lamb minus the skin, head, hooves and internal organs.
2 EDGE network is a series of workshops that provides technical and business skills for sheep farmers.
3 Making More from Sheep is a manual containing 11 sections on ‘best practice’ technical information for sheep health, pastures, breeding, business management, etc. Information signposting is also provided allowing producers to find further information.
4 RamSelect is a one day training course offered by the Sheep CRC designed to build sheep producers’ confidence around using breeding values for ram selection and purchase.
5 Bestwool Bestlamb is a Victorian producer network program whereby likeminded sheep producers come together and with the help of a facilitator establish self-directed learning.
institutional constraints to innovation. This permits critical analysis of the broad perspective, encompassing the whole production system and institutional environments in which actors are embedded (Amankwah et al., 2012).

A key concept underpinning AIS is that is stimulates innovative developments. Systems often work imperfectly (Amankwah et al., 2012; Islam et al., 2013; Lamprinopoulou et al., 2014), presenting 'innovation system failures'. Structural and functional elements help identify transformational failures and merits (Klerkx et al., 2012). The failures become analytical focus points (Hekkert et al., 2007) which identify pathways for alignment and coordination (Wieczorek & Hekkert, 2012). Overall functionality of the entire innovation system may therefore be examined to determine if collective innovation priorities are being met, ‘and if not, what prevents transformative change towards desirable direction’ (Lamprinopoulou et al., 2014, p. 4).

The strength of AIS, recognised as such amongst researchers (Lamprinopoulou et al., 2014) is that it encompasses a holistic diagnostic view of an agricultural innovation that includes the individual adopter (commercial lamb producer), service providers (public and private agribusiness) and formal science stakeholders (Sheep CRC6, LAMBPLAN) (Amankwah et al., 2012). A whole systems approach to investigating genetic improvement within the lamb industry affords a richer analysis of technology adoption issues whereas analytical tools used in isolation only tell part of the story.

The purpose of AIS in the wider study is firstly to inform the lamb industry about its capacity and potential as a successful innovation system by identifying constraints and enablers across the supply chain and secondly to contribute to the literature on the operational performance of agricultural innovation systems for diagnosing, planning and intervening to improve innovation. Klerkx, Aarts and Leeuwis (2010, p. 391) also suggest that the use of AIS can ‘contribute to building blocks for adaptive agricultural innovation policies that can deal with the unpredictability of innovation processes’. The empirical application and analysis of a key Australian agriculture industry as an innovation system will furthermore contribute to AIS literature.

This paper however specifically explores the role, enabling environment and activities between farmers and intermediaries to elicit knowledge and a better understanding of the fit, role and operational performance of the intermediary that leads to innovation.

Methods

This paper provides a preliminary insight into the enabling environments that occur between farmers and intermediaries in the Victorian lamb industry, Australia. The data presented in this study are obtained from interviews with farmers, research and industry organisations who are involved with the use or non-use, diffusion, extension or development of genetic innovations.

The interview questions and analyses used to inform the discussion were structured according to a criteria based upon the agriculture innovation systems framework and social research methodology. This is being used to map and understand the interactions and organisation of the genetic improvement system.

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6 Cooperative Research Centre for Sheep Industry Innovation, Australia
Semi structured interviews were conducted over 2015 with fifteen ram breeders, breed society members and research and industry people involved in the extension, diffusion or development of genetic innovations including private consultants, livestock agents, sheep pregnancy scanners, public extension officers, processors and scientists. The key question which this cohort of the supply chain aims to address is: ‘How do value chain actors influence the benefits producers can attain from use of improved genetic animal selection information?’

Focus group interviews were conducted with over thirty like-minded commercial farmers that either use or did not use rams with breeding values. The groups were purposely split into separate focus groups so that the questions could be explored in some depth without opposing views being expressed during the interview. The key question under investigation includes ‘How do different producer groups differ in their decision processes associated with animal selection and the use of quantitative assessment measures? With a specific focus being placed on attitudes and beliefs about quantitative assessment, the farm system context, market influences and advisory support’.

All interviews were audio recorded and subsequently transcribed. The software program NVIVO 11 was used to facilitate a thematic analysis of farmer and intermediary interviews.

In this paper the analysis was extended to provide further understanding on knowledge exchange, actor interactions, enabling environments and specific activities around the application of genetic technologies. The key question being addressed in this paper is ‘to what extent is there a presence of enabling situations between farmers and intermediaries that lead to innovation within the Victorian lamb industry?’

Findings
Findings from the thematic analysis of farmer and intermediary interviews are presented as a set of responses to the key research interest in this paper around the roles of actors embedded within the system, enabling environments and specific activities that generate spaces for innovation.

The role of intermediaries in the Victorian sheep industry
Sheep farming in Australia is in general a pasture fed, extensive system sitting within a mixed farming enterprise. The majority of the farmers interviewed in this study ran up to three different enterprises on their farms: a lamb or red meat enterprise; a wool enterprise as a result of using Merino7 ewes for lamb mothers and the third was generally a cropping (grain) enterprise.

Given the diverse nature of the enterprises run on these farms there are many actors who potentially act in intermediary roles in the Victorian sheep industry. This includes farmers, agribusiness, public and private extension providers, private sector stakeholders, processors and research organisations. Private sector actors include consultants (who provide financial, general farm advice or specialist advice in disease, nutrition or breeding), agribusinesses (who

7 A Merino is a specialist wool producing sheep that is the predominant ewe mother for lamb (red meat) production in Australia.
provide general farm supplies, chemicals, meat and wool agents, pregnancy scanners and shearers), veterinarians and breed societies.

Within an innovation system actors are those that contribute to the development, diffusion and utilisation of a technology, product or service (Islam et al., 2012). In AIS actors are conceptualised under four broad areas namely, research, enterprise, intermediary and demand according to the actor's activities and roles in the innovation system. The research domain (universities, research institutes) produce basic or applied research and generate knowledge and is considered a supplier of knowledge. Actors on the demand side use innovative products and services (farmers, processors). In between the supply and demand domain are the intermediaries (public and private extension officers) who may not necessarily provide expert advice or be involved in knowledge creation or usage but facilitate knowledge flow and exchange by joining fragmented innovation system actors.

Intermediaries that participated in this research included:

Two public extension officers: state government funded employees who undertake project work and operate in the Bestwool Bestlamb network (state funded project run by Agriculture Victoria) facilitating self-directed farmer groups and delivering knowledge and information with the aim of enhancing the productivity, efficiency and profitability of farmers.

Four private consultants: three are involved in the Bestwool Bestlamb network in addition to operating their own agricultural consultation business. The fourth operates independently and operates more often in the wool industry but was starting to service an increasing number of clients in the lamb industry.

Interviews conducted with the following group of actors, it could be argued, fit in the supply (research) and demand (farmers) sectors of the AIS framework. Yet information obtained from the actors below found that all have performed in an intermediary role when time and situation has created the space for this function. Furthermore it is recognised that an actor can move between roles (Islam et al., 2012; Lamprinopoulou et al., 2014).

Two science researchers who work in industry funded research and development corporations develop knowledge but also pilot and deliver extension knowledge and programs to farmers through existing networks. Both people have been involved in the development and delivery of national projects designed to accelerate genetic improvement by ram breeders and commercial farmers.

Further interviews were undertaken with other highly networked actors embedded within the lamb industry including: two livestock agents, one pregnancy scanner, one red meat processor and two breed society members who are also stud ram breeders.

Early results suggest that there are two or three key relationships influencing farmers' decisions around ram buying criteria and the application of improved genetics such as Australian sheep breeding values.

The majority of participants considered livestock agents and ram breeders to highly influence farmers’ use of genetic innovations. Livestock agents are part of a well-connected network of actors within the lamb system. They buy and sell sheep for clients and act as a conduit of information and knowledge on current market place requirements for farmers who employ their
services. Livestock agents were used as a source of expertise to select and buy rams by some farmers as they had confidence and trust in their judgement. Interestingly the pregnancy scanner suggested that the livestock agents could also be used as a sounding board by farmers to reassure decision making processes, thus setting the scene for an enabling environment where innovation could occur.

“Agents are used by farmers as a confidence boost, they want a second opinion and they are the boost they need to select” (pregnancy scanner)

Based upon their role and capabilities, livestock agents and other sheep industry service providers such as pregnancy scanners and shearers are similarly aligned to farmers under the AIS conceptual framework whereby knowledge, innovative products and services tend to be demand driven and put into practice. Yet within the context of this research the livestock agents ‘fit’ was more aligned within the intermediary domain where it was observed that they facilitated knowledge flow between actors in the innovation system. It was noted that a number of the commercial farmers actively sought livestock agents out for advice and guidance about ram selection decisions as they were seen as experienced, knowledgeable and well networked individuals. The livestock agents are therefore not just facilitating information flow but are contributing knowledge that is influencing how farmers use genetic innovations.

**Generating spaces for innovation**

In this section the presence of enabling situations between farmers and the intermediaries (as described above) that impacted or influenced the use of genetic innovations were explored.

To examine this area further, questions posed to intermediaries, such as; ‘Describe how you help farmers to select their ram breeder / individual rams’ and ‘Who do you think gives good advice to help farmers make choices about ram selection?’ were used to learn about knowledge exchange and to better understand the relationships between actors. Furthermore thematic coding along the lines of influences, participation in events, information source and selection practices generated findings around enabling environments or constraints seen within the genetic innovation system.

**Enablers within the innovation system**

Participation in an ‘elite’ group for one ram breeder provides the motivation and encouragement to undertake innovative processes. The ram breeder is a strong advocate for breeding values and uses them for animal selection within his flock. He is also a member of the national genetic scheme LAMBPLAN. Discussion with the farmer suggest that the environment in which he operates pushes him to be perhaps less risk adverse and more open to innovations and experimentation. Fellow group members collectively share and support the decision making processes especially when it comes to evaluating young sires (rams) that could be viewed as high risk breeding prospects as they tend to have less accurate breeding values. Group members undertake and share similar risks in their progression to accelerate genetic gain within their flock. In addition to his participation in an engaging environment this ram breeder is a firm believer in the uptake of new technology and it was a word that was reiterated throughout the interview, especially in the context of genetic innovations.

“Well it’s new technology and it has the potential to increase the value of our livestock” (ram breeder using breeding value technologies)
Genomic technologies to discover the genes for improved meat eating quality are currently being evaluated within his flock.

An interview with a different ram breeder told a similar story. He is embedded within a different breed based group that again share similar interests, goals and risks. This group can be seen to provide engaging environments where innovation processes are shared between people with similar interests in achieving genetic gain.

Both ram breeders are long term members of the national genetic scheme LAMBPLAN that provides a further innovative enabling environment. Findings however suggest that for one ram breeder this group is viewed in a very different light to that of the breed society. Participation in LAMBPLAN, for him, is used more for marketing purposes.

In relation to this work, the supportive breed groups seem to be providing the engaging environment in which both farmers operate and undertake innovations. In addition both farmers are highly networked individuals to many actors across the supply chain that are positive and encouraging of accelerating genetic gain within the industry.

### Constraints within the innovation system

The following findings explore some of the likely constraints occurring within the innovation system.

“If you are not using Australian sheep breeding values you’re a bloody idiot” (science supplier)

The quote leans towards a source of disengagement and disconnect between the science suppliers and this particular ram breeder. This was found to be a shared experience with some other interviewees.

Livestock agents were frequently referred to as a cohort that inhibited the uptake of genetic innovations by intermediaries (private and public consultants, pregnancy scanner) and farmers whom are advocates of genetic technologies.

“Agents are notoriously low for using ASBVs and that. They need a bomb under them to get them to the right side of the ledger I think” (ram breeder using breeding value technologies)

In this sense livestock agents are viewed as gate keepers to the use of improved genetics by these actors. Livestock agents are highly valued by many of the farmers that participated in this research and for some agents are used to select and purchase rams on their behalf. The farmers trust and have confidence in the decision making processes of the livestock agent.

Agents as a trusted confidant of the farmer can reinforce the perception that breeding values do not provide value as suggested by this farmer and which was recounted similarly by others.

“I think if it could be demonstrated that buying rams with figures improved your bottom line, as opposed to buying rams visually, I think that would be enough to make me want to do it” (commercial lamb producer)

Yet knowledge about the science which has been proven to work and repeatedly demonstrated in scientific and practical on-farm trials (section 2.1) has been disseminated to farmers since the formation of LAMBPLAN, over 20 years ago.
A further viewpoint similarly shared by other intermediaries considered the farmer as the gatekeeper to any changes.

“There are more people using objective assessments, they are tending to move away from that subjective assessment of sheep, they are starting to understand the difference. But the ones that aren’t, I think there’s 2 things going on there, they’re too busy, don’t want to know, or I’m too old, I’ve done it this way forever, I’m making enough money, and I don’t care. I think that’s reality. There is a definite generational thing but also I’m too busy trying to keep my head above water to look up and see what’s going wrong” (private consultant).

The norms about what is or is not a good ram was conveyed strongly by participants from all sectors of the supply chain.

“Size matters. A producer will not a buy a small ram no matter what the Australian sheep breeding values say” (innovation broker)

This idea resonated strongly and was approved of when discussed with different groups of commercial farmers, despite close links with intermediaries or other enabling environments.

Discussion and Conclusion
This paper considers two areas of insight into the presence of enabling situations between farmers and intermediaries that impact on innovation within the Victorian lamb industry. Additional work is still to be undertaken to substantiate and provide further data around the following outcomes.

Ram breeders and livestock agents are key actors within the lamb industry who influence ram selection decisions. Livestock agents play an important role in the dissemination of knowledge, information and technologies to farmers. Their beliefs and knowledge, own life experiences and potential bias becomes a source of powerful messages and influences conveyed to some but not all farmers. Intermediates, both public and private advisors, although engaged and part of the network were not seen to be as well utilised as the livestock agents as a source of knowledge. Yet there are an increasing number of private consultants that are being sought out by science suppliers to support commercial farmers and ram breeders to accelerate genetic progress. This is thought to be achieved by helping farmers to select the right ram and placing them in the right situation for optimum production and economic output while meeting the desired breeding objectives of the farmer. If farmers are actively seeking advice from livestock agents about breeding and ram selection decisions however, then this cohort of actors need to be more actively engaged by the research sector so as a wider network of farmers can be reached and educated about objective genetic innovations.

Livestock agents in this study are viewed mostly as gatekeepers to the use of improved genetics. They therefore act as a constraint to the acceleration of genetic gain, particularly to the level being sort by industry bodies to maintain domestic and export market competitiveness. Further research will define if there is a self-reinforcing community of practice emerging in this space. In particular we need to understand if the livestock agents are training the next generation of gate keepers. This in turn will lead to a greater understanding around the relationships formed with farmers and the part they play in enabling or constraining the application of genetic innovations.
Other findings that relate to the wider study but could potentially provide further insight into the nature of relationships between farmers and intermediaries include the presence of norms about what is a good ram or breeder. There is a need to understand how strongly these beliefs are held, to what extent are they being reinforced and by whom. An unexpected finding was the lack of awareness of some farmers that they are purchasing rams from ram breeders who are embedded in the genetic scheme LAMBPLAN. Additional investigation is taking place to understand how this is possible and any potential implications.

With genetic technology rapidly expanding, becoming more sophisticated and possibly more complex, there is now a greater need to recognise how producers make sense of an innovation and how social influences impact upon behaviour and beliefs or the meaning given to actions (Nettle et al., 2010; Sneddon et al., 2009). In addition there is a recognised need to learn more about the intermediaries; the nature of their relationships (Howells, 2006), their specific capabilities (Klerkx & Leeuwis, 2009) and for them to be operationally defined and well-evaluated (Koutsouris, 2014).

This study takes a step towards understanding some of the underlying social dynamics, influences and technical arrangements within the Victorian lamb industry. This includes defining the type of functions or roles, relationships and fit of intermediaries within the Victorian lamb industry to fully appreciate their impact on genetic innovation processes. In identifying constraints and enablers across the lamb supply chain the aim is to inform the industry about its capacity and potential as a successful innovation system.
References


Development of an assessment framework for researcher-farmer knowledge exchange: the case of DAIRYMAN

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Abstract: Knowledge is being recognised as a crucial resource in the search for more sustainable farming practices. We present a literature review discussing i) the types of knowledge at stake, ii) by who and how it can be created or acquired optimally, and the different associated learning processes and iii) the role of networks and communities in supporting processes of knowledge exchange and co-creation. Taking indications from literature we propose an assessment framework to evaluate the potential of an extensive network to provide farmers with support to tackle sustainability challenges. The international network consisted of 10 interconnected, smaller regional networks and was created during the European Interreg IV project ‘DAIRYMAN’ (2009-2013). Our framework is aimed at assessing individual learning in a social context, combining elements from an individual-centric framework developed by Lankester (2013) with the concept of value-creation designed for networks and communities (Wenger et al., 2011). Follow-up research will use the developed framework to answer two main research questions i.e. i) does the DAIRYMAN network support knowledge exchange and what, how and why have participants learned? and ii) what are the differences in regional networks, and has this influenced participants’ learning outcomes?

Keywords: Knowledge, learning, networks, assessment framework, sustainable farming

Introduction

In the challenge for farmers to produce in a sustainable way the concept of knowledge has taken a central position (Wood et al., 2014). Farmers are expected to learn continually to keep up with innovative technologies and farm management practices. At the same time, they also need to stay connected with changing societal and legislative expectations and ways of incorporating these into their day-to-day farming practice (Bergevoet et al., 2004; Darnhofer et al., 2010; Lankester, 2013). The European Commission stated that today’s Agricultural Knowledge and Information Systems (AKIS) do not meet the challenge to increase simultaneously agricultural productivity and sustainability. There is a need for more effective innovation processes. Despite the continued generation of knowledge through scientific projects, research results are often insufficiently exploited and taken up in practice and innovative ideas from practice are not captured and spread (EU SCAR, 2012).

So what entails a successful innovation process and what is the role of knowledge in these processes? Questions still remain on the type of knowledge required, by who and how it can be created optimally and how this knowledge can be shared and transferred. This is a concern for farmers, advisors and researchers alike (Curry & Kirwan, 2014; Eshuis & Stuiver, 2005;
Klerkx & Jansen, 2010; Lankester, 2013; Martin, 2015; Novo et al., 2015). These questions have inspired stakeholders from different backgrounds to move away from the traditional model of knowledge dissemination, where new knowledge is generated by scientists and disseminated to possible end-users. Novel ways of cooperation have been introduced recently, with the intention of creating a science-society interaction with a mutual learning process (Moschitz & Home, 2014). In these novel practices the willingness of different actors to share knowledge is important because different actors gather or create different types of knowledge. Hence, these knowledge exchange practices between actors have the potential to produce more knowledge than each can produce individually (van den Ban, 2002).

To support these knowledge exchange processes numerous networks and communities have emerged, either bottom-up or top-down. In the context of sustainable agriculture the Learning and Innovation Networks for Sustainable Agriculture (LINSA) (Moschitz et al., 2015), and Farmer Field Schools, developed by the FAO, are well-known examples. Although existing networks differ greatly in composition, level of stakeholder participation, specific goals and aims, duration, available resources, etc., they all aim to provide access to (practical) knowledge, experiences and innovative developments. The connections in a network can function as learning ties providing access to information flows and exchanges (Wenger et al., 2011). The heightened interest in these processes is also illustrated by the launch of the European Innovation Partnerships (EIP) by the European Commission, which supports and builds numerous networks in the form of Operational Groups and Thematic Networks. These bring together all relevant actors at EU, national and regional levels in order to enable knowledge exchange on research and innovation.

To further our understanding of the types of knowledge at stake, by who and how this can be created optimally, and how this knowledge can be shared and transferred in networks for sustainable agriculture, we present a literature review on knowledge and learning in networks, more specifically in the context of sustainable agriculture. Based on this literature review we propose an assessment framework to evaluate the potential of an extensive network created during the European Interreg IV project ‘DAIRYMAN’ (2009-2013).

The paper is structured as follows: in the next section we present a literature overview to i) gain an insight into the differences in understanding knowledge and learning in the context of sustainable agriculture and ii) establish the importance of networks and communities in this respect. The literature overview concludes with a brief section on existing evaluation frameworks. The second section presents the DAIRYMAN case and an assessment framework building on insights from literature, followed by future research steps and a brief concluding section.

**Knowledge and learning for sustainable agriculture: assessing what and how**

*What kind of knowledge?*

Knowledge encompasses the understanding and skill gained through experience and education. In agriculture different types of knowledge are needed to develop solutions for the variety of challenges associated with sustainable development (van den Ban, 2002). What farmers need to know, and hence what they need to learn, varies from one situation to another (Blackmore, 2007). In literature on knowledge management and organisational learning two types of knowledge can be discerned, i.e. explicit and tacit knowledge (Nonaka & Takeuchi, 1995). Although they are often discussed as two distinct types of knowledge, the original
assumption asserts that all knowledge has tacit dimensions (Collins, 2010; Polanyi, 1966 in Leonard & Sensiper, 1998), and that knowledge exists on a spectrum. At one end knowledge can be almost completely tacit, which is semi- or unconsciously held in individuals minds and bodies, while at the other end knowledge is almost completely explicit and as such accessible to different people (Leonard & Sensiper, 1998). Explicit knowledge “can be expressed in words or numbers, and can be easily communicated and shared in the form of hard data, scientific formulae, codified procedures, or universal principles” (Nonaka & Takeuchi, 1995). Tacit knowledge on the other hand is knowledge that is not explicated, residing in the minds and bodies of people. For tacit knowledge two dimensions can be distinguished; i.e. a technical dimension or ‘know-how’, which encompasses the skills and crafts that a practitioner gains through years of practical experience, and a cognitive dimension, consisting of an individuals’ mental models, ideals and values (Nonaka & Takeuchi, 1995; van den Ban, 2002). In previous decades farmers could rely on readily available technical, explicit knowledge, usually supplied by ‘experts’ in the field, i.e. researchers and advisors. This process has been fueled by an objectivist view on agriculture. In light of such a view, ‘scientific’ knowledge is believed to be superior, as it is founded on evidence and experimentation and not confounded by errors or biases due to perspectives, history or culture (Curry & Kirwan, 2014; Morgan & Murdoch, 2000). This view has been criticised extensively in the past and Curry and Kirwan (2014) argue that “approaching sustainable agriculture through a constructivist knowledge lens allows a range of these values within ‘sustainable’ agriculture to be more clearly identified thus improving an understanding of the distinctive nature of sustainable agriculture”. In this context access to tacit knowledge is required to adequately address the issue of sustainable farming and associated farming practices (Curry & Kirwan, 2014; van den Ban, 2002).

**What kind of learning process?**

Various learning theories describe how individuals or collectives acquire and shape knowledge, and if and how this knowledge is turned into action (Blackmore, 2007). De Laat and Simons (2002) plotted learning processes against learning outcomes at both individual and collective levels and distinguished four kinds of learning as a result: i) individual learning; ii) individual learning processes with collective outcomes; iii) learning in social interaction and iv) collective learning. In the context of sustainable development, initiatives and research quite often focus on collective learning, where both the learning processes and outcomes are collective (e.g. Armitage et al., 2008; Blackmore, 2007; De Laat & Simons, 2002; Leeuwis & Pyburn, 2002; Leys & Vanclay, 2011; Marschke & Sinclair, 2009; Sinclair et al., 2008; Sol et al., 2013; Wals & Corcoran, 2012). This can be explained by the fact that sustainability issues are often complex, clouded by uncertainty, contested and surrounded by controversy, competing interests, visions and values (Triste et al., 2016; Wals, 2011). Learning systems for sustainable agriculture are required to embrace often diverging values and principles of a variety of stakeholders. They must continually adapt over time to changing conditions and insights, making them very complex (Curry & Kirwan, 2014).

Given this perspective, different notions of learning come into play. Vare and Scott (2007) make a distinction between education for sustainable development 1 and 2 (ESD1 and ESD2), which is similar to Wals (2011) who distinguishes between an instrumental perspective and an emancipatory perspective. Learning from an instrumental perspective is aimed at changing behavior, including attitudes, beliefs and values, i.e. learning from an instrumental perspective (Wals et al., 2008; Wals, 2011). An instrumental approach assumes that “a desired behavioural outcome is known, agreed on (more or less) and can be influenced by carefully
designed interventions”. In other words, learning goals and notions of what is ‘good’ or ‘right’ are established beforehand, often by experts distinct from the learners. Learners are considered as passive ‘receivers’ of knowledge (Wals et al., 2008). The theory of planned behavior (Ajzen, 1985) is a well-known model describing this process of behavioural change in which behavior is linked to knowledge and awareness on a particular subject. Although the instrumental perspective or ESD1 is the dominant discourse within education for sustainable development (Van Poeck & Vandenabeele, 2012) such models are criticised for overly simplifying the complexity of an individual's behavior in the context of sustainable development. But providing information, raising awareness and changing attitudes is not enough to change an individual’s behaviour (Vare & Scott, 2007).

As a critique on this instrumental perspective, which assumes that the future can be planned rationally from above, a more emancipatory perspective on education for sustainable development has developed over the years. Learning from an emancipatory perspective aims at capacity building and critical thinking, to enable individual and collective action and transformation towards a more sustainable society (Wals et al., 2008; Wals, 2011). It is believed that, to effectively embrace different stakeholders’ values, learning processes have to be participatory (Pretty, 1994). Loeber et al. (2007) consider such learning as a way to ensure that any particular elaboration of what is sustainable is meaningful and practical to whom it concerns through i) facilitating determination of sustainability in a given context, ii) inducing processes of value judgment and iii) supporting system innovation through reflection on theories, beliefs and assumptions underlying action. Several new learning approaches fall within this scope e.g. social learning, collaborative, transformative and emancipatory learning (Triste et al., 2016; Wals, 2011). Although they differ in focus these forms of learning have some common characteristics, e.g. the consideration of learning as not merely knowledge-based, or the view of learning as transdisciplinary and cross-boundary in nature (Wals, 2011).

Social learning in particular has been widely used in the context of learning for sustainability, but has come to mean very different things over the years built on differing theoretical perspectives and disciplinary backgrounds (De Laat & Simons, 2002; Reed et al., 2010). Perhaps the main difference is that for some social learning refers to individuals learning in social settings, while others define it as learning by social aggregates (Parson & Clark, 1995 in Wals & van der Leij, 2009). Social learning can be regarded as a naturally occurring phenomenon where learning is regarded as ubiquitous and part of human activity as such, i.e. learning cannot be avoided; it is not a choice for or against learning but the result of processes of participation and interaction (Elkjaer, 2003; Nicolini & Meznar, 1995). However, it can also be viewed as a way to organise and structure learning (Wals & van der Leij, 2009), in which the shared learning of interdependent stakeholders is a key mechanism for arriving at more desirable futures (Leeuwis & Pyburn, 2002; Wals, 2011).

**Networks to support learning processes**

Research on knowledge, learning processes and education for sustainable development has led to the development of various mechanisms, tools, structures and/or educational practices to support the change towards a more sustainable society. Policy makers across the world have developed support measures or subsidy schemes (e.g. Global GAP, CAP), researchers have developed sustainability assessment tools and frameworks (FAO, 2014; Galan et al., 2007; Gerrard et al., 2012; Zähm et al., 2008), networks or communities have been formed to foster innovation (e.g. Hermans et al., 2011; Klerkx et al., 2010; Kroma, 2008; Spielman et al., 2010; O’Kane et al., 2008; Oreszczyn et al., 2010), etc. In this section we would like to focus
in particular on networks and communities as a structure to support sustainable (agricultural) development.

Lave and Wenger (1991) were the first to make the idea of communities of practice (CoP) explicit in their work on apprenticeship and situated learning. A CoP can be defined as “a learning partnership among people who find it useful to learn from and with each other about a particular domain. They use each other’s experience of practice as a learning resource and they join forces in making sense of and addressing challenges they face individually or collectively” (Wenger et al., 2011). The notion of networks of practice originated in the work of Brown and Duguid (2001) who applied the term to the relations among groups of people with looser connections than expected in a CoP. Individuals in the network use their connections and relationships as a resource to quickly solve problems, share knowledge and make further connections (Wenger et al., 2011). Rather than seeing them as two different types of social structures, Wenger et al. (2011) prefer to think of community and network as two aspects of social structures in which learning takes place. The network aspect refers to the set of relationships, personal interactions and connections, while the community aspect refers to the development of a shared identity around a topic or set of challenges.

These social structures or networks are increasingly recognised for their potential in co-creating knowledge and innovation between academic and non-academic stakeholders. They are also increasingly being employed deliberately as ‘tools’ for knowledge management (e.g. Klerkx et al., 2012; Oreszczyn et al., 2010; Schneider et al., 2012), opposite to the classical innovation-diffusion model which assumes a clear role for the different parties (i.e. scientists create new knowledge and technologies that are subsequently transferred by extension workers for farmers to adopt). Depending on the nature of the networking activities, they may also provide easier access to tacit knowledge. Unlike explicit knowledge, tacit knowledge is not easily processed or transferred in a systematic manner but is learned rather through practical experience or from observing people in practice. As a result, on-farm demonstration activities and the monitoring of farm businesses have gained an interest as they provide new opportunities for knowledge exchange through observation, interaction and discussion (Bailey et al., 2005; Hall & Pretty, 2008; Klerkx & Proctor, 2013).

The actual realisation of this potential however, i.e. supporting different types of learning processes, knowledge co-creation and tacit knowledge exchange, is not guaranteed merely by engaging in network or community building. It is heavily influenced by issues such as trust, power relations, level of participation, network/community characteristics and individuals’ personal characteristics and competencies (De Laat & Simons, 2002; Eshuis & Stuiver, 2005; Oreszczyn et al., 2010; Sligo & Massey, 2007; Wenger et al., 2011; Wood et al., 2014).

Evaluation frameworks for networks and communities
Communities and networks are dynamic structures and this poses challenges for evaluation (McKellar et al., 2014). Evaluating the impact of such activities is also debatable because of difficulties in attribution, linking cause and effect quantitatively (McKellar et al., 2014; Purcell & Anderson, 1997). Nevertheless, several frameworks have been developed over the years to ascertain what is actually realised by investing in networks and communities. McKellar et al. (2014) present a systematic scoping review of evaluation frameworks for CoP and knowledge networks and found a total of 16 evaluation frameworks. Frameworks varied in purpose; some focused on assessing performance, while others were aimed at determining critical success factors, but based on this review they conclude that more detailed and targeted
evaluation frameworks are needed. In particular, the intangible or hard-to-measure aspects, such as trust, social capital, tacit knowledge exchange and learning, are seldom addressed, with the exception of the framework by Wenger et al. (2011) which uses member narratives. Furthermore, empirical evidence of the performance and learning outcomes of such networks and communities in the context of sustainable agriculture is relatively scarce. Wood et al. (2014) have examined knowledge-sharing relationships between science and farming based on the study of a pastoral farming experiment collaboratively undertaken by 17 farmers and 5 scientists. The analysis focused on the process of exchange and networking and the value of different contacts for farmers, but did not discuss specific learning outcomes of the networking activity. Bailey et al. (2005) present an evaluation of three separate pilots for on-farm demonstrations to support change at farm level and concluded that such activities can contribute to learning. However, specific information on what kind of learning process is supported is lacking. Eshuis & Stuiver (2005) describe the learning process of a group of 60 farmers in a nutrient management project as ‘learning in context’, where a (shared) meaning is given to existing knowledge to become valid or useful within a local situation. Learning outcomes are described in terms of the three learning loops developed by Argyris and Schön (1996). Finally, Lankester (2013) developed a framework based on adult learning theories. The framework questions who learns?, what is learned?, why is it learned?, and how?, from an individual-centric perspective, i.e. focusing on individual learning processes but taking social dimensions to individual learning into account. The framework was used to analyse the what, why and how of beef producers’ learning to improve land condition.

Knowledge exchange and learning in the DAIRYMAN case

Case description
The DAIRYMAN project (INTERREG NWE, 2009-2013) was largely inspired by the Dutch ‘Cows and Opportunities’ network, the initiators of which were also involved in DAIRYMAN. ‘Cows and Opportunities’ started in 1998 as a public-private partnership to deal with nutrient management issues in dairy farming (Oenema et al., 2001). This example was upscaled to the broader north west European region and main activities from the ‘Cows and Opportunities’ network were copied in the DAIRYMAN project. They included: the construction of a farm development plan by the pilot farmers in collaboration with researchers and/or advisors; monitoring farm performance through a standardised data collection sheet; and the organisation of pilot farmer meetings and farm visits on a regular basis to facilitate knowledge exchange on sustainable farm management practices.

The overall aim of the DAIRYMAN network was to strengthen rural communities in the regions of north west Europe, where dairy farming is a main economic activity and a vital form of land use, through better resource utilisation and stakeholder cooperation. The DAIRYMAN project intended to elaborate an alternative approach of cooperation for knowledge production and transfer. Networks were constructed in 10 European regions, comprising 7 countries., Networks differed somewhat in composition across regions but common to all regions was a group of pilot farmers and a Knowledge Transfer Centre (KTC). Pilot farmers were commercial dairy farmers who agreed to provide associated researchers with data and participate in specific project activities. KTC’s were either experimental farms or agricultural schools. In addition, or in relation to the KTC’s, research institutes and/or advisory services were involved, depending on the region. Network participants (farmers, researchers, advisors) were involved in regular, mainly regional, meetings and activities. Other stakeholders were involved on an
irregular basis (policy makers, non-involved researchers and farm advisors, etc.). Three main activity areas could be distinguished: i) pilot farm activities (e.g. discussion groups, farm visits); ii) KTC activities (e.g. training courses) and iii) regional activities (e.g. broader stakeholder workshops). Interaction between the 3 areas was possible, e.g. KTC representative attending pilot farm meeting, but was not organised on a structural basis. The focus of DAIRYMAN was not limited to a specific topic or issue within the field of sustainable dairy farming, e.g. greenhouse gas mitigation, water quality, or biodiversity, but participants were free to cover a wide range of economic, ecological and social topics. In addition to regional networking activities, the DAIRYMAN project also undertook steps to connect the different regional networks through exchange visits for farmers and other stakeholders. Inter-regional networking activities stopped at the end of the project period, but some of the regional activities are still ongoing.

Assessment framework
Returning to our research question, our aim is to assess the potential of the DAIRYMAN network to provide farmers with support to tackle sustainability challenges. In the next steps of our research, we will focus on the farmers as key stakeholders in achieving agricultural sustainability. Building on the literature we find several interesting clues to construct our assessment framework (Figure 1). First, we will focus on ‘learning in social interaction’, i.e. on individual learning outcomes in a collective learning process and not on collective learning outcomes. Although the issue at stake, i.e. sustainable dairy farming, is inarguably complex (with existing competition for land and other resources), the project did not focus on specific conflict situations and did not aim to achieve a collective vision or action for network participants, not even at a regional level. The project did however aim to act as a platform for knowledge exchange by providing access to and information on different types of dairy farming systems. In this respect the framework from Lankester (2013) provides us with a clear outline to assess the different components, i.e. who, what, how and why of the individual farmer’s learning process. Second, as we also want to see how the DAIRYMAN context has influenced the different components of individual learning, we have integrated the concept of value creation (Wenger et al., 2011). Wenger et al. (2011) describe 5 cycles of value creation, mirroring the richness of values created by communities and networks, i.e. immediate, potential, applied, realised and reframing value. Firstly, immediate value considers that networking activities and interactions have value of themselves. Potential value refers to ‘knowledge capital’, whose value lies in its potential to be realised later. Applied value refers to the adoption and application of the knowledge, practices and results learned in one’s personal life or professional context. Fourthly, realised value goes further than only application. It looks at the effects and successes of the novel practices, both for farmers and other stakeholders. Finally, reframing value reflects on changed understandings, strategies or goals and changes in the definition of what matters, at individual, collective and organisational level. Although there are causal relationships between the different cycles, no simple causal chain or hierarchy of levels is assumed. Also, success does not necessarily coincide with reaching reframing value (Wenger et al., 2011). Given the DAIRYMAN setting, we expect to achieve immediate, potential and, possibly, applied value.
Figure 1. Assessment framework (adapted from Lankester (2013) and Wenger et al. (2011))

Further research steps
We followed a qualitative research approach and have conducted in-depth semi-structured interviews with regional key persons and selected pilot farmers. The assessment framework has been used to structure our interview guide. The regional key persons were researchers or advisors who had a central position in the regional network and who were actively involved in the inter-regional project coordination. We have included 3 DAIRYMAN regions in the current research (the Netherlands, Flanders (Belgium) and Northern Ireland (UK)). The authors of this paper were actively involved in the DAIRYMAN project and we have selected these regions to reflect the diversity of regional networks structures in the overarching DAIRYMAN network. Interviews are currently being transcribed, coded and analysed in NVivo9.

Conclusion
Issues of knowledge and learning in the context of sustainable (agricultural) development are complex. Nevertheless, we believe that the presented literature review has offered us some important indications for analysing the DAIRYMAN case. The importance in distinguishing between individual and collective levels of learning, between tacit and explicit forms of
knowledge and between instrumental and emancipatory forms of learning, will enable a more thorough analysis. By doing so, we aim to provide an answer to the two following research questions: i) does the DAIRYMAN network support knowledge exchange and what, how and why have participants learned? and ii) what are the differences in regional networks and has this influenced participants’ learning outcomes?
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University research enters practice – and is enhanced by farmers. A precision farming case study

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Abstract: This paper describes the case of a Precision Farming technology, the Yara N-Sensor. This successful university research based innovation is more than 15 years old and has been supplemented by two modules which have been co-developed by farmers. Today the optical crop sensor is used for site-specific nitrogen, growth regulator and fungicide application deriving optimum site-specific application rates which are sent to the spreader or sprayer. The most important impacts of the N-Sensor are efficient use of inputs, higher yields and a better harvesting performance. We trace the innovation’s impact pathway from the initial research proposal to the current adoption on an estimated 700,000 hectares (ha) of agricultural land in Germany. Based on a dissertation project running from 1994 to 1996 at the University of Kiel, the innovation was brought into practice by Yara, a mineral fertiliser producer, in 1999. It has since been constantly enhanced, not only by Yara but also by a German SME named AgriCon. The latter company is responsible for sales and marketing in Germany and became a co-developer of the sensor through the development of the two additional modules together with farmers. For the case of the YARA N-sensor, we detect enabling factors and barriers for innovation. Based on these results we draw conclusions on what we can learn from the presented case on how to foster the innovation diffusion and related knowledge co-production and learning processes. Closeness and proximity to farmers seems a key factor in this respect.

Keywords: Impact pathway, precision farming, knowledge co-production, transdisciplinarity, multi-actor networks, learning networks, interactive innovation

Introduction
In recent years the Common Agricultural Policy (CAP) and Horizon 2020 have put renewed emphasis on agricultural research and innovation. At the same time there is a broad variety of Agricultural Knowledge and Innovation Systems across Europe (Knierim et al., 2015). In all these systems research based innovations need to find their way into practice and there will be no one ideal solution on how this works best in different systems. We can however learn from innovations which are today successfully applied by tracing back their impact pathways and detect enabling and disabling factors.

The EU FP7 project ‘Impact of Research on EU Agriculture’ (IMPRESA) intends to measure, assess and comprehend the impact of all forms of European sustainable research on achieving key agricultural policy goals, including farm level productivity but also environmental enhancement and the efficiency of agri-food supply chains. One activity to rise to this challenge was carrying out studies on a small number of cases of mature research based innovations.

One of these studies was conducted on a precision farming technique in crop production, the Yara N-Sensor. The optical crop sensor for nitrogen application was initially developed at the
German University of Kiel at the end of the 1990s. It was produced and has been constantly enhanced by the company Yara. In Germany, and nowadays a number of other countries, it is supplied by the spin-off company Agricon. Based on self-driven tests and experiments by farmers Agricon co-developed two additional N-Sensor modules for applications to growth regulators and fungicides (Figure 1). In Germany the N-sensor is currently used by around 730 farmers on around 700,000 ha UAA (Utilised Agricultural Area), with a main area of distribution on farms with more than 500 ha.

The paper starts with an outline of the case. We then describe the IMPRESA methodology and in the following section its application to the case. We will describe the impact pathway and show enabling and disabling factors. Based on these results we draw conclusions on what we can learn from the presented case on how to foster the innovation diffusion and related knowledge co-production and learning processes.

**Figure 1. N-Sensor application of the additional module for crop protection.**

**The case: the Yara N-Sensor**
In this section we will present the story line of the N-Sensor from initial research activities, describe its market entry and briefly outline the current situation.

**Initial research activities**
The optical sensor is based on a dissertation project within the Institute of Agricultural Engineering of the University of Kiel, where it was part of the Collaborative Research Centre (Sonderforschungsbereich) 192 ‘Optimisation of crop production systems’ and thus funded by the DFG, the German Research Foundation (Heege, 1994). The intended research activities were carried out by a doctoral student who had been recruited from the Department of Physics at the same university.

In 1996 project results were presented at different meetings and conferences, raising the interest in Yara, formerly known as Norsk Hydro. At that time, Yara (Norsk Hydro) already had a tool for testing the N-content of a plant on the spot, the N-Tester. Like the sensor it is an optical tool which measures the chlorophyll content of the leaf in order to give fertilising
recommendations. The tester can be considered as a proof of principle raising the interest in Yara to develop an easier way for users to receive more specific fertilising recommendations for more than one plant at the same time and apply them on the go. Yara approached the University project team and offered a job to the doctoral student at its R&D Centre in Germany, which he accepted after finishing his thesis in 1997 (Reusch, 1997).

Product development ran from 1997 to 1999 at Yara based on the results of the research project described above.

The innovation enters the market
When the first prototypes were presented a young German start-up, Agricon, approached Yara and acquired the distribution rights. Since then Yara has worked continuously on the adaptation and development of algorithms and control functions, as well as further technical developments, while Agricon cares for sales and marketing activities in Germany. In addition both carry out field trials. Besides these Yara’s direct contact with farmers is rather limited, while Agricon established a close contact with farmers as part of their marketing activities. Together with farmers they continuously work on the development of additional precision farming solutions. The company is located in Saxony and Agricon’s other branch, soil sampling, has led to various contacts with Eastern German crop farmers managing more than 1000 ha of agricultural land. As a marketing strategy the company concentrated on these in the beginning and promoted the pioneers as role models for others.

While the adoption process in Eastern Germany started with the market entry, the number of sensors sold in Western Germany has increased considerably since 2008. In 2008 prices for inputs started to increase which served as an entry point to the N-Sensor on Western German farms (Figure 2).
Figure 2. Cumulated sales figures from 1999-2015 for Germany and other countries in which Agricon is distributing the N-Sensor (Authors’ illustration).

Today’s situation
Currently 1500 copies of the N-Sensor have been sold worldwide (800 by Agricon) - 713 of these are used in Germany, the rest have been purchased by farms in Austria and Eastern European countries where Agricon currently develops a market (Figure 2).

Within our case study we carried out a user survey. On average users are 50 years old (range 16 to 68). Three quarters of them graduated from universities or applied universities. There are farms with a big field plot size, with up to 10,000 ha being cultivated by one farm. The survey shows that the average farm size of N-sensor users is around 1350 ha, with half of the user farms however having less than 1000 ha.

Most advisory services related to the N-Sensor (and other Precision Farming solutions) are provided by the Agricon company consultants. In some countries a small number of other advisors can be found who are trained in Precision Farming solutions.

How to detect impacts of innovation: the application of IMPRESA’s stepwise approach
In the early 2000s the impact pathway method was suggested and applied by different authors mainly from the field of agricultural development cooperation e.g. Douthwaite et al. (2003) and Springer-Heintze et al. (2003). The intention was to better capture remote parts of the traditionally applied logical framework. Douthwaite et al. (2003) proposed that the project participants themselves draw an impact pathway at the beginning of the project and carry out monitoring and later ex post impact assessment, with the impact pathway as explicit theory of how the project will achieve impact. This is “particularly useful in view of the new perspective
on impact, which conceptualises technical change in agriculture as a complex process involving feedback loops, and interactions between social, cultural and biophysical systems” (Briones et al., 2004 p. 561). If drawn when setting up the project the pathway will make explicit intended outcomes and impact, which serve as a basis for setting up indicators. These can be measured in the course of the project. During the project’s lifetime the impact pathway will evolve and gain complexity, but stakeholders as ‘owners’ of the impact pathway will be able to follow it easily. Carrying out the ex post impact assessment the evaluator is supposed to establish plausible links between the project’s impact pathway and subsequent changes (Douthwaite et al., 2006). Within the IMRESA project we tested the transfer to ex post impact assessment of agricultural research projects and followed a case study approach in order to reconstruct the impact pathway of a research-based innovation. A stepwise approach was elaborated which was applied for all of the six case study regions (Stigler et al., 2014).

In the German case, research work was organised along the steps which were adjusted case-specifically, reflecting the availability of actors, literature and data, etc. An initial screening comprised a review of literature on adoption and impacts of the N-Sensor as well as explorative in-depth interviews with experts in the field of Precision Farming (PF). We then started with the process of impact pathway building based on literature and semi-structured interviews with key stakeholders. The ‘Sectoral Study on the Analysis of the Innovation System of the German Agriculture’ conducted by Bokelmann et al. between 2010 and 2012, published in 2012, was of special help. With financial support from the Federal Institute for Agriculture and Nutrition the project consortium analysed a broad set of literature, interviewed experts and held Delphi-rounds and expert workshops (Bokelmann et al., 2012). Adding to that, we analysed in our case study a broad set of literature specifically on the effects of the N-Sensor and carried out our own interviews with key stakeholders. In order to evaluate the impacts, we carried out a full user survey and held a workshop with farmers, advisors, product and sales managers. The impact pathway was drafted by the case study team first and then reflected with stakeholder and expert judgement (via interviews, survey and workshops). This deviation from Douthwaite’s methodology was necessary as our work collided with the field work peaks of farmers, but was justifiable due to the good set of available literature both on the innovation system and the effects of the N-Sensor, as well as the available project documentation in combination with the in-depth interviews. Each link of the pathway was tested against counterfactual reasoning (if it wasn’t for the sensor, would it have occurred) and strong links were made visible graphically by use of more width and colours (Figure 3). The pathway reflection led to crossing out of elements if the attribution to the innovation was not confirmed.

The impact pathway of the Yara N-Sensor and its enabling and disabling factors
The impact pathway was drawn alongside the story of the N-Sensor and was drafted chronologically in earlier versions. In order to allow better readability, it was then rearranged along the traditional linear causal chain from output to impact, the so-called logical framework. It becomes obvious that there are multiple interlinkages between the different pathway elements, underlining the often voiced criticism against the linear chain (Douthwaite et al., 2003).

We present the results of the pathway according to the impacts we were able to confirm. We then give an overview on enabling factors and barriers influencing the impact pathway.
Figure 3. Impact Pathway of the N-Sensor. The strength of the arrows and the colour shows the contribution of the research to the respective link (black is weak, orange is medium, red is strong).
Impacts of the N-Sensor

There is a broad set of literature available on the effects and impacts of the N-Sensor. While Agricon continuously carries out its own field trials in order to gain more insights into the effects of the N-Sensor and thus be able to use them as selling arguments, universities, consulting companies and advisory services also show an increasing interest in finding out if, and in what way, fertilising was improved by the use of the N-Sensor. The minimum design of those studies is an annually repeated testing of N-Sensor fertilising compared with standard fertilising on a number of plots.

Early studies (Wenkel et al., 2002; Lenge, 2003; Rademacher, 2004; Rösch et al., 2005; Feiffer et al., 2005) show impressive effects of the use of the sensor in terms of N-savings in comparison to standard fertilising. For winter wheat for instance, the amount of fertiliser used is reduced by between 2 to 18% (Rösch et al., 2005 p103). Wenkel et al. (2002 p. 258) report 14 kg/ha which equals 7% reduction of N-fertiliser. Rademacher (2004 p. 198f) shows a saving of 14 kg/ha with a small loss of yields between 0.7 and 4 dt/ha. On the other hand Reckleben and Isensee (2005), Rösch et al. (2005) and Feiffer et al. (2005) detect an increase in yields: Feiffer et al. (2005 p.117f) report 7% higher yields with 14% less N-savings. These results are supported by the user survey, which was conducted in the frame of the IMPRESA study. Most of the users report N-savings. Nonetheless, there is a need to differentiate between different crops, because for some crops high N-savings can be observed, while for others these may be negligible (workshop statement).

In general it can be stated that site-specific fertilising leads to the adaptation of N to the actual need of the plants (Pahlmann, 2011). The results however depend very much on land and weather conditions: if there is extreme dry weather or if there are dry areas with low groundwater conditions, there is a threat of over-fertilisation (Kock, 2013; Schliephake, 2007; Schneider & Wagner, 2007; Rösch et al., 2005). The workshop attendees point out that although the N-Sensor is used the farmer still needs to apply his agronomic knowledge and has to calibrate the sensor according to conditions. Agricon tries to provide support, especially on the need to take weather conditions into account, by sending out regular newsletters to all users.

After first harvesting periods, combine harvester drivers reported that harvesting was easier in stocks which had been fertilized with the N-Sensor. Based on these observations the Harvest Pool carried out studies and found that stocks show a more uniform growth (Feiffer et al., 2005). In addition the spear stability is increased leading to less lodging (Feiffer et al., 2005, also reported by Lenge, 2003). Improvement of spear stability, less lodging and uniform growth lead to a higher harvesting performance. A performance increase of 15-20% for different crops was reported. At the same time, a broader harvest window of around 5 days more time for harvesting was observed. In the user survey we conducted, user statements validated the better harvesting performance (82%), whereas the broader harvest window was not observed by users (71% state there was no change, while 8% observe a slightly broader and 8% a slightly smaller harvest window).

In the impact pathway logic, the application of the N-Sensor for site-specific fertilising has led to the outcomes harvesting performance, N-savings and higher yields which contribute positively to the impact ‘higher net earnings’. Investments for the N-Sensor start at about 26,000€ for the N-Sensor and 39,700€, for the ALS. Additional costs may comprise investments in machinery as a prerequisite for the use of the sensor (e.g. a new fertiliser
spreader), as well as maintenance and advisory services (Kock, 2013 calculates an additional 5-13€/ha in comparison to standard fertilising for winter rapeseed and winter barley). As with every investment in agricultural machinery, these costs have to be taken into account when calculating the net income. According to Agricon, 100 ha of land for N-Sensor use is the current threshold at which the purchase of the machine is worthwhile.

Research on the effects is being carried out continuously; nowadays the results are more moderate. Agricon officials assume that there has been a learning process for users: the effects are measured in comparison to constant N-fertilising and it is hypothesised that test farmers have adjusted constant fertilising due to experiences with the N-Sensor; the workshop participants supported this assumption. Due to the fact that the N-Sensor and also other sensors exist, farmers, even if they are not using a sensor, have hinted at the fact that it might be profitable to adjust the N-application to the actual plant and soil conditions. Publications in farmers’ magazines but also discussions between farmers have broadened the mind-set and led to a more site-, weather- and soil-specific thinking instead of following fixed fertilising schemes. Besides the fact that there is the impact ‘adaptation to the actual need of the plant’, we can conclude the impact ‘learning of users and non-users’, i.e., learning of adopters and those who have not (yet) bought a sensor.

Since 2006 several enhancements have been made. Yara launched the N-Sensor ALS (Active Light Source), which worked in a similar way as the classic N-Sensor but has its own built in light source (Xenon flash lamps) enabling sensor operation independent from ambient light conditions. In the late 2000s some farmers tested other uses of the N-Sensor, first on growth regulators then on fungicides. All of these experimenting farmers had a long client relationship with Agricon. Their problem-oriented research was crucial for the development of the module or as one farmer put it: “we pushed Agricon to take up our own trials with growth regulators and develop a module for it”. Based on farmers’ positive results Agricon developed the module for the sensor. The additional application entered the market in 2008. Leithold & Volk (2007), Volk et al. (2012) and Volk (2015) report higher yields and less lodging, both outcomes contributing to a higher net income. In addition, they report a reduction of use of growth regulators, which is supported by the survey we conducted. Together with the N-savings we therefore summarised as an impact ‘reduction of inputs in the ecosystem’.

The development of and continuous work on the Yara N-Sensor has led to the creation of jobs. The precise number can only be estimated. Interviewees and workshop attendees estimated that around 50 jobs have been created.

There are two environmental impacts, which we hypothesised resulting from the site-specific fertilising and N-saving: the project proposal (Heege, 1994) intended to contribute to higher groundwater quality due to reduced nitrate leakage; in addition, Pahlmann (2011) found a reduction in greenhouse gas emissions if used for the production of rapeseed biodiesel. Both impacts were ruled out by the workshop as they were hard to detect, not really measurable and attributable to the N-Sensor and depending very much on soil conditions.

**Enabling factors within the impact pathway**

In our case, the most important factor for the development of innovations and their adoption seems to be knowledge exchange: between disciplines, between science and industry, between the sales company and customers, i.e., farmers, and between farmers themselves.
The intra-university exchange between disciplines, agricultural engineering, crop sciences but also physics laid the foundation for the successful project. After the first prototype had been developed contact opportunities like fairs and exhibitions as well as conferences were crucial in order to spread the idea and bring scientific knowledge into practice. Meanwhile networks between science and industry have established: Agricon for example seeks direct contact to scientists and works together with them in different networks and projects or provides information if there are requests for support or knowledge. It is thus able to keep up with developments in the field and can react to findings.

Exchange with and between farmers seems of special relevance. Agricon has an elaborated marketing and sales plan in which around three quarters of activities focus on direct contact and exchange with a special focus on peer-to-peer contact and information. They organise, for example, regular meetings between users, seminars for drivers, hold webinars etc. The advisory services of Agricon helped to establish contact with both experimental and ‘lighthouse’ farmers, for whom Agricon sets the scene e.g. as testimonials in farmers’ magazines. The IMPRESA survey showed that the buying decision was strongly influenced by exchange with other farmers such as neighbours or other colleagues. Sixty-two percent of the users had recommended the N-Sensor to other farmers, 42% even demonstrated the N-Sensor to others. In addition, experimenting farmers frequently exchanged information informally and thus pushed each other into testing and improving new ways of application leading to the two modules.

Around 750 copies of the N-Sensor have been sold in Germany. Based on interview statements and our own survey we assume that nearly all of the big farms cultivating more than 1000 ha in Germany have at least one sensor. The adoption of the N-Sensor seems to exemplify the hypothesis of Bokelmann et al. (2012) stating the capacity to innovate correlated with the size of the farms: larger farms have the financial resources for the considerable investment; in addition, the return on investment is higher the more hectares are being cultivated; and the education level of farm managers of these large Eastern German farms is generally high. The workshop attendees added that due to higher personnel resources, farm managers, or those responsible for crop cultivation, have more time to inform themselves about innovations and they have personnel which can be trained on the use of the machine – in contrast to most farm managers in Western Germany who often run one-man companies. Smaller farms on which the N-Sensor was adopted are often run by well-trained, prospective thinking farmers who have a technical interest. They are often part of the tinkering or experimenting farmers who bring about incremental innovations (Bokelmann et al., 2012).

While the adoption process in Eastern Germany started with the market entry, the number of sensors sold in Western Germany has increased considerably since 2008. Interviewees and workshop attendees hinted at the fact that prices for inputs started to increase in that time, so there seems to be a direct influence of market prices and margin calculations – making the prospective return on investment more attractive for smaller farms too. This is reflected in our survey, in which half of the farms cultivate less than 1000 ha and 30% less than 500 ha, illustrating that the N-Sensor is increasingly of interest to comparatively smaller farms. On the other hand, experts hint at the fact that the investment behaviour of farmers is volatile and may change from year to year.

The adoption process is also influenced by the respective innovation system. Though criticism has been voiced against Roger’s theory (e.g. Robertson et al., 1996) we still borrow his two
definitions of heterophilous and homophilous innovation systems (Rogers, 1962 quoted after Stigler et al., 2014), as they are helpful in our context and case. In heterophilous systems, changes from system norms are encouraged. The continuous manifold interactions between people from different backgrounds create a space for new inputs. In these systems change agents can focus on targeting “the most elite and innovative opinion leaders and the innovation will trickle down to non-elites. If an elite opinion leader is convinced to adopt the innovation, the rest are going to adopt it. The domino effect begins with enthusiasms rather than resistance” (Stigler et al., 2014 p. 47). Examples of heterophilous systems seem to be Saxony and the Rhineland. The opposite are homophilous systems which tend to preserve system norms. Interactions remain mostly between people from similar backgrounds. There is an aversion to innovation as ideas differing from the norm and people thinking outside the box are considered strange and undesirable. Change agents have to focus on a wide group of opinion leaders because in these closed systems it is less likely that innovations or new ideas will find their way to the ground. A homophilous system can be assumed in Schleswig-Holstein. This is also reflected in the research and advisory community: while in Saxony for instance good testing results are achieved and the N-Sensor is advocated by advisors, in Schleswig-Holstein the agricultural chamber, responsible for advisory services there, is involved in research activities showing critical outcomes. Distribution rates in Schleswig-Holstein are accordingly low.

Another enabling factor is the innovation capacity and innovation willingness of farmers, which has increased in the last 20 to 30 years due to the higher education level, the increased market pressure and changing requirements and expectations of society (Bokelmann et al., 2012). Correlating age and year of purchase of the N-Sensor, our survey shows that farms now innovate quicker, i.e. more often than just with a change to the next farmer’s generation, as was often the case in the last century.

**Barriers**

Besides enabling factors in the innovation systems we also found barriers in the impact pathway of the innovation.

One of the most important barriers internally are technical and knowledge-based related problems of farmers with the system. In the IMPRESA survey, 72% of the farmers say that working themselves into the system was moderately laborious and 13% found it very laborious. We even had a small number of farmers answering the survey who had stopped using the sensor and often it was related to the handling of the sensor. In order to use it properly, drivers need additional knowledge on the different application opportunities and the technical features of the sensor. Agricon tries to close the knowledge gap through different dissemination and advisory activities and offers training, but drivers still need the cognitive capacity to be able to operate the machines correctly.

Since its market entry the N-Sensor has been enhanced, and currently more than 100 algorithms, different crops and different forms of application are possible. In addition smart cloud and software solutions have been made available. All of this adds to the complexity for users. In addition farmers need to apply their agronomic knowledge and they have to be able to calibrate the sensor according to (land and weather) conditions. This might be easier for Eastern German farmers who usually have personnel resources and more time to get familiar with a new technique than the typical Western German one-man company or family farm.
If a homophilous innovation system (Rogers, 1962, quoted after Stigler et al., 2014) prevails it may serve as a barrier too. Even if a farmer is located in a heterophilous innovation system, critical studies and critical advisors may considerably lower interest in adoption. In our survey we found that it took an average of five years from the point of time when a farmer first learned about the N-Sensor until he actually bought a copy of it. During this span of time farmers seek contact with colleagues, they read magazines, some see a presentation, others test it etc. Any critical study, testimonial or remark by an adviser may influence the buying decision, even if these are controversial themselves. In particular, some advisers seem to lag behind in terms of knowledge on new agronomic and Precision Farming developments and prefer to stick to classical pieces of advice.

A future barrier may be the growing share of users which has led to a situation where Agricon has introduced a hotline for farmers who have been dealt with before as preferred customers, being able to contact ‘their’ Agricon advisor directly whatever question or remark they had. This may lead to the frustrating feeling of being ‘downgraded’ to a normal customer and may lower the closeness between Agricon and farmers which has proved to be positive for incremental innovations.

**Learning from the case**

The impact pathway analysis sheds light on impact as (technical) change in agriculture through complex processes and interactions between social, cultural and biophysical systems (Briones et al., 2004 p. 561). The result is a complex impact pathway which has evolved and gained complexity through the project’s lifetime, but stakeholders as ‘owners’ of the impact pathway will be able to follow it easily. We found limitations if applied to ex-post impact assessment of mature innovations. Due to a collision with field work peaks for farmers and other stakeholders we scratched a first version of the impact pathway based on the intended impacts in the proposal, a review of studies on the effects and interviews. Though justifiable from a content perspective (good set of available literature, available project documentation, rich in-depth interviews), it made it difficult for stakeholders to follow the naturally complex pathway of this mature innovation when we finally presented a first version to them. For better readability we rearranged the pathway along the logical framework (which we considered outdated and initially didn’t want to have a slightest notion in our pathway). Nevertheless, drawing the impact pathway helped us to take into account a broad range of elements and reflecting, as well as representing in the graph, the manifold links between these.

The analysis of enabling factors and barriers led us to the question of how to create space for innovation and what prerequisites needed to be there in order to foster knowledge co-production processes. One main element might be stimulating the evolvement of heterophilous systems through leveraging continuous manifold interactions between people from different backgrounds. This will create space for new inputs, which in the end encourages changes from system norms. The experiments of the farmers were only taken up by Agricon because of the close personal contact to these farmers. There was so little distance between the two parties that farmers felt able to push Agricon to take up their trials and on the other side Agricon had enough trust in the abilities and knowledge of these farmers to rely on their tests and initiate the development of the two modules. Thus we can conclude in line with Bokelmann et al. (2012), referring to Koschatzky (2001), that close proximity and socio-cultural networks help to reduce uncertainties in the innovation process, which is especially valid for complex technologies. The success and high innovation capacity of SMEs like Agricon is based on the strong integration in rural networks and their closeness to customers.
In addition, the case illustrates the need for independent advisors. They can play a key role in mainstreaming Precision Farming inventions like the N-Sensor and thus helping it to become an innovation, i.e. a new practice which is widely accepted. Our case illustrates the current situation (cp. EIP AGRI FG Precision Farming, 2015) that Precision Farming technology transfer is mostly left to private, often company consultants like Agricon. These pieces of advice, however, will always be conflicting with their own marketing agenda. Advisers need appropriate training and knowledge on Precision Farming solutions in order to be able to perceive the potential to improve advisory services by improving management and the efficient use of resources and help farmers to set up the most appropriate farm management system causing as little frustration as possible (ibid.).

There needs to be continuous exchange and communication at various levels: between disciplines at university level; between science and industry, etc. Of particular relevance is regular and close contact to users with communication as equals. All of these communication processes require time, opportunity and communication skills, but in the end they will broaden the mind-set and foster interactive innovation.

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References


Building social capital and promoting participatory development of agricultural innovations through farmer field schools: the Greek experience

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Abstract: More than 25 years after the first implementation of Farmer Field Schools (FFS): there is a rich corpus of evidence that participation in FFS improves farmers' knowledge, skills and competencies. On the other hand several studies converge to show that FFS, by strengthening group action, have the potential to build-up social capital among participants and, thereafter, within local communities. However, it is not yet clear if this social capital is reflected in the levels of knowledge gained by FFS participants and to what extent it promotes farmers' participatory engagement in the process of innovation development. To answer these questions we used between and within-subjects approaches. Data were drawn from facilitators and cotton farmers who participated in an FFS project aimed at the development of competencies in three domains: integrated crop management, farm management and occupational safety. In a first step we developed three measures to assess: the levels of social capital among farmers; the degree to which each participant contributed to the co-production of innovations within the framework of the project and the knowledge gained by farmers. Regression analyses confirmed that the levels of social capital – and especially bonding social capital – do indeed predict both the co-production of innovations by farmers and the levels of knowledge they gain through their participation in FFS. These findings indicate that cultivating social capital among FFS participants is a key element in facilitating the construction of knowledge and the co-evolution of agricultural innovations by farmers, two of the core foci of FFS’ approach.

Keywords: Farmer field schools, social capital, innovations, agricultural extension, participatory innovation development, integrated crop management

Introduction
Farmer Field Schools (FFS) were first implemented in Indonesia in 1989 as a way to help rice farmers reduce their reliance on agrochemicals and to promote integrated pest management (Van de Fliert, 1993). In FFS groups of 20-25 farmers meet on a regular basis with an expert (facilitator) to observe, analyse and experiment in real-farm settings. Participants, under the guidance of the facilitator, try to find problems and to solve them using the shared knowledge they construct during the course of FFS. FFS curricula are not strictly mandated thus allowing farmers to self-regulate their learning. The FFS cycle follows the life cycle of the crop (planting to harvesting). Hence participants have the opportunity to deepen their understanding of the wide-ranging and complex factors which affect their crops, as well as to enhance their problem-solving competencies.
As Kenmore (2002) notes, the core aim of FFS is to help farmers increase their analytical skills, improve their decision-making capacities and sharpen their critical thinking skills. FFS philosophy goes beyond traditional models of agricultural knowledge diffusion. The principles of social learning (Pretty & Buck, 2002); transformative learning (Taylor et al., 2012); and experiential learning (Nederlof & Odonkor, 2006) occupy central positions in the FFS approach. Learning in FFS emerges as the output of hands-on experimentation and interactive learning, while farmer-to-farmer learning activities help participants to increase their communication and collaborative skills (Braun & Duveskog, 2008; Van den Berg & Jiggins, 2007; Feder et al., 2004). During the course of FFS, farmers actively participate – both individually and collectively – in the development, implementation and evaluation of time- and context-specific innovations (Charatsari, 2015). This participatory process paves the way for the adoption of innovative technologies, ideas and practices.

Despite the criticism of their ability to reach a wide range of farming communities (Thiele et al., 2001); to attract farmers from all social strata (Simpson & Owens, 2002) and to produce a stable increase in economic gains (Praneetvatakul & Waibel, 2006): FFS remain an effective model in the developing world, where this alternative approach continues to climb in popularity especially among poor farmers (Davis et al., 2012). Research has repeatedly proved that participation in FFS sharpens farmers’ specialised knowledge and expertise (Ortiz et al., 2004); strengthens their system thinking skills (Yang et al., 2008); helps them to achieve a more holistic comprehension of the ways farm practices affect crop responses (Dalton et al., 2010) and increases their decision-making performance (Yang et al., 2005). As a result FFS participants enjoy higher yields (Cai et al., 2016) and higher incomes (Mutandwa & Mpangwa, 2004).

Interestingly these benefits of FFS extend beyond individual-level frameworks. FFS participants are able not only to apply the knowledge produced and shared within FFS but also to effectively transfer this knowledge to other farmers (Jørs et al., 2016). Moreover participation in FFS is associated with a reduction of agrochemicals use (Tripp et al., 2005) and an increase of social capital within farming communities (Settle & Garba, 2011). In this vein, FFS also have positive environmental and social impacts.

Over time FFS curricula started to incorporate non-farming issues, related to important problems of farming communities in the developing countries such as domestic violence or HIV prevention (Friis-Hansen et al., 2012). In other cases FFS-based approaches like “Farmer Livestock Schools” in Vietnam (Minh et al., 2010) or “Climate Field Schools” in Indonesia (Siregar & Crane, 2011) were designed to address specific needs and/or to target specific population groups. Recently, some successful attempts have also been made in the developed world, like the “East Bay FFS” in San Francisco, U.S.A. (Berman, 2016) and the FFS for cotton and rice producers in Greece (Charatsari, 2015).

Enabling social capital through FFS

Social capital is a concept widely used in many disciplines, from sociology to medicine (Macinko & Starfield, 2001): management sciences (Adler & Kwon, 2002): economy (Knack & Keefer, 1997) and politics (Jackman & Miller, 1998). Hence, literature on social capital is characterised by a broad variety of definitions and a wide range of foci, which complicates any
attempt to compare social capital in different contexts. In addition the measurement of social capital is a difficult task since, as Paldam (2000 p. 649) notes, in social capital literature “there is far more theory and speculation than measurement”.

Social capital encompasses multiple layers, including social trust (Fukuyama, 2001) and reciprocity (Whiteley, 2000); social bonding (Larsen et al., 2004); social cooperation (Newton, 2001); willingness and/or ability to form social networks (Onyx & Bullen, 2000); social connection (Morrow, 1999) and psychological engagement with a group of people (Breim & Rahn, 1997); to mention only a few. Nevertheless from the pioneering work of Bourdieu (1980) until today there is a general consensus among researchers that participation in social groups – for example, religious associations (Strømsnes, 2008); ethnic organisations (Brettel, 2005) or groups of volunteers (Peachey et al., 2015) – facilitates the development of social capital.

FFS, by definition, have been developed around the idea of creating strong social ties and networks not only among participants but also within farming communities. Participants in FFS form social bonds with their co-learners (Palis, 2006); develop a sense of confidence with their colleagues (Pretty & Buck, 2002); reshape their perceptions toward gender roles (Najjar et al., 2013); build collaboration schemes with other farmers (David, 2007) and develop a logic of collaborative action (Friis-Hansen & Duveskog, 2012) and mutual support (Dzeco et al., 2010); all signs of social capital creation.

**The present study**

The rich body of literature on FFS offers a variety of findings on the effects of this alternative approach to the creation of social capital. The reverse relationship however has not yet been studied. So two central questions remain open: how does social capital affect the levels of knowledge participants acquire?; and to what extent does the social capital developed in the group of farmers affect the degree to which they participate in the process of co-production of innovative solutions and problem-solving techniques? Hence, unlike much of the abovementioned literature, the present study focused on the ways social capital among trainees influences two key-factors that determine the effectiveness of an FFS project: the levels of knowledge gained by farmers over the course of the programme, and the degree to which farmers participate in the process of the co-development of innovations.

Another point that differentiates our study from previous works which examine the relationship between FFS and social capital is our focus on different dimensions of social capital. Most contemporary efforts to conceptualise social capital within the FFS framework consider just one, or only a few, aspects of this multidimensional concept. Mancini et al (2007) for example and Palis et al (2005) described social capital in terms of access to social assets (e.g. networks, groups); David & Asamoah (2011) used farmers’ participation in communities of interest to define social capital, while Mancini & Jiggins (2008) added the dimension of trust. In a meta-analysis, Phillips et al. (2014) refer to social capital as social connections, whereas Settle et al. (2014): in a study based on retrospective data, provide an example of a collective help-giving behaviour as an indication of social capital development after FFS participation.

Although all the above mentioned aspects represent different forms of social capital, grounded in the seminal works of Coleman (1998), Portes (1998) and Pretty (2003), other dimensions of social capital that can emerge within the FFS framework have not been yet operationalised.
In our study, drawing on works from social psychology (e.g. Cook, 2005): work psychology (e.g. Carmeli et al., 2009) and economic sociology (e.g. Nahapiet & Ghoshal, 1997): we tried to take into account some new (emotional and cognitive) components of social capital.

The study used data drawn from cotton farmers and extensionists who participated in an FFS project conducted in Thessaly (Greece) during the growing season of 2015 (thirteen weeks from early June to early September). The aim of the project was threefold: to help farmers understand the principles of integrated crop management; to increase their knowledge on occupational safety issues and to enhance their farm management skills. A variety of learning activities were designed so as to provide the basis for the integration of knowledge, skills and attitude change on these three areas.

It is worth noting that this was the first attempt to implement FFS in Greece. Given that FFS philosophy was built around the developed countries' special contexts and needs, a couple of minor methodological adaptations were made in order to tailor the current project to the specific social, cultural and attitudinal background of Thessalian farmers as well as in order to better fit the project with the competencies of the facilitators. First, a group of three to five extensionists (agronomists) was used to guide and facilitate the learning process of each group of farmers (20-25 persons). The use of groups of extensionists was preferred because it permits the collaboration of scientists with different knowledge bases. This need has to do with the high degree of Greek agronomists' specialisation (one of the major shortcomings of the higher agricultural education system in Greece): which eliminates their ability to engage in a vast range of topics. Secondly, instead of focusing on the ‘technology development’, the project aimed at the participatory development of innovative solutions – not technological but rather conceptual or managerial.

Method
Participants and procedure
Data for this study were drawn from 36 farmers (34 men, mean age 40.53 years, S.D. 14.72) and 6 trainers/facilitators (5 men, mean age 44.83 years, S.D.14.22) who participated in the FFS project. Farmers came from 27 local communities. Twelve of the participants (33.33%) reported having social relationships with other trainees (mean number of social relationships with other trainees was 0.56, S.D. 0.91) before the starting day of the FFS project. Most of the farmers had secondary education (44.44%): while their average income was €13,680 (S.D. 4,078).

Trainees completed a series of instruments, including the In-Group Social Capital Scale (completed after the end of FFS) and a questionnaire aimed at exploring the levels of knowledge gained through their participation in the project (answered before the start and after the end of the project). Trainers also completed a questionnaire designed to assess multiple facets of the FFS programme, as well as to collect information about the degree to which each farmer contributed to the co-production of innovations over the course of FFS.

Measures
In-group social capital scale
To assess the social capital in the group of trainees we first developed 20 7-point items, pertaining to different dimensions of social capital. Items were selected from a wide range of fields (sociology, social psychology and cognitive science) so as to reflect a wide spectrum of
concepts, extending from the pleasure offered by the involvement and participation in a group of people to the identification with the group and the development of a sense of common purpose. Next, items were rated for content relevance and face validity by four researchers on a 3-point scale (from ‘poor’ to ‘fair’ to ‘good’). Items with less than 75% ‘good’ ratings were discarded. After this phase, the final list included 14 items (Table 1).

This final list was administered in the last meeting of FFS. An exploratory factor analysis using alpha factoring and varimax rotation was performed to explore the factorial structure of the scale. The analysis revealed four factors with eigenvalues greater than 1.00, which cumulatively explain 89.28% of the total variance (Table 2). Cronbach’s alpha values exceed 0.8 for all factors. The first factor was labeled “Social bonding” (Mean 4.32, S.D. 0.96) and includes four items that refer to the development of bonding social capital between the participants in the FFS project. The second factor “Social cohesion” (Mean 3.82, S.D. 0.97) reflects the degree to which farmers have social ties with their group mates and feel satisfied with the group membership. The third factor was named “Social identification” (Mean 3.26, S.D. 1.13) because it comprises three items that concern the degree to which farmers identified with the group of trainees. The fourth factor “Social connection” (Mean 4.04, S.D. 1.01) consists of three items that refer to the sense of connectedness with the other group members.

Knowledge gained over the course of FFS
A self-assessment measure was used to assess participants’ levels of knowledge prior and after their participation in the project. The instrument comprises 20 items, measured on a five-point scale (ranging from 1: “very low level” to 5: “very high level”). Items were divided into three a priori specified categories which referred to the three main educational objectives of the programme, namely: integrated crop management (11 items): occupational safety (4 items) and farm management (5 items). Farmers were asked to assess their level of knowledge about these 20 topics pre- and post-participation in the FFS. In this way we calculated a baseline knowledge score (before FFS) and a final score (after participation in FFS). After deducting baseline from final scores we calculated the knowledge gained in each one of the three categories.

Table 1. Items included in the final “in-group social capital scale” and sources from which they were derived

<table>
<thead>
<tr>
<th>Item</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I feel connected with the other members of the group, even those who I don’t know well</td>
<td>Putnam (1995)</td>
</tr>
<tr>
<td>2. I feel that I belong to a group that shares a common aim</td>
<td>Forrest &amp; Kearns (2001)</td>
</tr>
<tr>
<td>3. I feel that with these people we are a homogeneous group</td>
<td>Putnam (1995)</td>
</tr>
<tr>
<td>4. I feel that with my co-learners we face the same problems</td>
<td>Jansen et al. (2006)</td>
</tr>
<tr>
<td>5. To participate in this group of people is really important for me</td>
<td>Luhtanen &amp; Crocker (1992)</td>
</tr>
<tr>
<td>6. I don’t feel that I have any special commitment to this group*</td>
<td>Ellemers et al. (1997)</td>
</tr>
<tr>
<td>7. It is really important for me to know that I belong to this group of people</td>
<td>Baumeister &amp; Leary (1995)</td>
</tr>
<tr>
<td>8. Sometimes I feel isolated within the group*</td>
<td>Epley et al. (2008)</td>
</tr>
</tbody>
</table>
9. With the other farmers we can understand each other  Kearns & Forrest (2000)
10. I like to offer support to the other participants  Turner (1999)
11. I really feel that I can trust my co-trainees  Adler & Kwon (2002)
12. I really like the sense of being a member of that group  Friedkin (2004)
13. I take part in every joint action in the group  Marsh et al. (2009)
14. To be a member of that group is an integral part of my life  Leach et al. (2008)

Note: * negatively worded item

Table 2. In-group social capital scale: factors, loadings, eigenvalues and explained variance

<table>
<thead>
<tr>
<th>Subscale/item</th>
<th>Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Social bonding (Eigenvalue: 4.48; Explained variance: 32.01%)</strong></td>
<td></td>
</tr>
<tr>
<td>I really feel that I can trust my co-trainees</td>
<td>0.92</td>
</tr>
<tr>
<td>I like to offer support to the other participants</td>
<td>0.91</td>
</tr>
<tr>
<td>I feel that with these people we are a homogeneous group</td>
<td>0.91</td>
</tr>
<tr>
<td>It is really important for me to know that I belong to this group of people</td>
<td>0.86</td>
</tr>
<tr>
<td><strong>Social cohesion (Eigenvalue: 3.74; Explained variance: 26.74%)</strong></td>
<td></td>
</tr>
<tr>
<td>I feel that I belong to a group that shares a common aim</td>
<td>0.95</td>
</tr>
<tr>
<td>With the other farmers we can understand each other</td>
<td>0.88</td>
</tr>
<tr>
<td>I feel that with my co-learners we face the same problems</td>
<td>0.85</td>
</tr>
<tr>
<td>I really like the sense of being a member of that group</td>
<td>0.84</td>
</tr>
<tr>
<td><strong>Social identification (Eigenvalue: 2.48; Explained variance: 17.72%)</strong></td>
<td></td>
</tr>
<tr>
<td>To be member of that group is an integral part of my life</td>
<td>0.94</td>
</tr>
<tr>
<td>I don’t feel that I have any special commitment to this group*</td>
<td>0.92</td>
</tr>
<tr>
<td>To participate in this group of people is really important for me</td>
<td>0.87</td>
</tr>
<tr>
<td><strong>Social connection (Eigenvalue: 1.79; Explained variance: 12.81%)</strong></td>
<td></td>
</tr>
<tr>
<td>I take part in every join action in the group</td>
<td>0.95</td>
</tr>
<tr>
<td>Sometimes I feel isolated within the group*</td>
<td>0.94</td>
</tr>
<tr>
<td>I feel connected with the other members of the group, even those who I don’t know well</td>
<td>0.87</td>
</tr>
</tbody>
</table>

Note: * negatively worded item

Participatory development of innovations

To assess the degree to which trainees engaged in the process of joint development of innovations we designed and used a three item measure. Trainers/facilitators were asked to rate each farmer who attained the project on the degree to which he/she: i) involved in the joint activities designed to promote the development of innovations (he/she actively participated in the collective processes of discovering gaps and proposing new ways to overcome them); ii) shared innovative ideas with the other trainees (he/she proposed and discussed with the other members of the group innovative ways to solve problems) and iii) facilitated the integration of his/her co-trainees into the spirit of FFS (he/she helped other trainees to make sense of the experiences they have encountered during FFS and to generate ideas collaboratively).

A 5-point scale from 1 (not at all) to 5 (very much) was used. For each farmer a new variable reflecting the degree to which he/she participated in the co-development of innovations during
the FFS project was calculated as the mean of ratings across the three items (Cronbach’s \( \alpha = 0.69 \)). The mean score of the variable was 3.78 (S.D. 0.95).

**Data analysis**

To provide a brief overview of our data we used correlations (Pearson’s \( r \) for normally distributed variables and Spearman’s \( \rho \) when at least one of the variables did not have a normal distribution): independent sample t-tests, paired sample t-tests and Mann-Whitney U tests. Moreover we used regression analyses to answer the main questions of the study.

**Results**

**Preliminary analyses**

In a first step we conducted Pearson’s product-moment correlations to examine for possible associations of farmers’ age, education and income with the basic variables of the study. Age was significantly correlated with two subscales of in-group social capital – social bonding (\( r = -0.37, p = 0.027 \)) and social cohesion (\( r = -0.35, p = 0.037 \)) – while another significant correlation was observed between level of education and social bonding (\( r = 0.48, p = 0.008 \)). On the contrary, income did not show any significant correlation with the basic variables of the study (\( r < 0.31, p > 0.05 \) in all cases). Moreover, the analysis proved that the number of previous social relationships did not correlate with social bonding, cohesion, identification and connection (\( \rho < 0.11, p > 0.05 \) in all cases). Mann-Whitney U tests were used to ascertain if participants who had previous social relationships versus those who did not, differed in their scores on the four social capital subscales. In all cases, no significant differences were found (\( p > 0.05 \)).

Furthermore, no significant correlations were found between trainees’ demographics and their contribution to the development of innovations during the project or their levels of knowledge before and after the attendance at FFS. We also examined all the basic study variables for gender differences. The only gender effect observed was for social cohesion (\( t = -1.82, p = 0.000 \)): with women reporting higher levels of cohesion with co-trainees than men. Additionally paired sample t-tests were used to assess the levels of knowledge gained by farmers over the course of the FFS project. The tests revealed significant increases in all three pre-specified thematic areas (Table 3).

**Table 3. Knowledge levels of farmers before and after their participation in the FFS project**

<table>
<thead>
<tr>
<th>Category</th>
<th>Example item</th>
<th>Cronbach’s ( \alpha )</th>
<th>Score Before FFS</th>
<th>Score After FFS</th>
<th>Mean difference Mean difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrated crop management</td>
<td>Integrated disease management</td>
<td>0.73</td>
<td>2.58</td>
<td>2.77</td>
<td>0.19 (( t=5.02^* ))</td>
</tr>
<tr>
<td>Farmer’s safety</td>
<td>Use of protective equipment</td>
<td>0.71</td>
<td>2.63</td>
<td>2.99</td>
<td>0.36 (( t=5.50^* ))</td>
</tr>
<tr>
<td>Farm management</td>
<td>Cultivation practices</td>
<td>0.70</td>
<td>2.82</td>
<td>3.14</td>
<td>0.32 (( t=5.30^* ))</td>
</tr>
</tbody>
</table>

*Note: *\( p<0.01 \)
Social capital and participatory development of innovations

To examine the influence of the different forms of social capital on the degree to which farmers participate in the process of co-development of innovations within the framework of FFS, we regressed farmers' scores onto the four dimensions of in-group social capital. In a second step we also entered gender, age and level of education as control variables. In the first step (F=4.98, p=0.030) we found that social bonding (β=0.42, p=0.007) and social connectedness (β=0.42, p=0.006) were significant predictors of the level of the dependent variable. These effects remained significant after controlling for demographic variables in the second step (β=0.40, p=0.027 and β=0.46, p=0.008 respectively) as illustrated in Table 4.

Table 4. Results of hierarchical regression analysis

<table>
<thead>
<tr>
<th>Predictors</th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R²</td>
<td>β</td>
</tr>
<tr>
<td><strong>Step 1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social bonding</td>
<td>0.42</td>
<td></td>
</tr>
<tr>
<td>Social cohesion</td>
<td>-0.02</td>
<td></td>
</tr>
<tr>
<td>Social identification</td>
<td>0.06</td>
<td></td>
</tr>
<tr>
<td>Social connection</td>
<td>0.42</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>0.11</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>0.05</td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td>-0.06</td>
<td></td>
</tr>
</tbody>
</table>

Note: Significant coefficients are presented in bold (p<0.05)

Social capital and knowledge gained

We then examined the associations of the three scores that referred to the knowledge gained by farmers over the course of FFS with the four forms of in-group social capital. To this end, the four subscales of in-group social capital were entered into three regression equations, one for the level of knowledge gained on each one of the three main topics of the FFS project; i.e. integrated crop management (F=3.01, p=0.033, R²=0.19): farmer’s safety (F=3.31, p=0.023, R²=0.21): and farm management (F=4.41, p=0.006, R²=0.28). The analysis revealed that the development of social bonding significantly predicted the levels of knowledge in all three equations (β=0.42, p=0.011 for ICM; β=0.33, p=0.038 for occupational safety; β=0.38, p=0.015 for farm management). In addition, as shown in Table 5, the development of a sense of connection to the group of trainees was significantly positively associated with the levels of knowledge gained in the areas of farmer’s safety and farm management (β=0.40, p=0.013 and β=0.29, p=0.049 respectively). In-group identification also had significant positive effects upon the levels of trainees’ knowledge on issues pertaining to farm management (β=0.42, p=0.012).
Table 5. Coefficients (β) of regressions used to test the association of social capital with knowledge gained over the course of FFS

<table>
<thead>
<tr>
<th>Predictors</th>
<th>Knowledge score</th>
<th>Farmer’s safety</th>
<th>Farm management</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I.C.M.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social bonding</td>
<td>0.42</td>
<td>0.33</td>
<td>0.38</td>
</tr>
<tr>
<td>Social cohesion</td>
<td>0.24</td>
<td>-0.09</td>
<td>-0.08</td>
</tr>
<tr>
<td>Social identification</td>
<td>0.04</td>
<td>0.09</td>
<td>0.42</td>
</tr>
<tr>
<td>Social connection</td>
<td>-0.04</td>
<td>0.40</td>
<td>0.29</td>
</tr>
</tbody>
</table>

*Note: Significant coefficients are presented in bold (p<0.05)*

Discussion and conclusions

In this study we attempted to establish preliminary evidence that the cultivation of social capital among FFS participants on the one hand promotes the participatory development of innovations within the FFS framework and, on the other, fosters the construction of knowledge by farmers. In doing so the present research goes beyond the existing literature on the association between FFS attendance and social capital in a number of ways. First, despite the value of past research on the relation between FFS participation and social capital, most of the work published on this issue examines the social capital as the output of participation in FFS. In our study we investigated whether social capital among FFS participants triggers knowledge creation and acquisition and facilitates farmers’ involvement in the process of innovation development. Second, most past research relies on qualitative methods or on unidimensional assessments of social capital. In the current work, by developing a multidimensional instrument, we tried to capture – and examine – different forms of social capital. Hence, despite the limitations associated with the small sample size, this work offers some new insights and plots a course for future research.

Our results indicate that social capital and in particular its most ‘soft aspects’ (social bonding and social connection) positively affect farmers’ engagement in the process of innovation development, while the dimension of social identification also predicts the levels of knowledge gained by FFS participants. These findings imply that the creation of social capital – and especially bonding social capital – should be a top priority for facilitators. In addition, when considered in conjunction with previous work which concludes that farmers participate in FFS not only to gain knowledge but also to cover their basic psychological need to belong to a group of people (Charatsari et al., 2015): our results suggest that social benefits from participation in FFS deserve more attention by both researchers and FFS designers.

This leads to the question ‘what strategies can facilitators use to nurture social capital within the group of participants?’ To address this question FFS planners should put more emphasis on social activities targeted at promoting bonding among farmers as well as to integrate concepts and findings from different domains in the FFS blueprint. For example, research on organisational culture argues that the encouragement of cooperation among the members of a group positively influences the in-group social capital (Carmeli et al., 2009): while work on social psychology (Ryan & Deci, 2000) postulates that – in educational settings – the development of a sense of relatedness, not only among learners but also between teachers and students, facilitates students’ integration into the educational climate and fosters their motivation to learn. A challenging priority for future research and practice is to identify and compare factors that enhance and maintain FFS participants’ (both farmers and facilitators)
motivation to engage in and adhere to social capital generating behaviours. When viewed in a more general context the conclusions from this study suggest that, to enlarge spaces for innovation, policy planners and intermediaries must focus not only on the structural conditions that support innovation processes but also on the factors which create social reinforcement contingencies able to foster farmers’ capacity to innovate.

Acknowledgements
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References


Workshop 1.2: Monitoring and evaluation for learning and innovation
Convenors: Boru Douthwaite, Ann Waters-Bayer, Bernard Triomphe, Barbara van Mierlo, Cees Leeuwis and Rodrigo Paz.

Rural innovation systems are complex adaptive systems. In such systems the way that interventions, intermediate results and impact are evaluated can positively or negatively affect the capacity of that system to innovate. For example, linear and often exaggerated expectations of impact can lead to over investment in baselines that take energy and funding away from creating, supporting and scaling the innovation processes and capacities required to have impact in the first place. A key ability for researchers and development practitioners wishing to intervene effectively is to do so based on understanding how innovation and change come about in complex systems, not on the basis of linear and usually simplistic logframes and theories of changes that can come with conventional M&E. Evaluation can build this ability by focusing on understanding how project and programme interventions actually work, or not, and - by doing this “in real time” - can, at least in theory, influence on-going implementation by allowing the project or programme to ‘learn its way forward’.

The workshop collated and collectively explored a body of empirical evidence and theory as to where and how monitoring and evaluation (M&E) works to support learning, adaptive management and foster innovation. To this end, the workshop called for papers on the following:

● Cases of M&E that have attempted to support learning, adaptive management and/or foster innovation, successfully or unsuccessfully

● The conceptual and theoretical design of M&E approaches that try explicitly to foster learning and innovation

● The use of M&E methodologies to support learning about how innovation and change happens, including the use of impact, pathway, theory of change, realist evaluation, contribution analysis and developmental evaluation

● Understanding and measuring whether and how different types of interventions build capacity to innovate among innovation system actors in a given site and the subsequent manifestations of that capacity.

This workshop explored both theoretical and practical perspectives. The outputs included a set of propositions about how to build and measure system capacity to learn and innovate, and resulting impact, reflecting on experiences and lessons identified during the workshop. The main results will form the basis of a written synthesis and (hopefully) a multi-author journal article. The workshop process consisted of short presentations of selected papers submitted beforehand, followed by group work and facilitated plenary discussion. Interested paper authors were invited to meet to develop an annotated table of contents for a journal article before the end of the Conference.
Applying the Participatory Impact Pathway Analysis (PIPA) approach to enhance co-innovation for sustainability within livestock family farming in Uruguay

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National Agricultural Research Institute (INIA), Uruguay

Abstract: Participatory approaches are needed to ensure learning processes and to incorporate lessons learned during the implementation of a project. This is particularly important when the aim is to improve farm sustainability considering changes in knowledge and skills, natural resources management and networking. This paper describes the Participatory Impact Pathways Analysis (PIPA) implemented within the participatory action research project ‘Co-innovating for the sustainable development of livestock family-farming systems in Rocha, Uruguay’, which involved stakeholders for planning, monitoring and evaluating of the project’s progress. Six workshops were implemented during 2012 - 2015 to enhance the project’s actions. Participatory methods were used to adapt PIPA to the Uruguayan culture. During 2013 an interinstitutional network was established, a shared vision of expected project results was defined, as well as impact pathways, goals and activities to achieve them. During the 2014-2015 workshops, reflections and suggestions led in turn to new or modified activities. This process contributed to confidence and commitment building, improving the quality of the established relationships and strengthening networking to enhance the dissemination of the project findings. As a result of the learning process, and inspired by the project’s methodological and technological results, one stakeholder organisation established a project for another region. The last workshop focused on a participatory evaluation of the whole project, demonstrating that a successful innovation process took place. This Uruguayan case showed that within the co-innovation framework, the PIPA approach nurtured the creation of a common space for social learning and innovation, providing a useful instrument for rural development.

Keywords: Learning Process, methods, networks, planning, monitoring and evaluation

Introduction
The traditional linear transfer of technology model is a top-down process from research institutions to farmers. This model is still predominant worldwide and has often led to low use of many improved agricultural technologies (Moschitz et al., 2015; Okali et al., 1994). To overcome this, new theoretical perspectives had emerged where the development of network and system approaches and the inclusion of relevant actors to broaden agricultural innovation were incorporated (Klerkx et al., 2012). These new perspectives are most needed when dealing with natural resource management systems to improve farm sustainability (Speelman et al., 2007), where a variety of stakeholders are involved (Schut et al., 2015). However, most of the institutions in charge of fostering innovation are still locked into old approaches and methods of intervention (Moschitz et al., 2015).
Participatory collaboration in knowledge generation, technology development and innovation has proved its ability to add value to science-based technology development (IAASTD, 2009). Working with a network of researchers, extension agents, farmers and local actors, focused on bringing new products or new processes into economic use as well as sharing and exchanging knowledge among them, strengthens innovation (Klerkx et al., 2009). To promote changes in agricultural practices towards more sustainable production systems, a collective learning process among all stakeholders is needed (Dogliotti et al., 2014). Stakeholders are actors interested in addressing a problem and their participation is seen as a critical success factor to solve complex agricultural problems (Schut et al., 2015). Social learning projects should include a reflexive design to encourage and facilitate the learning processes, particularly when outcomes are expected to contribute to sustainable development (Loeber et al., 2007).

Project monitoring and evaluation (M&E) can be used to enhance learning during its implementation and not only for accountability issues (Douthwaite et al., 2003; Rossing et al., 2010). M&E is increasingly seen as crucial to the success of rural research and development projects because it supports a real-time feedback (Douthwaite et al., 2007a). Furthermore, stakeholders should periodically reflect on the validity of the impact hypotheses and the entire process should be facilitated (Moschitz et al., 2015) and documented so as to better understand the mechanisms through which socio-technical changes are fostered.

Participatory Impact Pathway Analysis (PIPA) draws from program theory evaluation (Rockwell and Bennett, 2004), social network analysis and ongoing research for development to understand and foster innovation and is related to designing strategies, as well as a basis to set out a monitoring and evaluation framework (Alvarez et al., 2010). The PIPA method was successfully used by Douthwaite et al. (2007b) to enhance the developmental impact of projects through better impact assessment, to provide a M&E framework, to allow stakeholders to learn for future initiatives and to provide information that can be used for public policies.

Between 2000 and 2011 in Uruguay a 21% reduction occurred in the number of farms (most of which were family farms). At the livestock farming level, there are more than 26,000 farms in 11.7 million hectares, 60% of which are family farms (Tommasino et al., 2014). There are opportunities for improving family farms sustainability by re-designing those systems through an adequate selection and orientation of production activities and the use of appropriate technologies and farming management skills, through a participatory intervention to promote learning and innovation (Albicette et al., 2016).

Between 2012 and 2015 a group of researchers at INIA (Spanish acronym for National Agricultural Research Institute) implemented the project ‘Co-Innovating for the sustainable development of family-farming systems in Rocha-Uruguay’. The project presupposed an innovation paradigm shift through participatory research, aiming to contribute to the improvement of livestock family farms’ (LFF) sustainability and rural development. Three interconnected and simultaneous participatory processes took place: at farm level; at research team level and at Rocha regional level, with specific methods for each one (Albicette et al.,...
2016). In this article we focus on the regional level where the PIPA method was adapted to plan, monitor and evaluate the co-innovation process throughout the three years of the project, engaging regional stakeholders in a participatory learning process. We describe the method used, the M&E activities, the results obtained and the lessons learned.

Methodology
The co-innovation approach is considered as a participative and interactive approach to foster effective innovation across stakeholders (Coutts et al., 2014), combining farming systems theory, social learning and dynamic project monitoring and evaluation (Dogliotti et al., 2012; 2014; Rossing et al., 2010). In this project the approach was implemented between 2012-2015, considering three interconnected simultaneous processes: (i) at farm level, seven representative LFF based on native grasslands (project farms) (Albicette et al., 2016) were selected as case studies to assess sustainability using the MESMIS framework (Spanish acronym for Evaluation of Natural Resource Management Systems Incorporating Sustainability Indicators (Masera et al., 2000)); (ii) at research team level, a participatory action research (PAR) methodology was used to implement the project; and (iii) at regional level, the PIPA method (Alvarez et al., 2010) was adapted to involve local actors to monitor and evaluate the project.

PIPA participatory methods, techniques and tools
Specifically at regional level, the PIPA method was adapted and implemented to plan activities, to M&E the project, and to include the lessons learned during the process in real time. The PIPA method was implemented through workshops held at the local offices of farmers’ organisations. Thus, six half-day PIPA workshops (PW1 to PW6) took place between July 2012 and August 2015 with two major objectives: (i) to share and discuss results at the farm level as a monitoring and evaluation process, promoting a learning process among participants; and (ii) to jointly develop activities to share the results.

In order to promote a constructive atmosphere to monitoring and evaluating the project advances and generate a learning process during the six project workshops (PW), six key points were considered: (i) each PW was carefully planned using a script with roles and responsibilities, specifying timetable and methodological tools, and the expected outputs were written down and distributed among the research team (Schut et al., 2015); (ii) the agenda for each PW was written on a flip chart to share it with the participants; (iii) the date for each PW was coordinated among project farmers, research team and other stakeholders, who were invited by e-mail (with the agenda and the minutes of the previous workshop attached) to be used as a kick-off point for the PW; (iv) moderation cards and visualisation charts (Schut et al., 2015) using different participatory techniques selected from a toolkit (Knowledge Sharing Toolkit, 2009) were applied during the PW, leading to a collaborative knowledge and reflection process; (v) a facilitator (member of the research team) oriented each PW introducing the methodology, guiding plenary sessions, monitoring group sessions and facilitating workshop sessions (Home and Rump, 2015); (vi) all materials and results were photographed and presentations were recorded in order to document the information (Akpo et al., 2015).
**PIPA steps**

Originally the PIPA process starts with the definition of a problem tree to understand the problems that the project addresses and what needs to change (Alvarez et al., 2010). In our case, a Rapid Rural Appraisal of the region (Capra et al., 2009) was used, with which the main constraints of LFF systems were identified. We therefore started the process by inviting farmers, researchers and local actors to build a regional interinstitutional network (IN) (Table 1) to plan and M&E the project ‘Co-Innovating for the sustainable development of family-farming systems in Rocha-Uruguay’.

**Table 1. Stakeholders of the Interinstitutional Network (IN)**

<table>
<thead>
<tr>
<th>Stakeholder groups[^1]</th>
<th>IN Stakeholder</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Research and Training</strong></td>
<td>INIA - Research Team (Research Institute)</td>
</tr>
<tr>
<td></td>
<td>Facultad de Agronomía – FAGRO (University - Research and Education)</td>
</tr>
<tr>
<td></td>
<td>Centro Universitario Regional Este - CURE ((University - Research and Education)</td>
</tr>
<tr>
<td></td>
<td>Instituto Plan Agropecuario -IPA (Extension and Training Institute)</td>
</tr>
<tr>
<td><strong>Government</strong></td>
<td>Intendencia Municipal de Rocha - IMR (Local Government)</td>
</tr>
<tr>
<td></td>
<td>Sistema Nacional de Áreas Protegidas - SNAP (Environmental Ministry)</td>
</tr>
<tr>
<td></td>
<td>Ministerio de Ganadería Agricultura y Pesca - MGAP (Livestock Ministry)</td>
</tr>
<tr>
<td><strong>Non-governmental organisations (NGO) and civil society organisations</strong></td>
<td>Comisión Nacional de Fomento Rural - CNFR (National Farmers’ Union)</td>
</tr>
<tr>
<td></td>
<td>Delegates from SFR 109 and SFR-C (Local Farmers’ Organisation)</td>
</tr>
<tr>
<td><strong>Farmers</strong></td>
<td>Project farmers</td>
</tr>
<tr>
<td></td>
<td>Farmers of the region</td>
</tr>
</tbody>
</table>

[^1]: Based on Schut et al. (2015)

Based on the project objectives, in PW1 the participants expressed what their goals concerning the project were and what they expected at the end of it (the shared vision). The starting question to elaborate that vision was: “What will be happening in 2015 with farmers, professionals, organisations and their relationships after the successful ending of the project?”. Based on the vision, the IN generated the outcome model considering the following questions: “What changes do we intend to undergo?”, “Which are the actors expected to change?”, “What is needed to achieve the expected changes?”, “Through which activities?” and “Who will do/implement them?” (Table 2).
As a way to implement the activities on the outcome model, the IN suggested the development of a Communication Plan (CP). For this, a committee of 4 IN stakeholders designed a strategy which was presented as a draft at the PW2, in order to discuss and formalise a CP. Finally the CP was defined and the activities were planned annually at PW3 and PW5, considering three target groups: farmers, professionals and organisations related to rural development.

During PW2 to PW6, M&E was done by IN stakeholders through the discussion of partial results presented by the research team and the analysis and reflexion of the outcome model and CP. These cycles of M&E led to a continuous process of knowledge acquisition, where strengths and weaknesses, suggestions to improve the project implementation to achieve its goals and IN vision were identified. Thus, several learning cycles occurred.

A final participatory evaluation of the project methodology and results was carried out with a survey of 17 questions and an open space for comments, answered by 18 IN stakeholders (INIA researchers were not included). The survey (see Appendix) was designed following Bennett’s hierarchy criteria (Bennett, 1975; Rockwell & Bennett, 2004). The evaluation was processed (i) during the PW6 where participants copied the answers onto a pin board where the questions were written, and the results were discussed and analysed in a plenary session (Figure 1) and (ii) after PW6 where it was processed in order to collect and make sense of quantitative and qualitative results. Quantitative results were determined calculating the average score for each response, which had been previously scored on a 5 points scale (++ = 5, + =4, 0 =3, - =2, -- =1).

**Figure 1. Plenary discussion during final evaluation**

**Results and Discussion**
Significant changes were obtained at the three levels where the project was implemented to enhance co-innovation in order to improve LFF sustainability. At farm level, the farming systems were re-designed by adjusting the stocking rate and sheep:cattle ratio, allocating
pasture according to biomass height and using low cost breeding practices. These changes in turn resulted in a 23% meat production increase and a 56% increase in net income, while maintaining natural resources untouched. Furthermore a 25% reduction was observed in the estimated workload on animals and pasture management, a 97% implementation of 11 of the proposed technologies and the incorporation of mid-term planning. The mentioned changes revealed changes in farmers’ knowledge and skills related to their LFF system (Albicette et al., 2016).

At the research level, by applying PAR methodology it was possible to consolidate a ‘research team’, with a mutual understanding of how to address the problem and the methodological approach to adopt to face it. From a group of researchers with a varied range of backgrounds and expertise - agronomy, environmental and social sciences - (Albicette et al., 2016), transdisciplinarity emerged as a new property where disciplinary scientific knowledge (scientific evidence) and knowledge from other sources (field experiences) were combined (Moschitz et al., 2015; Wiesmann et al., 2008).

At regional level PIPA method was adapted for planning and reviewing the project’s progress towards its objectives, becoming more impact oriented (Alvarez et al., 2010). The key results of this level are described below.

*A network perspective*
Six PWs (PW1 - PW6) were organised during the project’s implementation with an average number of 32 participants (from 29 to 39). All IN stakeholders that were invited to PW1 in 2012 participated throughout the six PWs. This outstanding level of participation demonstrated that stakeholders were supporting what was taking place during the PWs and were highly involved in the process (Home & Rump, 2015).

During the PW1 IN stakeholders developed a shared vision of the project. In their own words: (i) “There is a considerable improvement of farms sustainability, using suitable technologies that resulted in higher income, preservation of natural resources and life quality improvement”; (ii) “farmers adopt an interactive working style”; (iii) “farmers and professionals acquire knowledge and develop skills for specific techniques and resource management”; (iv) “regional organisations are involved in the improvement of LFF, working as a network” and (v) “appropriate knowledge is being shared through presentations and field days and through mass media, making an efficient use of communication tools”. This vision was a clear expression of the stakeholders’ dreams about the project’s impact and became a strong motivating force for them to design a clear strategy and activities to be implemented (Douthwaite et al. 2007b).

Based on the IN vision, stakeholders defined impact pathways using an outcome model (Alvarez et al., 2010), describing what is expected from the project, the ways in which stakeholders can adjust their behaviours and the interactions needed to achieve their project vision (Table 2). The outcome model was agreed during the PW2 and was used as a basis for the project M&E (Alvarez et al., 2010). This strategy presupposes a paradigm shift during the
research process (design and methodologies) in order to achieve development impacts, where end-users are proactive actors in socio-technical changes (Akpo et al. 2015).

Table 2. Outcome Model elaborated by the Interinstitutional Network

<table>
<thead>
<tr>
<th>What changes do we intend to undergo?</th>
<th>Which are the actors expected to change?</th>
<th>What is needed to achieve the expected changes?</th>
<th>Through which activities?</th>
<th>Who will do/implement them?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sustainability of the PF(^1) enhanced</td>
<td>PF and RT(^2)</td>
<td>Interaction between field agronomist, RT and PF. Discussions and agreements to generate learning and change. Commitment of RT and PF</td>
<td>On farm Work</td>
<td>Mainly PF and RT. Strategically, IN(^4) professional</td>
</tr>
<tr>
<td>Farmers in the region are aware of technologies promoted in the project</td>
<td>PF</td>
<td>PF interacting with their groups</td>
<td>Strategic group meetings</td>
<td>PF, professionals and IN organisations</td>
</tr>
<tr>
<td></td>
<td>Organisations' farm members</td>
<td>Members of the organisations interacting with PF</td>
<td>Yearly meetings for presentation and exchange of ideas</td>
<td>PT (^3)</td>
</tr>
<tr>
<td></td>
<td>Farmers in the region</td>
<td>Farmers interacting with PF</td>
<td>Various activities: face to face, mass media, web.</td>
<td>PT</td>
</tr>
<tr>
<td></td>
<td>Professionals working in organisations linked to the project</td>
<td>Professionals interacting with PF</td>
<td>Strategic visits to PF</td>
<td>PT</td>
</tr>
<tr>
<td></td>
<td>Professionals working on other organisations</td>
<td>Inform and raise awareness about the results and ways of working in the region</td>
<td>Various activities</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IN representatives</td>
<td>Encourage networking</td>
<td>Lead by example</td>
<td>PT</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Channelling issues to corresponding organisations</td>
<td>Acts as an emissary of the new ideas</td>
<td>Delegate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Encourage organisations to adequate approach for working with LFF</td>
<td>Workshops with organisations/policy makers for awareness</td>
<td>PT</td>
</tr>
</tbody>
</table>

\(^1\)PF: Project Farmers, \(^2\)RT: Research Team, \(^3\)PT: Project Team = project farmers, research team and professionals of the IN, \(^4\)IN: Interinstitutional Network

High stakeholder involvement was achieved as they were asked to monitor the process. Constraints and interests of different stakeholder groups were considered, allowing the triangulation and validation of the products generated by the IN (Schut et al., 2015). Some
conflicts emerged in relation to high stakeholder expectations of the project considering the resources available to implement it. Negotiating was therefore necessary to balance the demands into a mutually acceptable solution (Leeuwis, 2000). As stakeholders’ suggestions were incorporated, the original high motivation level remained. Farmers and other stakeholders were seen as relevant actors in the process (Leeuwis & Van der Ban, 2004), rather than perceived as technology consumers (Moschitz et al., 2015).

Two annual communication plans (CP) (2013 and 2014-2015) were elaborated by the IN stakeholders focused on activities to share project methodologies and results related to the LFF. These aimed to promote learning among different target groups i.e. farmers, professionals and organisations. On-farm meetings and local activities were included to enhance the interactive learning process among farmers and professionals in the region. Dissemination activities were important to respond to local farmers’ demands. Field days were key activities for sharing results and interacting with a broader audience. Promotion of the projects progress using mass media was important to reach politicians and people from outside the region. Project strategy and results were also presented at national and international academic events and at activities related to LFF policy makers (Table 3).

Table 3. Summary of the communication plans elaborated by the Interinstitutional Network (IN)

<table>
<thead>
<tr>
<th>Activities</th>
<th>Objective</th>
<th>Who were invited</th>
<th>Channels used for invitation</th>
<th>N° of Activities and Total Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-farm meetings</td>
<td>Share and discuss implementation and results of the project at farm level</td>
<td>PF¹ groups, their agronomist and neighbours</td>
<td>Personal invitation SMS²</td>
<td>9 meetings 100 participants</td>
</tr>
<tr>
<td>Local activities</td>
<td>Exchange information on specific technological topics (e.g. cattle body condition scoring, pastures management, ovarian diagnosis activity)</td>
<td>IN² stakeholders</td>
<td>SMS</td>
<td>3 on-farm activities 90 participants</td>
</tr>
<tr>
<td>Dissemination activities demanded by local farmers organisations</td>
<td>Exchange information on technological topics (bull and cow management for mating, heard management under drought conditions)</td>
<td>Farmers in the region</td>
<td>SMS</td>
<td>2 meetings 70 participants</td>
</tr>
</tbody>
</table>
PW1 to PW6 Planning, M&E IN stakeholders Personal e-mails and SMS 6 PW 180 participants

Seminars for professionals related to rural development Technical discussion (Social and Environmental issues) Professionals E-mail 2 Seminars 90 participants

Field days at PFs Share project results and processes Open invitation Personal Invitations, Newsletter INIA, Twitter, SMS, advertising in mass media, Web, flyers 5 Field days 600 participants

Participation in mass media Disseminate of project activities and results PT5 9 articles in rural magazines, Radio and TV interviews.

Participation in national and international academic events Disseminate of project methodologies and results RT6 20 activities with 1900 participants, 13 conference papers

Participation in interinstitutional meetings Discuss co-innovation related to LFF policy makers PT 5 activities 110 participants

1PF: Project Farmers, 2 SMS: Short Message Service, 3 IN: Interinstitutional Network, 4 PW1: Workshop 1 to PW6: Workshop 6, 5 PT: Project Team = project farmers, research team and professionals of the IN, 6RT: Research Team

On December 8th 2015, 200 people attended a field day where project final results were presented. The evaluation sheet for the activity was responded to by 98 participants: 93% considered the activity excellent or very good; 83% indicated that the proposed technologies presented during the field day were feasible to implement in their own farms. Furthermore, at the end of that day, seven national authorities stressed the importance of the project approach and results in relation to: (i) fostering farm sustainability through an intensification process and adaptation to climate change, while maintaining farming families on their land; (ii) enhancing farmers’ knowledge and skills; (iii) promoting regional networking; (iv) generating scientific data to support family farm policies. Finally, the process was highlighted as a methodological innovation for INIA, as “a way of working which thinks on what (...) and how things are done”.

A summary (in Spanish) of the field days of 20141 and 20152 is available at INIA’s website.

1 2014 Field day: http://www.inia.uy/estaciones-experimentales/direcciones-regionales/inia-treinta-y-tres/jornada-de-producc%C3%B3n-familiar
**Monitoring and evaluating the project’s progress as a learning process**

Throughout PW2 to PW6 research team members and farmers presented and shared the project activities and farm results, so that anyone could follow and monitor the project advances. Special attention was paid to reporting all activities; a key factor in the co-production of knowledge in a multi-stakeholder processes (Akpo et al. 2015). The participatory M&E process enhanced stakeholders’ learning through a regular reflection on the project progress and results, using a different perspective of impact assessment (Douthwaite et al., 2003; Rossing et al., 2010). M&E is traditionally used for accounting project achievements whereas we used it for analysing the process and emphasising the importance of real-time feedback, thus promoting learning (Douthwaite et al., 2003; 2007a).

Due to active M&E stakeholders suggested improvements to the outcome model (Table 2) and to the CP (Table 3). This process contributed to confidence and commitment building, improving the quality of the relationships and strengthening networking. As posited by Schut et al. (2015) different stakeholders enhanced insights into the different dimensions of a problem and could look for different types of solutions. As an example of the depth of the M&E process, some reflections of the 30 participants during the mid-term workshop (PW3, September 2013) are presented in Table 4. Participants analysed project achievements and difficulties as well as elaborated suggestions for enhanced project implementation. Most project achievements were related to the co-innovation approach used. At farm level this was reflected by the ‘good farm results’, at the research team level by an ‘efficient methodology to work with at farm level’ and at the regional level by the consolidation of an Interinstitutional Network (Table 4). Difficulties at the farm level were associated with the decision-making process and animal health management, whereas at the region level difficulties were due to interinstitutional coordination and the scope of the process. Suggestions for improvement were considered and most of them included in the CP (Table 3). Incorporating a specialist in the area of animal health was not possible.

**Table 4. Stakeholder’s perception of project achievements, difficulties and suggestions for improvement analysed during mid-term PIPA workshop (PW3, September 2013)**

<table>
<thead>
<tr>
<th>Stakeholders’ reflections</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project achievements</strong></td>
</tr>
<tr>
<td>“There are already good farm results”.*</td>
</tr>
<tr>
<td>• Unexpected productive performance (positive results)</td>
</tr>
<tr>
<td>• High increase in meat production</td>
</tr>
<tr>
<td>• Farm planning</td>
</tr>
<tr>
<td>• Learning about production technologies</td>
</tr>
<tr>
<td>• Continuous technical support</td>
</tr>
<tr>
<td>• Be aware of a different way of working (“we have changed our minds”)</td>
</tr>
<tr>
<td>“There is an efficient methodology to work with at farm level”.</td>
</tr>
<tr>
<td>• Interaction farmers – research team</td>
</tr>
<tr>
<td>• Assess natural resources management in relation to production activities</td>
</tr>
<tr>
<td><strong>Consolidation of Interinstitutional Network (IN)</strong></td>
</tr>
</tbody>
</table>

---

*Note: The asterisk (*) indicates a special note or condition related to the achievement.*
<table>
<thead>
<tr>
<th>Knowledge acquisition by IN stakeholders</th>
<th>More linkage between regional organisations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project difficulties</strong></td>
<td></td>
</tr>
<tr>
<td>At the project farms</td>
<td></td>
</tr>
<tr>
<td>• Difficulties with implementing changes on the farm.</td>
<td></td>
</tr>
<tr>
<td>• Some technical issues uncovered (“we need animal health assistance”).</td>
<td></td>
</tr>
<tr>
<td>At IN</td>
<td></td>
</tr>
<tr>
<td>• “Project coordination with other regional organisations was difficult at the beginning”</td>
<td></td>
</tr>
<tr>
<td>• “We have difficulties following the process”</td>
<td></td>
</tr>
<tr>
<td>• “How project results could reach other actors is not clear”</td>
<td></td>
</tr>
<tr>
<td><strong>Suggestions for project improvement</strong></td>
<td></td>
</tr>
<tr>
<td>At the project farms</td>
<td></td>
</tr>
<tr>
<td>• Include animal health plan in the re-design of the LFF</td>
<td></td>
</tr>
<tr>
<td>• Include on-farm meetings with neighbours to learn about the LFF re-design process</td>
<td></td>
</tr>
<tr>
<td>At the research team</td>
<td></td>
</tr>
<tr>
<td>• Incorporate a veterinarian</td>
<td></td>
</tr>
<tr>
<td>At IN</td>
<td></td>
</tr>
<tr>
<td>• Exchange information among IN stakeholders on specific technologies being used at the farms</td>
<td></td>
</tr>
<tr>
<td>• Efforts to reach more farmers: use mass media to enhance dissemination of project results</td>
<td></td>
</tr>
<tr>
<td>• More coordination with other organisations, especially with MGAP to disseminate on-farm approach.</td>
<td></td>
</tr>
</tbody>
</table>

*Statements in italics are stakeholders statements recorded during PW3*

The last workshop (PW6) focused on a participatory evaluation of the whole project and tackled different topics: global project assessment, goal achievement, project performance and personal changes in knowledge and practices. The methodology used allowed the participants to immediately visualise the results of the survey and reflect on the process (Knowledge Sharing Toolkit, 2009), and was aligned with the whole participatory process (Home & Rump, 2015). The collective reflection on the individual responses constituted the global perception of project results and was later reinforced by the quantitative analysis of the survey.

The quantitative analysis of the survey valued the overall project performance positively: all topics were rated above 3 in a 5 point scale (Table 5). Global project assessment in particular was rated highly with a mean value of 4.22 out of 5, whereas the achievements reached at the farm level (questions 2a, 2b, 3 and 8) were among the highest values. The weakest points were related to knowledge of project results (question 5) and future impact of project results in the region (question 16), with mean values of 3.61 and 3.44 respectively. Several open
questions allowed participants to express their own ideas and perceptions of the process. Some comments of the participants were: “The project improved over time”; “It is a very valuable experience”; “The methodology of co-innovation stands out”.

Table 5. Final Project Evaluation results

<table>
<thead>
<tr>
<th>Question N°</th>
<th>Question topic</th>
<th>Mean Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Global project´s assessment</td>
<td>4.22</td>
</tr>
<tr>
<td>2a</td>
<td>Changes in the farms</td>
<td>4.17</td>
</tr>
<tr>
<td>2b</td>
<td>Relevance of the farm changes</td>
<td>4.28</td>
</tr>
<tr>
<td>3</td>
<td>Methodology used to work with project farmers</td>
<td>4.44</td>
</tr>
<tr>
<td>4</td>
<td>Methodology used to work with local actors</td>
<td>3.67</td>
</tr>
<tr>
<td>5</td>
<td>Knowledge of project´s results</td>
<td>3.61</td>
</tr>
<tr>
<td>6</td>
<td>Knowledge of technological information to be promoted by public policies</td>
<td>4.06</td>
</tr>
<tr>
<td>7</td>
<td>General project´s implementation performance</td>
<td>4.44</td>
</tr>
<tr>
<td>8</td>
<td>Work at farm level</td>
<td>4.44</td>
</tr>
<tr>
<td>9</td>
<td>Communication plan</td>
<td>3.94</td>
</tr>
<tr>
<td>10</td>
<td>Interinstitutional coordination</td>
<td>4.17</td>
</tr>
<tr>
<td>11</td>
<td>Incorporation of suggestions during the project</td>
<td>4.17</td>
</tr>
<tr>
<td>12</td>
<td>Fulfilling of personal expectations</td>
<td>4.06</td>
</tr>
<tr>
<td>13</td>
<td>Knowledge related to LFF</td>
<td>3.94</td>
</tr>
<tr>
<td>14</td>
<td>“New ways to do things”</td>
<td>3.72</td>
</tr>
<tr>
<td>15</td>
<td>Personal feeling related to participation</td>
<td>4.39</td>
</tr>
<tr>
<td>16</td>
<td>Impact of project´s results in the region</td>
<td>3.44</td>
</tr>
</tbody>
</table>

1 See Appendix for detailed questions. 2 Mean values were calculated as the average of the responses. Each response was rated on a 5 point scale: ++ = 5, + =4, 0 = 3, - = 2, -- =1

PWs were the key-elements for interaction among stakeholders (Home & Rump, 2015). All project outcomes were possible because participation of IN stakeholders during PWs was adequately organised and facilitated. Considerable time and resources were allocated to this process (Klerkx & Leeuwis, 2009; Home & Rump, 2015). The social learning process could be seen as different stakeholders interacting to solve a problem, while simultaneously acquiring new skills (both technical and social), producing knowledge, as well as developing relationships (Schut et al., 2015). This participatory process continued as an interactive experimental learning cycle (Douthwaite et al., 2002).

As a result of the learning process, and inspired by the project’s methodological and technological results, one stakeholder organisation established a project for another region. The CNFR Farmer Union had highly valued this way of working and presented a project to a competitive fund which, if approved, will allow them to obtain funds to work with other farmers using the co-innovation approach.

Lessons learned
Stakeholders successfully worked together in the IN over a three year period to support a participatory and collaborative process to generate innovation in the seven LFF, which
contributed to the success of the whole project and to the dissemination of its results. The stakeholders involved in the IN were strongly committed from the beginning of the project, their continuous engagement was essential in the building of network reliability (Akpo et al., 2015). Furthermore, some process characteristics were particularly relevant: (i) clear objectives; (ii) negotiation and facilitation; (iii) systematisation and keeping up with a certain continuity and coherence between PW; (iv) consideration of local culture to define when and where to set the PW and (v) a clear agenda for PW.

The shared vision of the project’s expected results along with the required activities to achieve them contributed to a clear and common understanding of the desired project outcomes and was also a source of motivation. As the impact pathways to achieve the project vision were validated and made explicit throughout activities, it was easier to M&E the advances and final results. However, specific indicators would be needed in the future for M&E. In our case, during PWs stakeholders reflected on the obtained results and shared ideas for project improvement in real time, identifying whether or not interventions successfully contributed to achieving the vision.

The co-elaboration of CPs by the IN with specific activities was a strong tool that generated interaction and promoted coordination among local organisations. From the activities organised for farmers and technicians to share results and to exchange ideas on new technologies, we would highlight on-farm field days. An evolution of project farmers’ role was noticeable: after three years they directly explained to others the changes and associated results introduced in their LFF, reflecting the undergoing learning process.

The spaces generated with the PWs and the implementation of the CPs could be seen as platforms for social learning and innovation for farmers, researchers and local actors where the ‘real world’ actors are involved in the process. These spaces demanded time and resources to reach a common understanding of how the project would achieve the desired impact. Within this platform, the M&E allowed visualising of the changes and their relevance at farm level in a particular context, while making learning cycles explicit throughout the process.

Final reflections
This Uruguayan case demonstrated that applying the PIPA method enhances co-innovation at regional level and nurtures the creation of a common space for networking, participatory planning, M&E and social learning. Researchers, farmers and organisations were capable to plan, monitor and evaluate the project focusing on sustainable LFF production systems. Several learning cycles took place to adapt and adjust the project in real time, while strengthening the impact-oriented vision of the project. The PIPA method provided a good framework for innovation towards sustainable LFF providing a useful instrument to contribute to rural development. As stakeholders understood the benefits of the approach, they effectively used the new knowledge for their own organisations to identify key issues for future initiatives and to provide information for agricultural family farming policy makers.
Acknowledgements
The authors are grateful to the families who shared their experiences with us and to the local actors who participated in the PWs and in the elaboration and implementation of the CP. The authors also thank the whole project research team and Sophie Alvarez for their suggestions during the writing process, Fiorella Cazzuli for her support on language editing and INIA for its financial support.
References


Appendix

FINAL PROJECT EVALUATION

Co-innovating for sustainable development of family farm production systems in Rocha-Uruguay

To answer the following questions there are five alternatives:

(+++)  (+++)  (++)  (+)  (0)  (-)  (--)  

Please indicate with (X) which best reflects your opinion.

OVERALL

1) How do you assess the project globally?

Excellent ( )  ( )  ( )  ( )  ( ) Very bad

Comments:
_____________________________________________________________________
_____________________________________________________________________

GOAL ACHIEVEMENT:

Considering the objectives of the project and the shared vision generated by the interinstitutional network (IN), assess the following:

2) Did the project allow positive changes in the 7 farms considering their sustainability?

a) Many changes ( )  ( )  ( )  ( )  ( ) No changes

b) Very relevant ( )  ( )  ( )  ( )  ( ) No relevant

Please indicate the most significant changes for you:
_____________________________________________________________________

3) Was an appropriate methodology used in working with project farmers?

Very appropriate ( )  ( )  ( )  ( )  ( ) Inadequate

Comments:
_____________________________________________________________________

4) Was adequate methodology used to promote networking and thus contribute to regional development?

Very appropriate ( )  ( )  ( )  ( )  ( ) Inadequate

Comments:
_____________________________________________________________________

5) Do farmers, professionals and local organisations know the results of the project?

Know much ( )  ( )  ( )  ( )  ( ) Unknown

Comments:
_____________________________________________________________________

6) Do farmers, professionals and organisations know high-impact information technology to be promoted through public policies for family farming?

To a high degree ( )  ( )  ( )  ( )  ( ) to a low degree

Comments:
_____________________________________________________________________

PROJECT IMPLEMENTATION

7) Generally speaking, how do you think the project has worked during this time?

 Appropriately ( )  ( )  ( )  ( )  ( ) Unsuitably

Please indicate the most significant aspects for you:
_____________________________________________________________________

_____________________________________________________________________

206
8) To what extent was it appropriate at farm level?
To a high degree (  )   (  )    (  )   (  )         (  ) to a low degree
Comments:

9) To what extent were the activities foreseen in the communication plan drafted by the IN appropriate?
To a high degree (  )   (  )    (  )   (  )         (  ) to a low degree
Comments:

10) To what extent was the institutional coordination of the activities from the project adequate?
To a high degree (  )   (  )    (  )   (  )         (  ) to a low degree
Comments:

11) To what extent you believe the project was "permeable" to suggestions for improvement made by yourself during the process?
To a high degree (  )   (  )    (  )   (  )         (  ) to a low degree
Comments:

OTHER TOPICS
12) How far were your expectations regarding the project fulfilled?
To a high degree (  )   (  )    (  )   (  )         (  ) to a low degree
Comments:

13) To what extent have you improved your knowledge on technological strategies for family livestock?
To a high degree (  )   (  )    (  )   (  )         (  ) to a low degree
Please indicate the most significant aspects for you:

14) To what extent do you have "new ways of doing things" in relation to your work with livestock farming?
To a high degree (  )   (  )    (  )   (  )         (  ) to a low degree
Please indicate the most significant aspects for you:

15) How did you feel about your participation in this process?
Comfortable (  )   (  )    (  )   (  )         (  ) Uncomfortable
Comments:

TOWARDS THE FUTURE
16) To what extent do you believe the project results may impact in the region?
To a high degree (  )   (  )    (  )   (  )         (  ) to a low degree
Please indicate three aspects that facilitate this process:

Please indicate three aspects that limit this process:
17) Based on the experience and learning generated within the framework of this project, which suggestions would you make to policy makers when defining public policies for family farming?

Name three aspects or policies considered critical to support family farming in Uruguay:
_____________________________________________________________________
I would also like to add:
_____________________________________________________________________

INDIVIDUAL CHARACTERISTICS

Are you?

Mark with an X the option/s that correspond
(I) Project farmer? -----------------------------
(II) Farmer representative of a SFR? -------------
(III) If you represent a SFR, please give us its name ------------------------
(IV) A professional -------------------------
(V) If you are a professional, which organisation do you belong to ..............

THANK YOU
What is capacity to innovate and how can it be assessed? A review of the literature

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Abstract: ‘Capacity to innovate’ is an emerging concept, especially in agriculture and rural development. There is no universally agreed definition for this concept, but many authors agree that it refers generally to the ability of actors to continuously identify constraints and opportunities and to mobilise capabilities and resources in response – i.e. to produce and sustain innovation processes in a dynamic systems environment. Increasingly, capacity to innovate (C2I) is recognised as playing a critical role in successfully responding to a changing external environment. Facilitating and building this capacity is therefore crucial for adaptable farming systems and for improving the resilience and livelihoods of poor farmers and other rural actors. This paper summarises the findings of a targeted literature review aiming to unpack the concept of C2I, exploring its meaning across all research sectors and ways to assess it in agricultural communities. We propose that the various dimensions of C2I identified through the literature review can be a starting point for developing an assessment framework to measure changes in C2I. Specifically, we identify four core capacities that make up C2I: (1) to envision and create new ways of doing things; (2) to connect with others to access and understand new information and resources; (3) to experiment, test, assess and adapt; and (4) to work with others to achieve action and change. We review previously described indicators to measure these concepts and accordingly propose an initial set of metrics for use in agricultural communities. We conclude that the C2I concept puts a spotlight on process-driven approaches to innovation that have previously been undervalued.

Keywords: Innovation, capacity, agricultural innovation systems, capacity to innovate, metric, capabilities

Introduction
Innovation plays a fundamental role in economic development and is considered a key factor in determining the ‘success’ of societies, sectors and firms (Bell & Albu, 1999; Freeman, 1987; Mytelka, 2000). Defined as “the new use of existing or new ideas or the combination of ideas that have social or economic significance” (Mbabu & Hall, 2012), innovation is increasingly seen as critical to achieving economic, social and environmental goals in a rapidly changing world (Jones, 2004). While not a panacea nor an end in itself (sometimes resisting change may be what is needed), agricultural innovation may be particularly vital for feeding a growing global population in a sustainable manner (FAO, 2014; Jones, 2004), and is especially important in developing countries where agriculture plays a critical role in the local and national economy (Thomas & Slater, 2006; World Bank, 2008).
Conventional approaches towards agricultural innovation involve the creation of new technologies by research and development organisations, and then 'pushing' them to farmers and other end-users. This assumes that the lack of (adequate) technology is the primary obstacle to agricultural innovation and development. However, the limitations of this technology-led approach have been increasingly recognised (Clark, 2005; Hall et al., 2007; Johnson & Segura-Bonilla, 2001). Many scholars and practitioners acknowledge that the constraints to agricultural innovation and development are not only the ability to produce new knowledge or technologies, but also the ability of stakeholders to put relevant knowledge and technological inventions into use. This includes adapting inventions and practices to rapidly changing conditions and locally-specific contexts and often requires changes to social, economic, institutional and technological systems (Chataway et al., 2005; Hall et al., 2007; Schut et al., 2015).

The understanding of the importance and nature of innovation led to the development of the innovation systems concept, defined as the complex networks of interacting actors (individuals, organisations and enterprises) involved in developing and putting an innovation into use, together with the institutions and policies that support this (World Bank, 2007). Innovation systems thinking is now commonly applied to agriculture, as Agricultural Innovation Systems (AIS) (Assefa et al., 2009; Klerkx et al., 2012; Pant & Hambly Odame, 2009). Along with the emergence of innovation systems analysis, and reflecting the importance of actors’ capacities to engage in innovation processes, over the past twenty years a related concept has emerged, that of ‘capacity to innovate’ or C2I.

As a concept, C2I is significant not only in the agricultural sector (Schut et al., 2015) but also in business (Hult et al., 2004), medicine (Caccia-Bava et al., 2006), engineering (The Royal Academy of Engineering, 2012), education (Grogger & Hanson, 2011) and in relation to national innovation systems (Wonglimpiyarat, 2010). It is closely related to the concepts of adaptive capacity and capacities for social learning and has been increasingly seen as playing a key role in helping local system actors respond effectively to rapidly changing external contexts, including climate change (Berkes, 2007; Lybbert & Sumner, 2012). Despite this, the lack of a universally accepted definition for C2I reflects a certain ‘fuzziness’ about what it means (Chuluunbaatar & LeGrand, 2015; Hall, 2005; Hall et al., 2007).

With the greater focus on C2I has come an increasing concern over how to evaluate it (Furman et al., 2002; OECD, 2012). Measuring C2I is important to evaluate the efficacy of interventions and to assess C2I changes over time, and for this more robust monitoring and evaluation (M&E) tools are needed than those currently available.

This paper proposes an approach to developing metrics for assessing C2I. By taking a broad look at the growing literature on C2I and related terms, we review how this concept has been defined and identify its key conceptual components. From this, we identify the dimensions of the concept which are particularly relevant to agricultural innovation systems and propose a framework for understanding and for measuring C2I. This framework then serves as the starting point for developing a proposed set of metrics and indicators for assessing C2I within the context of rural communities.
Searching the literature: methods and bibliometric data

Bibliographic searches
We searched for references to C2I across a range of peer-reviewed and practitioner publications, including in the Scopus, Web of Science and AGRIS databases, and by searching donor, implementer and research institution websites. Our search focused on keywords used in the literature, covering all terms related to “capacity to innovate”, including “capacity for innovation”, “innovation capacity”, and “innovation capability”. The resulting documents were screened for relevance if they made reference to:

- C2I concept and/or component capacities;
- interventions aiming (explicitly or implicitly) to improve C2I; or
- indicators or methods of assessment or evaluation of capacity to innovate

While reading these papers, relevant cited references were also added to the database, as were references suggested directly by a handful of knowledgeable resource persons.

Bibliographic results
From a total 2254 documents retrieved through the above searches, 748 passed title and abstract screening and 149 passed full text screening as referring to the C2I definition, concept/component capacities, interventions or indicators. As expected for an emerging topic, the number of documents retrieved by year of publication has increased sharply since 2000 (Figure 1). Of these, more papers used “innovation capacity” than “capacity to innovate”.

More literature was published in China than any other country (Error! Reference source not found.), probably due to a strong national emphasis on it becoming an “innovation-oriented nation” by 2020 (Zhang & Wu, 2012). Other major sources of references include the USA and then Western European countries (UK, Spain, Germany, France). By subject, C2I occurs most in business and management literature (21%), followed by social science (18%) and engineering (14%). However, this varied by country, with over half of all publications from China being from business and management sectors. Agricultural and biological sciences are only 7th on the list, illustrating that the C2I concept is used in a number of contexts beyond that of agricultural innovation systems.

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1 The country/territory detailed in Scopus is determined by the location of the publisher; see Scopus coverage guide https://www.elsevier.com/__data/assets/pdf_file/0007/69451/scopus_content_coverage_guide.pdf
Capacity to innovate: definitions and component capacities from the literature

**Definitions of capacity to innovate**

Coined by Burns and Stalker (1961)\(^2\), the term *capacity to innovate* (C2I) has changed over time and across sectors of use. Early use of the term described it as the capacities “to successfully adopt and implement innovations”, seen as distinct from the capacities needed to “initiate and be receptive to innovations” which were termed *innovativeness* (Hurley & Hult, 1998; Hurley et al., 2005). Modern use of the C2I term includes these two capacities and additional sub-capacities which are seen as integral to the ability to produce and/or to use innovation (Hall et al., 2009; Leeuwis et al., 2014; Mayne & Douthwaite, 2015).

For some, C2I is defined simply (and redundantly) as the increased capacity to be able to innovate. Others have chosen not to give a one-phrase definition, going straight into detailing what component capacities are encompassed by the C2I concept. The few non-redundant, one-sentence definitions describe the capacities to access new innovations and apply them over time, e.g. “the continuing ability to combine and put into use different types of knowledge” (Chuluunbaatar & LeGrand, 2015). See Table 1 for a list of distinct, relevant definitions identified.

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\(^2\) As reported in (Hurley & Hult, 1998)
Table 1. Definitions of C2I and IC (in chronological order)

<table>
<thead>
<tr>
<th>Author</th>
<th>Definition or description of C2I or related terms</th>
<th>CI term</th>
<th>Research sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cohen &amp; Levinthal (1990)</td>
<td>&quot;the ability of a firm to recognise the value of new external information, assimilate it and apply it to commercial ends&quot;</td>
<td>Absorptive capacity; Innovative capabilities</td>
<td>Business</td>
</tr>
<tr>
<td>Hurley &amp; Hult (1998)</td>
<td>&quot;The capacity to innovate [...] is the ability of the organization to adopt or implement new ideas, processes, or products successfully&quot;</td>
<td>C2I; Innovativeness</td>
<td>Business</td>
</tr>
<tr>
<td></td>
<td>&quot;Innovativeness is the notion of openness to new ideas as an aspect of the firm’s culture [it] is a measure of the organisation’s orientation toward innovation.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&quot;Innovative capacity relates to [...] absorptive capacity&quot;.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neely &amp; Hii (2001)</td>
<td>&quot;Innovative capacity is the internal potential of a firm to generate new ideas, identify new market and technological opportunities, and implement innovations by leveraging resources and capabilities. In short, innovative capacity determines a firm’s ability to innovate.&quot;</td>
<td>Innovative capacity</td>
<td>Business &amp; management SME</td>
</tr>
<tr>
<td>Hult et al. (2004)</td>
<td>&quot;Innovativeness is defined here as the capacity to introduce some new process, product, or idea in the organisation&quot;</td>
<td>Innovativeness</td>
<td>Business</td>
</tr>
<tr>
<td>Caccia-Bava et al. (2006)</td>
<td>&quot;the organisation’s capacity to innovate (absorptive capacity), [is] the organisation’s ability to recognise the value of new information, assimilate it, and apply it to productive ends...&quot;</td>
<td>C2I Absorptive capacity</td>
<td>Health</td>
</tr>
<tr>
<td>Skilttere &amp; Jesilevska (2013)</td>
<td>&quot;the ability to generate new knowledge, new technology and new artefacts and to apply these novelties in a useful way. The concept of innovative capacity evaluates not only the current capabilities to innovate but also the innovative potentials that may affect innovativeness in the longer period of time.&quot;</td>
<td>Innovative capacity; IC; Innovative potential; Innovativeness</td>
<td>Business &amp; economics</td>
</tr>
<tr>
<td>Nair et al. (2014)</td>
<td>&quot;Innovation capacity is the collective ability of a firm to look into future through the eyes of customers and reengineer products and services accordingly'</td>
<td>IC</td>
<td>Business</td>
</tr>
<tr>
<td>Chuluunbaatar &amp; LeGrand (2015)</td>
<td>&quot;the continuing ability to combine and put into use different types of knowledge&quot;</td>
<td>C2I IC</td>
<td>Agriculture</td>
</tr>
</tbody>
</table>

3 The principal term (C2I, IC, etc) used for the definition is listed first, with other terms used interchangeably in the same text listed afterwards
AIS as C2I (TAP, 2016) or IC (Pound & Essegby, 2008).

The process by which C2I may be achieved. Some authors indeed specifically equate CD for AIS as C2I (TAP, 2016) or IC (Pound & Essegby, 2008).

**Key terms related to the concept of C2I**

As Table 1 illustrates, the terms *innovation capacity* (IC) and C2I have often been used interchangeably (e.g. Chuluunbaatar & LeGrand, 2015; Turner et al., 2015). However, particularly in business and management research, IC may be used to refer to how many innovations an organisation can produce and implement successfully, rather than the capacities needed to do so. These definitions of IC may include ‘structural properties’ of an organisation (e.g. measures of organisation size, finance and machinery) that most definitions of C2I do not include, as well as ‘human qualities’ such as communication, tolerance for risk-taking, power sharing, learning, collaboration, and participative decision-making that do align with C2I capacities (Aiken et al., 1980; Hurley & Hult, 1998). Thus, understanding of IC may vary with sector from being comparable to C2I, to being something much broader. We have not seen C2I used in this broader sense, and so consider it as the less ambiguous and therefore preferable term.

Another area where terms may be ambiguous relate to the concept of *capacity* itself. In the literature, *competence, capability, and capacity* are used in relation to innovation and yet the distinction is not always clear. Some authors use these in a nuanced way, differentiating between capacity as an overall ability of individuals, groups or systems to do something and capabilities as specific sets of skills (Mauerhofer, 2010; Pant, 2012; Sen, 1993; Skiltere & Jesilevska, 2013), while others use these interchangeably (Neely & Hii, 2001). While we appreciate the distinction, given that these related terms and concepts are not always used consistently, we have decided to pull all capacities, capabilities and competencies together in Figure 4.

<table>
<thead>
<tr>
<th>Mayne &amp; Douthwaite (2015)</th>
<th>“Capacity to innovate is then the ability to combine some or all of hardware, software and orgware to bring about innovation”</th>
<th>C2I</th>
<th>Agriculture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turner et al. (2015)</td>
<td>“Innovation capacity is the capability of actors to continuously identify and prioritise constraints, and in response mobilise new and existing capabilities and resources, i.e. adapt to realise opportunities in a dynamic systems context”. “to mobilise, combine and create resources and capabilities to successfully innovate”</td>
<td>IC C2I</td>
<td>Agriculture</td>
</tr>
</tbody>
</table>
Figure 2. Conceptual relationship between C2I (a state which changes dynamically over time) and CD (a process and set of activities which contributes to increasing C2I). The dashed line indicates that while the goal is to increase C2I, it may go up or down over time.

**What specific capacities are needed to innovate?**

The literature on C2I points to certain capacities and capabilities required by individuals, organisations and/or institutions which when combined create the capacity needed to innovate and sustain innovation processes over time. We sorted these into groups of capacities that were most alike or linked, giving four broad capacity groups each of which may occur at, or are supported by, individuals, organisations and the enabling environment, and which can be further divided into several sub-capacities (Figure 4):

1. **To envision, create and be open to new ways of doing things** - to individually and/or jointly envision something new and improved;
2. **To connect with others to access and understand new information and resources** – to form new connections and to use both new and existing relationships with diverse actors (individuals and entities) to obtain, share and understand information and resources;
3. **To iteratively experiment, test, assess and adapt** – to conduct experimentation involving iterative learning and improved processes and results over time; and
4. **To work with others to achieve action and change** - to work together formally and informally in order to take effective collaborative action and achieve common objectives.

The recognition of capacities to envision, generate and welcome new ideas (1), as separate from capacities to adapt (3) apply (4) those innovations, reflects earlier definitions of innovativeness (Hurley & Hult, 1998; Hurley et al., 2005), described as essentially a cultural trait (Woodside, 2005). Turner et al. (2015) named a similar grouping of capacities innovation capabilities, describing them as “processes for exploring and exploiting opportunities to innovate”, and encompass the capacities we describe in (1) while also overlapping with some of the capacities described under (2) and (3).
The capacities to connect with others to access and understand new information (2) are most closely aligned with definitions of potential absorptive capacity, which is the capacity to acquire and assimilate knowledge (Zahra & George, 2002). Some authors have bundled the concepts of acquiring and assimilating knowledge together with the capacities to use and apply that information. Both are reliant on networks and encompassed by definitions of absorptive capacity (Cohen & Levinthal, 1990) or absorptive capability (Turner et al., 2015). In this paper we have put the capacities to use and apply knowledge into a separate grouping - the capacity for collaborative action (4). We consider that these two sets of capacities are inherently different as ‘to understand and know’ does not automatically translate into ‘being able to do’.
Figure 3. Capacities to innovate

1. To envisage, create and be open to new ways of doing things

1.1 To generate new ideas and foster creativity: • Capacity to generate new ideas, products, processes for action1,2,3,4,5,6; • To foster creativity7,8,9,10; • Entrepreneurial spirit8

1.2 To be open to new ideas and actions (individuals, leaders and organisations)1,3,4,8

1.3 To identify and prioritise problems and opportunities and adapt/explore them accordingly6,11,12,13,14,15,16

2. To connect with others to access and understand new information & resources:

2.1 To link with others/network: • Develop, maintain and use effective networks8,9,11,12,14,17,18,19,20,21,22,23,24,25; • To intermediate/facilitate/broker for linkages, interactions and networks22,26,27,28,29,30,31,32,33,34,35,6; • Institutions support networks and collaboration, policy supports the development of networks35

2.2 To access, share and process information: • To have processes for acquiring, assimilating and transforming external knowledge12,13,36,19; • Capacity to link with others to access, share and process information37,38,39,40,41; • Institutions support knowledge sharing and interactive learning37,23,4,6

2.3 To understand and learn to process information: • Understand new knowledge (ideas, things, resources) and put to (productive) use1,17,11,39,25; • Capacity for reflection and learning8,39,12,26,22,5,20,41; • Organisations and Institutions support learning2,27,23,4,6

3. To iteratively experiment, test, take risks, analyse, assess

3.1 To test, experiment and assess • To experiment and assess arising trade-offs17,42,3,11,14; • Institutions support social and technical experimentation12,42,43,30,31,23,33; • Capacity to assess and take risks and a culture that supports that38,9,31,14,6

3.2 To adapt to change, be flexible: • Ability to change approach and partnerships/networks/interactions in response to change44,11,12,13,16,45,30,32,5,13; • Embed innovation and research activity in ongoing process of change22,14,6; • Leadership, institutions and culture support & embrace change and allow for rapid response/adaptive management44,45,42,31,23,46,14,5,6; • Flexible solutions to allow for revision12,43

4. To work with others to achieve action and change

4.1 To be motivated and to motivate others: • Individuals motivated to participate11,9,30,14,40; • Project champions37,26,30,31

4.2 To work with others effectively to achieve action: • Collaborate and work with others to achieve action38,18,32,14,25,16; • Capacity to mobilise resources and form support coalitions around promising options22,23,14; • Share risks and benefits/Diversify risks and share uncertainties38,22,3; • Institutions for sharing risks and benefits12,31,23; • Build a shared vision/goal and realise shared values5,25

4.3 To mediate and facilitate: • Actively manage interdependent and unpredictable interactions among network partners12,28,22,33; • Leaders and facilitators orchestrate and facilitate to enable action, can understand how change happens and how to intervene effectively14; • Mediate diverse groups with different skills5; • Mediate power-imbalance5; • Allow all members of the group to influence decisions1; • Leadership able to balance individual and collective interests to meet individual and collective needs12,43,34,46
**Capacities are interlinked and multi-dimensional**

The broad groups of capacities presented in the previous section and Figure 4 can be organised in a multitude of ways: the proposed grouping is not definitive and these capacities are interlinked, overlapping and exist on different dimensions. For example, while we have considered that ‘to learn and understand’ (2.3) most closely aligns with our C2I group of capacities ‘to connect with others to access and understand new information and resources’ (2), learning and understanding is also necessary for iterative experimentation.

In trying to group capacities, it is useful to think of ‘higher-level’ capacities needed to produce or sustain innovation compared to ‘building block’ capacities or sub-capacities that underpin or precede them. For example, the ‘higher-level’ capacity to envisage, generate and access new ideas assumes the presence of ‘building-block’ capacities to form and access networks (from where to find new ideas), to learn and understand those ideas, and to identify opportunities (see Figure 4 which shows some of the main links between these capacities).

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**Figure 4. Main links between 'building-block' and 'higher-level' capacities**

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**How to assess C2I**

Evaluating C2I has become a concern for those working to strengthen AIS (Furman et al., 2002), as well as within firms, and at regional and national levels (OECD, 2012). In addition to measuring the efficacy of interventions for reporting purposes, it is also important to assess C2I in order to inform organisational learning and the ability of programs and interventions to adapt (Mayne & Douthwaite, 2015). Measuring C2I is difficult as many of the desired results refer to processes and have no clear completion mark (Daane et al., 2009). In addition, it is important that measures be useful and accurate, particularly given that the way in which something is defined and assessed often affects how it is managed (Chuluunbaatar & LeGrand, 2015).
**Indicators proposed in the literature**

The literature reviewed outlines two main types of indicators for C2I. Most common are measures to assess C2I as a whole, using outcome indicators reflecting the presence or change in this overall capacity. Also proposed are measures aiming to assess the capacity directly using indicators linked to essential elements of C2I.

**Measurements linked to innovation outputs and outcomes**

Given that C2I refers to the ability to produce innovation, overall capacity can be assessed by looking at innovation outcomes. Thus, if C2I has increased over time, we should expect to see evidence of more or improved quality innovations, more effective innovation processes and/or innovation activity spread more broadly.

This is essentially what most business, national and regional measures of C2I assess. Common measures include indicators of new product output or the number of patents and patent citations (proxy measures of new product development) (Skiltere & Jesilevska, 2013; Song et al., 2014).

Outcome measures of C2I proposed in agricultural contexts include measures of up-scaling and out-scaling such as a) interlinked technical and social-institutional innovations, b) innovations being tested outside the initial intervention area, c) growing coalitions for change and d) lessons learned/principles/methods/strategies adopted elsewhere (Leeuwis et al., 2014; Mayne & Douthwaite, 2015). Others use higher-level measures of development and well-being such as job creation and income (Dalohoun, 2005).

**Measurements linked directly to C2I**

Within firms, there has been a move away from innovation output-only metrics towards the evaluation of multiple factors, including indicators of C2I itself (Boly et al., 2014). Similarly, most proposed measures of C2I within agricultural systems include indicators which seek to directly measure the component capacities of C2I. ‘Opening the black box’ allows us to see the extent to which C2I may have changed, even if innovation processes are still mid-course, which may be useful given that innovation processes typically take time, so there may be a considerable lag between the time when C2I is developed and the time when it manifests through specific measurable innovation outputs. It also facilitates understanding of which aspects of C2I have changed, which may be important for research, as well as for programs that seek to strengthen specific dimensions of C2I.

Indicators of C2I can therefore be categorised according to the type of capacities they measure, using the same general groupings proposed above. Thus indicators related to (1) **envisioning, generating or being open to new ideas** include measures of a change in mind-set, attitude, confidence or conducive modes of thinking (Leeuwis et al., 2014; Mayne & Douthwaite, 2015; Van Veldhuizen & Water-Bayer, 1997); or responsiveness of organisations to innovation opportunities (Spielman & Kelemework, 2009).

Indicators related to (2) **connecting to others to access and understand new information and resources** focus on assessing a) the scale of networks (e.g. # networks and initiatives involved in social enquiry/learning, or the diversity of those networks) (FARA, 2014; Leeuwis et al., 2014; Spielman et al., 2011; Spielman & Kelemework, 2009; Temel, 2004; Van...
Veldhuizen & Water-Bayer, 1997); b) the use of those networks to access information (Clark, 2006; Dalohoun, 2005; FARA, 2014; Jang et al., 2002; Leeuwis et al., 2014; Michailova & Husted, 2003; Van Veldhuizen & Water-Bayer, 1997); or c) learning and development or changes in learning processes (Boly et al., 2014; Dalohoun, 2005; Hurley & Hult, 1998).

Indicators of (3) testing, experimenting and analysing focus on the number of technical and social experiments done, which may include the number of novelties identified, tested, or discarded, and changes in the way that selection decisions are made (Leeuwis et al., 2014; Mayne & Douthwaite, 2015; Van Veldhuizen & Water-Bayer, 1997).

Finally, indicators to assess (4) achieving action as a group look at a) the number or scale of new ideas or practices adopted (Dalohoun, 2005; Hurley & Hult, 1998; Mayne & Douthwaite, 2015); b) organisational development (Van Veldhuizen & Water-Bayer, 1997) or coalition formation around promising initiatives (Leeuwis et al., 2014); c) measures of power-equity and participatory decision-making (Hurley & Hult, 1998); d) measures of leadership (Van Veldhuizen & Water-Bayer, 1997) and e) resource mobilisation (Van Veldhuizen & Water-Bayer, 1997).

**Proposed indicators to assess C2I**

The conceptual outline of C2I and its component capacities and indicators developed in this paper are based on the review of the literature on C2I across all sectors. In this section, we apply this to the agricultural context, proposing an exploratory framework and set of indicators for assessing C2I directly in the context of agricultural communities.

**Approaching the assessment of C2I: what makes a ‘good indicator’?**

When developing a method of assessment that can be used by researchers as well as project implementers seeking to measure C2I in a community-based setting, we propose that the following principles be applied:

1. Where possible, use validated indicators for a specific capacity before creating new ones (e.g. tested methods of assessing individual and collective efficacy already exist);
2. When choosing among indicators, prioritise those which can be readily measured;
3. To avoid wasting resources on unnecessary measurement, use as few indicators as possible – ‘bellwether indicators’ rather than complex sets of interacting factors.

Regarding the latter, to ascertain which indicators may be most suitable as ‘bellwether indicators’, it is useful to return to the idea of ‘higher-level’ and ‘building-block’ capacities described above. For example, if we find that a group of farmers has engaged in a series of experiments resulting in improved practices or prototypes over time (demonstrating iterative learning), we can assume that at least some of the precursor or underpinning sub-capacities (e.g. to identify opportunities for learning, to devise experiments and test different approaches, to analyse results of experiments and trials, and to reflect and learn from results) are present. If, however, we assess this group of farmers at the level of various sub-capacities—the capacity to devise experiments or analyse trade-offs emerging from experiment results, say—we may or may not find that this results in the higher-level capacity to conduct iterative experimentation. In complex, adaptive systems such as AIS, higher-level capacities—including the capacity to innovate itself—are emergent properties of systems dynamics and do not reliably or predictably emerge when only some lower-level system conditions are
present. In developing metrics to assess C2I, we therefore propose an approach that focuses on defining indicators for the highest-level capabilities that are needed in order to produce and sustain innovation.

That said, we note that while bellwether indicators may be helpful to track aspects of C2I over time or space, in some cases it may be necessary to further unpack the C2I ‘black box’. For example where there is a lack of innovation and C2I at these higher-level capacities, understanding the development of some of the building block capacities may be necessary to ascertain obstacles and change practices accordingly.

In developing indicators of C2I, we should also be mindful of the final objectives of development projects such as those aiming to develop C2I. Collecting data on, or including indicators of, innovation and of development outcomes is important in order to understand whether innovation has actually taken place, and whether that innovation has been accompanied by improvements (or not) in well-being. Assessing C2I allows us to understand how and by what processes these interventions have worked (and to continually develop and adjust interventions), while assessing development outcomes allows us to understand (eventually) if these interventions have worked. It may also be useful for local stakeholders themselves to reflect on their own C2I.

**Defining components of C2I**

The first task in developing metrics to assess capacity to innovate is therefore to define the core, high-level capacities within the C2I concept. We propose the following, which we consider as vital to C2I at the local community and local system levels:

1. **Creative drive and innovativeness**
2. **Networking and leveraging of linkages to access resources**
3. **Iterative experimentation**
4. **Collaborative action**

**Selecting indicators**

We suggest the following indicators in order to assess C2I. They reflect elements of the four core capacities as represented by, and to be measured at, the individual, community and local system levels.

**At the individual level:**

1. **Confidence** in ability to develop new and useful solutions to challenges and/or to experiment with and create new ways of doing things.
2. **Increased skills and abilities** associated with C2I at the individual level.
3. **Quantity and quality of experimentation**, e.g. more/better experiments or more/more diverse experimenters.

**At the group/community level:**

4. **Quality and effectiveness of stakeholders**: e.g. number/diversity of stakeholders, quality and effectiveness of their engagement
5. **Existence or growth in numbers of groups** or other organisations/community institutions with an innovation-related role
6. **Increased collective efficacy:** increases in strength and performance of these groups, such as a) increased confidence in the ability of groups to achieve objectives; b) improved inter-group dynamics; c) number of successful collective actions achieved by the group.

7. **Quantity and quality of innovation output**: more/better/more widely used innovations produced by groups or networks of people and individuals.

8. **Increased and strengthened linkages:** network size, strength, effectiveness in sharing resources/support.

**At the local system level:**

9. **Strengthened enabling environment:** e.g. elements of the enabling environment are strengthened or added to; local people are better at sustaining the various supportive elements of the local enabling environment.

10. **Changes in norms, attitudes, policies, rules, funding/resource availability** that reduced barriers to innovation and/or facilitated the ability of local people to advance innovation processes.

These indicators reflect a selection of what we consider to be the essential components of C2I, but we stress that these are not yet field tested. Some of these indicators specifically address 'higher-level' capacities (e.g. 3, 4, 6) while others are indicators of 'building-block' capacities that we consider to be critical and measurable capacities (1, 2, 5, 8, 9, 10). Finally, we also include measures of innovation outcomes (7). In addition to these, it may be important to add indicators directly measuring the processes which contribute to bringing about innovation and supporting ongoing C2I, as well as the presence, strength and effectiveness of certain structures and conditions that enable innovation to take place.

**Discussion**

In this paper we have used a focused literature review to develop a list of categories representing core elements of C2I. We suggest that these elements are a first step to developing monitoring and evaluation tools for measuring C2I, and then make steps towards describing indicators. We acknowledge that, as with many literature reviews based on the use of keyword searches, there are limitations to this approach. While we aimed to use a range of terms around this concept, and followed up on references through a snowball search, we are assuming that the finite number of terms searched are linked to the complex phenomena of C2I. In reality, these concepts are also discussed using different language, particularly in the wider social sciences and psychology literature. Thus, the approach taken here is likely to be a fair representation of the C2I concept amongst those using C2I terminology, particularly amongst those in the agricultural development field, but may not fully explore other interpretations of the concept, and so we should be wary of applying these conclusions and tools to other fields. Another limitation of this approach is that have restricted our search to literature which is online and relatively accessible. While we tried to search for practitioner publications as well as peer-reviewed publications, the former are not always as well-archived and bibliographic databases may be skewed towards the latter.

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4 Importantly this occurs and could be measured at the level of the individual and the group. i.e. innovations may have been spearheaded by an individual 'innovator' or by group activity.
Having accepted the limitations to our approach, we can still make some valid conclusions. The importance of catalysing and strengthening innovation for development outcomes is now accepted (FAO, 2014). The dominant approach to this has been to focus on the development of new technologies through agricultural research, the adoption of which is assumed to generate outcomes and impact. The value of the C2I concept is that it puts emphasis on the causal power of the process component of innovation (which is often over-looked), rather than on the artefact (technology) component. Research processes can build all of the capacities to innovate, and yet some don’t, or are not explicit about wanting to. C2I has the potential to increase the impact of agricultural research, in particular for more marginalised people for whom connectivity and capacity is more of an issue than available technology.

While some CD projects are moving towards developing capacities for innovation (e.g. the CD AIS project (TAP, 2016)), we argue that using the C2I concept bundles together a group of important capacities that conventional CD projects may overlook. Focus on the technology component of innovation has meant that conventional CD projects concentrate on scientific or technical capacities (TAP, 2016). These, while integral to innovation, are alone not sufficient to drive it (Dijkman, 2010). Instead C2I approaches emphasise transferable skills such as those needed to learn and access knowledge (Pant, 2012) and to combine research-based knowledge with context-specific knowledge (often ‘tacit knowledge’ that may not be written down) (Chuluunbaatar & LeGrand, 2015) facilitating the adaptation of innovations to local settings (Hall et al., 2009).

Projects focusing on, or recognising, C2I may also put more emphasis on cross-dimensional interventions, including improving capacities at different scales (TAP 2016) which ensures a more cohesive approach. In contrast, traditional CD interventions may fail to capture the full complexity of innovation processes (Aerni, 2013; TAP, 2016). Similarly, C2I approaches stress the importance of networking and participation (TAP, 2016), while traditional approaches may fail to strengthen inter-relational capacities (Gottret & Córdoba, 2004).

Key to making process outcomes of agricultural research more visible is rigorously showing that they exist and demonstrating their value. This requires measurement, and this paper has made steps towards developing a measurement system. The indicators developed here are targeted, measurable indicators linking to specific capacities to innovate. The next step will be testing and refining these indicators in the field, in order to develop a robust monitoring and evaluation tool, a work that is currently being done by the authors in a number of case studies.

Conclusion and Perspectives

The literature shows that although the emerging C2I concept is not concretely defined, most scholars now agree that it involves the continuing ability to access or generate innovations and to successfully apply them. There are the beginnings of a consensus over what component capacities the term encompasses, with most focusing on the capacities to generate or access innovations through networks, test and adapt innovations, and work with others to apply and adopt them. Accurate indicators linked to C2I capacities, rather than innovation outcomes, will allow us to assess the efficacy of different intervention types for different capacities. Testing the indicators proposed here may allow us to improve interventions for greater C2I and thus improve development outcomes.

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5 Knowledge based on experience in a specific situation and which is less likely to be codified
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Evaluating for learning and accountability in system innovation: incorporating reflexivity in a logical framework

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Abstract: Approaches to accelerate innovation such as Agricultural Innovation Systems and co-innovation (Brunori et al., 2008; Knickel et al., 2009; Fischer et al., 2012) have become more integrated and systemic over time. Primary Innovation is a New Zealand co-innovation programme in which innovation is conceived as being 'co-produced' by stakeholders who contribute their unique knowledge to solving a problem or realising an opportunity. In co-innovation, cyclical processes of planning, doing, observing and reflecting enable innovation to emerge from interactive learning among stakeholders (Botha et al., 2014). The value of applying logic models (logical frameworks, programme theories or theories of change) and concurrently evaluating the effects of co-innovation practices (particularly reflexive processes) in order to understand the extent of learning in and impact from systemic projects have been questioned and debated (Klerkx et al., 2012; Regeer et al., 2016). In this paper we argue that, when flexibly applied and adapted to capture dynamics typical in systems innovation projects, the Log Frame Approach (LFA) (Gaspar, 1999; AusAid, 2005; Kaplan, 2015) and logical frameworks (Kaplan, 2015) have considerable utility to support evaluation for both learning and accountability, and for identifying and addressing institutional logics which leads to system innovation. We demonstrate this for the case of Primary Innovation, and compare our experiences with the limitations and solutions suggested by Regeer et al. (2016) when applying logic models, logical frameworks, programme theories or theories of change as part of an 'adapted accountability framework'.

Keywords: Log frame approach, reflexivity, co-innovation, system innovation, impact, accountability, learning

Introduction

Expectations of the impact from public and private investments in innovation are increasing as commissioners seek reassurance that innovation programmes are successfully addressing the complex problems challenging global primary sectors (Coutts et al., 2014). As a consequence, a more systemic and integrated perspective of innovation is emerging in the form of Agricultural Innovation Systems theory and practice.

Agricultural Innovation Systems are complex adaptive systems characterised by a “large number of actors, diverse interactions and relationships and constantly changing influences emerging from technological, market, policy, cultural and other socioeconomic factors” (Spielman et al., 2009). From these complex adaptive systems, innovations emerge through a co-evolutionary process that combines technological, social, economic and institutional change (Klerkx et al., 2012). While such co-evolutionary processes generally take place...
autonomously (see Ekboir, 2003), the principles behind these processes can also inform approaches designed to accelerate innovation (see for example Nederlof et al., 2011 and Nettle et al., 2012). This implies a move from linear, technology transfer (technologies invented by science and disseminated by extension) to a wider system innovation (Fischer et al., 2012) involving interactive learning among all relevant actors in the agricultural sector, including farmers, growers, consultants, banks, agri-businesses, Government, NGOs and entrepreneurs. The key characteristics of system innovation projects are (Klerkx et al., 2010; Van Mierlo et al., 2010a):

1. Numerous stakeholders with multiple and often conflicting goals;
2. A focus on reflection, learning and action;
3. Co-evolution of technical, social, market and institutional changes; and
4. Emergent outcomes that are modified in response to changes in system understanding and external system changes.

In innovation projects these systemic aspects of system innovation create new challenges for traditional monitoring and evaluation methods and tools such as logical frameworks, which were historically used to meet the accountability needs of commissioners.

**Evaluation for learning and accountability in a system innovation programme: Primary Innovation**

Primary Innovation seeks to explore ways actors in the New Zealand primary industries can work together to jointly learn and co-develop innovations to complex industry challenges, such as water and land management (Botha et al., 2014). The programme also has wider system innovation ambitions to stimulate changes in the New Zealand Agricultural Innovation System so that adequate and complementary innovation policies, funding frameworks and organisational cultures enable the optimal performance of innovation networks (Turner et al., 2016).

Achieving system innovation requires reflexivity, learning and action among multiple actors in the Agricultural Innovation System (Van Mierlo et al., 2010a; Van Mierlo et al., 2010b) in order to tackle the key institutional logics that hinder the formation and functioning of innovation networks (Turner et al., 2016). Institutional logics are historically built-up and persistent structures and institutional arrangements that lock systems into current arrangements (Fuenfschilling & Truffer, 2014). Learning needs to stimulate structural (or system) change by participants in the system. This kind of learning is facilitated by a reflexive perspective, enabling things that are usually taken for granted to be challenged (Loeber et al., 2007; Van Mierlo et al., 2010a; Van Mierlo et al., 2010b). The outcome of reflexivity and learning in system innovation projects is practical action in the wider system and subsequent double loop learning from this action (Van Mierlo et al., 2010b).

In system innovation projects such as Primary Innovation, monitoring and evaluation are not separate, but become an integral part of reflexivity and learning (Van Mierlo et al., 2010b). To be effective in this highly adaptive setting evaluation must be flexible to respond to (i) learning from action and (ii) external system changes, especially to seize ‘windows of opportunity’ (Van Mierlo et al., 2010a; Beers et al., 2014). This places evaluation in a constructivist perspective that recognises the importance of multiple perspectives and values in shaping system innovation (Arkesteijn et al., 2015). Evaluation also needs to deal with ambiguity and disagreement and their influence on lock-in in systems due to existing institutional logics (Van Mierlo et al., 2010a).
At the same time, system innovation projects are also accountable to commissioners, who often have in place formal procedures for evaluating the efficiency and efficacy of project funding (Botha et al., 2014; Gosling & Edwards 2003b; Roberts & Coutts 2011). A common approach for achieving this is the use of classical project planning and evaluation such as the Logical Framework Approach (LFA) which has been characterised as a tool (Gaspar, 1999), methodology (AusAid, 2005) or approach (Kaplan, 2015) for designing, executing and assessing projects and programmes (AusAid, 2005). This approach was originally developed from an instrumental perspective, with the aim of meeting the accountability needs of project funders – upwards accountability (Gosling & Edwards 2003; Regeer et al., 2016). In this paper Logical Framework Matrix (LFM) (AusAid, 2005) or logical framework (Kaplan, 2015) refers to a matrix with columns and a number of rows that show inputs, outputs, short-, medium and long term outcomes. Its purpose is to translate a Log Frame Approach into action, and as a document it forms the basis of an actionable work plan that guides implementation through the programme lifecycle (Kaplan, 2015).

Applying logical frameworks - as tools for planning - to achieve upwards accountability has been based on rational planning and problem solving in which causes and effects are assumed to be predictable ex-ante and uncertainty reduced and managed (Arkesteijn et al., 2015). As has previously been observed, the use of such classical project evaluation creates tensions with the focus on learning that characterises system innovation projects (Botha et al., 2014; Regeer et al., 2016). This has led to five criticisms regarding the use of the Logical Framework Approach or log frame (Arkesteijn et al., 2015) in system innovation projects in which reflexivity, learning and action are essential:

1. It fails to recognise complexity and inherent uncertainty in system change
2. It focuses on what is agreed in formulating the project and does not make transparent the points of disagreement or conflict in system innovation
3. It assumes that society is amenable to rational design
4. Accountability outcomes tend to take priority over learning outcomes
5. Accountability to other stakeholders, besides funders, is ignored.

These criticisms raise several issues regarding the practical application of logical frameworks to support reflexivity and learning in system innovation projects while also meeting the upwards accountability needs of funders (Regeer et al., 2016).

Regeer et al., (2016) outline eight practical limitations to the application of logic models, logical frameworks, programme theories or theories of change in system innovation projects:

1. They cannot capture the diverse dimensions of accountability and learning because they are typically separated and not dealt with simultaneously in innovation (niche) projects
2. They are developed ex-ante to describe the expected causal relations between inputs, activities and desired programme outcomes
3. They are often used ex-post to assess whether, and to what extent, programme goals and objectives have been achieved – upwards accountability
4. They typically see accountability in terms of predefined goals and relationships with interventions that “presuppose a relatively stable programme, whose activities, goals and intended effects can be univocally described.” (Regeer et al., 2016)
5. They adopt a goal-oriented evaluation that does “not sufficiently take into account the emergent nature of complex projects and their multifaceted environment” (Regeer et al., 2016)

6. They fail to capture the effects of external and internal pressures on projects, which can affect the ambition for change, and do not reflect back these pressures as potential for structural change

7. They typically are not used during intervention processes nor include all stakeholders

8. They are commonly implemented by external evaluators and, depending on the commissioner, results may be publicly available. As a result, participants in the evaluation may be more inclined to defend the outcomes generated by their actions and decisions rather than be willing to internalise the findings and learn from them.

Recent work (Botha et al., 2014; Regeer et al., 2016) has called for the need to explore ways to reconcile these practical issues in meeting accountability needs from evaluation, with the reflexivity, learning and action needs of system innovation projects. This has stimulated modifications of logical frameworks to increase their flexibility (e.g. MERI (Monitoring, Evaluation, Reporting and Improvement)) (Dart, 2007) and, to some extent, the Theory of Change (Funnell & Rogers 2011). Regeer et al., (2016) argue for a reframing of accountability to not only funders, but all stakeholders in system innovation, with the implication that evaluation is undertaken to address these multiple accountabilities. Botha et al. (2014) call for ‘learning by doing’ to operationalise the use of logical frameworks for accountability, reflexivity, learning and action in a system innovation project. In this paper we present the insights gained from this ‘learning by doing’ in the Primary Innovation programme. Botha et al. (2015a) discussed the challenges when using a logical framework (Kaplan, 2015) in co-innovation projects and concluded that it worked well in Primary Innovation, was particularly useful in providing a monitoring and evaluation framework and guiding change, and matched a co-innovation approach to fostering change.

We argue that the practical limitations of the use of a logical framework to support both learning and accountability in system innovation projects, such as Primary Innovation, can be overcome by the way it is implemented during a project. We demonstrate this for the case of Primary Innovation and compare our experiences with the solutions suggested by Regeer et al. (2016) to the eight limitations listed above.

The paper is organised as follows: the next section provides a description of how a logical framework was implemented in Primary Innovation. The following section then describes how the programme addressed each of the eight practical limitations to using a logical framework in system innovation (Regeer et al., 2016). We conclude the paper with a discussion of the main insights on how to use a logical framework to simultaneously meet accountability, reflexivity, learning and action needs in system innovation projects.

**Methods used to implement a logical framework in Primary Innovation**

At the start of Primary Innovation, while there was no requirement to develop or use a logical framework, there was a recognition that it was a complex programme that required effective evaluation. To this end, the planned steps, process and aspirational outcomes needed to be defined and understood by the programme team (researchers and social scientists across participating research organisations) and endorsed by its 23 stakeholders (Botha et al., 2014). The large number and diversity of Primary Innovation stakeholders makes it impractical for everyone to be involved in the logical framework and monitoring and evaluation throughout
the life of the investment. While all Primary Innovation’s stakeholders are familiar with the logical framework, a small team consisting of individuals from AgResearch and Plant and Food Research, as well as Coutts J&R (a contracted evaluator), uses it to review the programme’s logic, expected outputs and theory of action, and evaluate impacts and processes rather than checking whether a predetermined path is unquestioningly pursuing contract milestones. The small team shares and discusses their findings and activities with the other 23 stakeholders through a newsletter, quarterly reports and other communication methods like phone calls, meetings, webinars and workshops.

The outcomes from Primary Innovation are emergent because system innovations have multiple socio-technical components that cannot be defined in advance (Wiskerke & van der Ploeg, 2004). However, to secure funding Primary Innovation was required to identify expected outcomes in the funding application and contract. These were used to help develop the first logical framework.

The levels used in the logical framework (Coutts et al., 2014) were: Longer term Outcomes – towards which the programme is intended to contribute along with other complementary initiatives; Key Result Areas – specific measurable short term impacts or achievements to which the programme is planning to deliver on in its life (including unintended benefits or consequences); Uptake Strategies – approaches used to reflect, communicate, influence, assist and/or encourage appropriate people or groups to effectively engage; Underpinning Activities – Research, Development & Planning Activities and Outputs needed or used (from other sources) to provide the science, tools, information or materials to support systems change processes; Supporting Structures – resources, staff, management processes, Steering Groups and other structures to oversee and undertake programme activities; and Context – political, economic, climatic and other factors that can affect the success or otherwise of the programme and process.

The first logical framework was developed by the programme team with the assistance of Coutts J&R who were embedded in the monitoring and ex-durante evaluation of Primary Innovation. This first draft was circulated for feedback to the programme team and the content was developed in a workshop where they created a flow diagram to develop a greater understanding and sense of ownership. This provided a focus for reflecting, discussing, understanding and refining the programme and its change ambition, and highlighted the key elements for evaluation in order to generate accountability and enable learning. The logical framework was revisited annually over the next two years as a basis for reviewing the programme and highlighting gaps in monitoring and evaluation data.

Three workshops were held with a monitoring and evaluation focus – all based around the logical framework. For example, the flow diagram developed in the first workshop was used at subsequent workshops to focus discussion, reflect on progress (including the ambition for change), analyse monitoring and evaluation data captured and look for gaps. Re-visiting the logical framework also provided an opportunity for ongoing reflection and discussion of what co-innovation meant in practice and how best to evaluate it. Following the workshops, participants were provided with structured feedback sheets and asked to reflect on their learning about and understanding of monitoring and evaluation as a result of participating in the development of the logical framework.
A team member was appointed to support the evaluation process and collect data to support the utility of the logical framework. Amongst other responsibilities, a reflexive monitor also kept track of how team members were responding to changes in the wider Agricultural Innovation System that were affecting Primary Innovation, such as the establishment of new platforms for innovation (e.g. the National Science Challenges), as an opportunity for furthering programme ambitions (Hekkert et al., 2007; Bussels et al., 2013; Rijswijk et al., 2015). A reflexive monitor’s role is to help programme participants reflect on process, action and progress towards agreed research goals (Van Mierlo et al., 2010a). It is a mechanism that the Primary Innovation team is using to help identify opportunities where co-innovation can enhance impact in the design or management of a series of innovation projects (case studies). Reflexive monitoring is also being used by the research team and stakeholders to remind them of their ambitions for system innovation, such as by challenging and changing presumptions, current systemic practices and underlying institutions (Botha, 2013). This is different from the role of a facilitator, in that reflexive monitors challenge, as well as support, participants to reflect on and address how the way they work together enhances or hampers progress towards their shared ambition for change (Botha et al., 2014).

Narrative reflective processes during the workshops helped participants to reflect upon their own and others’ learning (Schwind et al., 2012). These were recorded in a Dynamic Learning Agenda (van Veen et al., 2014).

The logical framework was also used for a mid-project evaluation during which available monitoring and evaluation data were analysed against the accountability performance measures at every level of the logical framework. This highlighted data gaps and issues that needed to be considered by the programme team and stakeholders, providing another opportunity to reflect on the extent of learning underway in the programme as well as increase accountability around programme performance.

**Results**

This section provides a description of ways the logical framework was applied in the Primary Innovation programme that may address each of the eight practical limitations, identified by Regeer et al., (2016), to using such a framework in system innovation. Lessons number two and three have been combined as they are closely related.

**Logical frameworks do not deal with accountability and learning simultaneously**

By using the logical framework in Primary Innovation in a flexible and reflective way, tensions that surfaced around learning across the programme were identified quickly and addressed. For example, tensions arose during a programme workshop about the speed of progress in the programme between the management team, researchers and practitioners when discussing and reflecting upon processes, outputs and learning. Learning about and understanding co-innovation was more important to researchers than practitioners who preferred learning-by-doing, while programme delivery and impact was important for upward (funder) accountability of the programme management team. These tensions were dealt with through regular telephone and face-to-face conversations between programme participants and a reflexive monitor for the programme who helped discussions to focus on the shared ambition for change. This has resulted in increased involvement of leaders of Primary Innovation case studies in reflexive sessions as well as increasing their involvement in writing up the results of the research.
Logical frameworks are developed ex-ante and applied ex-post
In Primary Innovation the logical framework was for practical reasons constructed and reflectively used ex-durante in order to re-visit and discuss the underpinning ‘theory of action’ of the programme and causalities assumed in the original project proposal. The ex-post evaluation is yet to be completed as the programme is still underway. However, a mid-term review was undertaken using the logical framework. This review included consideration of changes in the logical framework itself.

Logical frameworks typically see accountability in terms of predefined goals and relationships
The use of monitoring and evaluation with a logical framework has, in the case of Primary Innovation, been used to identify where changes are needed. One example is the membership and functioning of the Community of Practice – a mechanism through which Primary Innovation intends to ‘scale up’ co-innovation across New Zealand (that is, to influence and stimulate system innovation at the Agricultural Innovation System level) (Botha et al., 2014). Over time, through reflection, considering member feedback, an openness towards adaptation and by being pragmatic and flexible the role and membership of the Community of Practice has evolved. As well, the programme has created a Community for Change that consists of three integrated but smaller self-selected groups, with sufficient homogeneity and focus as well as ambition for change, to achieve impact around three distinct opportunities to enhance New Zealand’s Agricultural Innovation System. Further, two social scientists have joined the research team, bringing expertise in change management and using Communities of Practice to support institutional change, demonstrating how the logical framework supported identification of the need for new relationships. Another example of how the logical framework enabled accountability measures to be redefined is that one of the key measures of successful programme impact, ‘rate of adoption’, was changed to ‘rate of innovation’ to better reflect the ambition for change in the programme.

Logical frameworks fail to capture the effects of external and internal pressures on the ambition for change
Reflexive narratives by programme participants provide evidence of the programme’s contribution towards system changes and how current interventions, like the Community of Practice and case studies, could be adapted to suit external changes in the primary industry. For example, severe market volatility in dairying provided an opportunity for systemic change as well as adapting programme delivery.

Although this took resources away from the dairy innovation project within Primary Innovation, it created opportunities to discuss with industry partners different modes of intervention, like co-innovation and its benefits and costs (Botha et al., 2015b). These discussions challenge current modes of operation and institutions and provide opportunities to explore structural and institutional changes at the innovation project level as well as at the Agricultural Innovation System level.

Logical frameworks do not take into account the emergent nature of complex projects
The logical framework enabled a holistic view of Primary Innovation that included processes and assumptions like how programme goals, in the form of outputs and outcomes, would be achieved, as well as the anticipated role and impacts of the Community of Practice. The focus was on the type of impacts that might be observed from the research programme rather than specific pre-determined actions and impacts. This high-level perspective was critical to deep
reflexivity because it raised and encouraged in-depth discussions amongst the team that went well beyond merely achieving pre-set goals. Avoiding a solely goal-oriented evaluation approach helped the programme management team to ‘see’ the need for changes, like how the Community of Practice was being used. Combining reflexive narratives with the logical framework also helped to articulate and ‘picture’ programme outputs and impacts, and inform how anticipated interventions could be adapted to fit, and more strongly influence, the changing programme environment.

**Logical frameworks are typically not applied during intervention processes nor include all stakeholders**

As mentioned already the logical framework was used on an ongoing basis to guide evaluation and reflection, i.e. ex-durante, and most stakeholders were involved in these processes. For example, feedback was sought from all participants (including farmer and Māori representatives), directly after Community of Practice workshops and again through interviews. Evaluation was ongoing and involved the full project team in reviewing information provided from interviews. All of the project team had access to evaluation data and reports as they were collected and collated during the project.

**Logical frameworks are commonly performed by external evaluators**

In Primary Innovation the external evaluator has been contracted for the duration of the programme to support monitoring and evaluation, provide ongoing advice and build monitoring and evaluation capacity. However, rather than hindering the open exchange of views and learnings amongst the research team the external evaluator’s involvement is treated as an essential component and a valuable, well-utilised programme resource. For example, in the initial monitoring and evaluation workshop in 2013 (which used the logical framework), 19 participants rated the extent to which the workshop process clarified the objectives and performance indicators of the programme as good (7.5/10; range of 5-9), the extent to which they were comfortable with the monitoring and evaluation approach as 7.5/10 and their understanding of their role in the monitoring and evaluation process as 6.8/10. Seventeen of the 19 participants also indicated that they would consider the evaluation approach for other projects in their organisations. By the second monitoring and evaluation workshop (July 2014) there were a number of comments that indicated some participants already had a good understanding of monitoring and evaluation (from the first workshop) and the value of reinforcement and review. One noted that “the ability to physically ‘spread out’ the monitoring and evaluation plan (i.e., the logical framework) on the wall was a huge bonus - I could see it. We were able to locate and augment the framework so it became a tool to enhance project planning and management. I can now see how monitoring and evaluation works!” Another pointed out the value in being able to pick up the gaps.

Through the involvement of the external evaluator during the research programme the team’s understanding grew over the three workshops and there was an increasing consensus and commitment built around the programme aims and process as well as their role in its evaluation and reporting. As noted earlier, a team member was appointed to facilitate the evaluation process through the project with the external evaluator providing an ongoing source of mentoring and support that has created a high-level of trust and confidence in using the logical framework.
Discussion
This section of the paper discusses the main insights on how to simultaneously meet accountability, reflexivity, learning and action needs in practice in system innovation projects. We argue that the ways in which logical frameworks are utilised determine their suitability to achieve system innovation while simultaneously meeting the accountability needs of funders.

System innovation is challenging and involves long-term change (Geels, 2004). We are, however, realistic about what can be achieved through Primary Innovation and acknowledge – with Van Mierlo et al., (2010a: 144) – that, by definition, significant system change is complex with long time horizons. While this may limit what is achievable by a programme like Primary Innovation, contributing to system innovation by stimulating learning in the sense of a change of thinking and acting is, at this stage, the Primary Innovation team’s shared ‘ambition for change’, towards which the logical framework is enabling steady progress to be made.

Co-innovation occurs when different stakeholders collaborate and, over time, share their unique knowledge to solve a problem or realise an opportunity. The mid-term review has shown that the logical framework has enabled participants, through joint learning, to reach consensus on the overall plan for this complex programme by bringing the goals (impacts), objectives, outputs and activities together. This is important because shared goals, and a common understanding of the approach being taken to reach these, maximise the likelihood of research having impact (Campbell et al., 2015). Using the logical framework provided an agreed, consistent and coherent summary of the programme to all the stakeholders, including the funders. It supported culture change and helped discussions to focus on the collective goals, or ‘ambition for change’ (see e.g. Van Mierlo et al., 2010c) by creating a shared visual record of where things are heading.

The logical framework was useful to guide responses to changes or issues because it was used in a flexible way. A flexible approach to monitoring and evaluating progress is very important in allowing for ongoing adaptation, particularly when sustainable solutions are pursued (Rijswijk et al., 2015). Consideration of any unexpected, or even expected, negative outcomes is provided for every time the programme team meets to minimise the risk of them becoming fatal flaws and enable the programme to adjust in order to manage them. The mid-term review has confirmed that the way in which the logical framework was used in Primary Innovation provided sufficient flexibility, allowed adaptation, and thereby effectively guided co-innovation, while also providing accountability measurements and responses to the funders.

By explicitly including the process and principles of co-innovation in the way the logical framework was designed and applied, the team has been able to continuously evaluate in real time how well the process and principles are being applied across the programme work streams while learning together about the value of their application. It also facilitated accountability by measuring progress being made towards the delivery of programme impact.

Conclusion
Our use of a logical framework provided a point of convergence that stimulated project team members to spell out their assumptions about the relations between project activities and long-term goals as well as their own viewpoints and actions, and subject them to scrutiny and evaluation (see also Arkesteijn, van Mierlo, & Potter, 2007). This has helped participants to understand and, through reflexive narratives, learn about each other’s viewpoints and actions.
In our view this is an essential component of identifying and addressing institutional logics, which support system innovation.

When logical frameworks are employed adaptively they can, like in Primary Innovation, enhance project functioning in ways that create change while staying accountable. In our experience, when used adaptively, logical frameworks can greatly enhance the possibility of achieving impact by enabling reflection upon, and responding to, important contextual changes. We acknowledge that, when logical frameworks are used to control resource allocation and/or to manage contracts based on accountability, they can become a fixed and prescriptive mould that locks a project team into pre-determined actions, activities and outcomes while ignoring contextual changes.

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References


Outcome evidencing: a rapid and complexity-aware evaluation method

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Abstract: This paper describes the development and use of a rapid evaluation approach to meet programme accountability and learning requirements in an on-going research for development programme operating in five developing countries. The method identifies clusters of outcomes to which the programme has contributed, within programme areas of change. In a workshop, change agents describe the causal connections within outcome clusters to identify outcome trajectories for subsequent verification. Comparing verified outcome trajectories with existing programme theory allows the programme to question its underlying causal premises and adapt accordingly. The method can be used for one-off evaluations that seek to understand whether, how and why programme interventions are working. Repeated cycles of Outcome Evidencing can build a case for programme contribution over time that can be evaluated as part of any future impact assessment of the programme or parts of it.

Key words: Complex systems, outcome trajectories, theory of change, monitoring, evaluation, socio-technical niches, realist evaluation, mechanisms, innovation

Introduction
Agricultural research for development programmes intervene in complex adaptive systems fashioned by people and the agroecologies in which they live. In complex adaptive systems there are rarely ever any magic bullets: no intervention will ever work the same way, everywhere for everyone. In some contexts some programme offerings will work and in others they will not (Pawson, 2013). Evaluation methods therefore need to understand how different aspects of programmes work, for whom in different contexts. In other words, they need to unpack the causal black box between programme intervention and programme outcomes (Astbury & Leeuw, 2010). Most traditional impact evaluation methods do not dig into causality, but rather concentrate on establishing the worth of programme intervention, often evaluating it against whether its initial predicted routes to impact have come to pass (Mayne & Stern, 2013; Stern, 2015). Such methods are of little use to staff interested in understanding how their interventions are working so as to improve implementation and the chances of reaching larger numbers of people. Nor are they useful to donors interested in improving their returns on investment by making better investment decisions. Traditional impact evaluation methods risk failing to identify and learn from the parts of the programme that are working and have the potential, if supported and scaled, to make a real difference.

The literature that calls for complexity-aware impact evaluation to fill this gap is large and growing (e.g., Patton, 2011; Stame, 2004; van Mierlo et al., 2010; Mayne & Stern, 2013; Rogers, 2008; Douthwaite et al., 2003). The literature has less to say about the experience of developing and using complexity-aware impact evaluation methods and how they work, or not, in programmes that are themselves complex and on-going. This paper describes the development of a complexity-aware method called Outcome Evidencing within a systems-focused research for development programme of the CGIAR. The CGIAR is a worldwide...
partnership addressing agricultural research for development carried out by 15 research centres through fifteen CGIAR research programmes. CGIAR work contributes to the global effort to tackle poverty, hunger and environmental degradation.

Our objectives are two-fold: to describe and critically reflect on an evaluation approach that may be of interest to other programmes and to share the practical considerations involved in starting to use complexity-aware evaluation methods.

The need for complexity-aware evaluation in AAS
The goal of the CGIAR Research Programme on Aquatic Agricultural Systems (AAS) is to improve the wellbeing of poor people dependent on aquatic agricultural systems by putting in place the capacity for communities to pull themselves out of poverty (AAS, 2011). AAS began in 2011 by establishing programmes of work in five geographically defined hubs with an aspirational goal to make a positive difference to the livelihoods of 6 million poor and marginalised by 2023 (AAS, 2014). By the end of 2013 AAS was implementing programmes of work in the coral triangle of the Solomon Islands and the Philippines, the Asia mega deltas of the Mekong and Ganges–Brahmaputra–Meghna river systems (Cambodia and Bangladesh) and the African freshwater systems of the Niger and Zambezi rivers (Zambia), all of which are complex socio-ecological systems where millions of poor and marginalised small-scale fishermen and farmers make a living. Issues facing these aquatic agricultural systems are often complex because they arise from deep-rooted, complex, interrelated processes that operate across and between different scales from global to local and cannot be understood by separating them out for analysis by single academic disciplines (Halliday & Glaser, 2011).

In the same period the programme developed the research in development (RinD) approach as its main vehicle for achieving impact. The RinD approach allows research teams to work as part of a coalition of stakeholders to jointly tackle a broad development challenge. The RinD approach creates new and safe dialog and action spaces for stakeholders to engage with one another long enough to build trust, motivation, capacity and insight to do things differently. AAS overarching programme theory is based on the premise that agricultural research processes (e.g. multi-partner collaborations) and outputs (i.e. new technologies) work to catalyse and foster processes of rural innovation. It is these innovation processes that may be technical, institutional or both, that lead to development outcomes. The RinD approach is a way of building collaborations across institutional and scale boundaries (e.g. between farmers and researchers, or between different government ministries).

The authors, both with responsibility for programme evaluation, were aware that the investment being made in AAS was contingent on demonstrating that the RinD approach is working within the first phase of the programme scheduled to end in 2016. We expressed the evaluation challenge in terms of two evaluation questions:

- what types of outcomes is AAS contributing to?
- do these provide evidence that the overall programme theory of change is credible and how do they help us understand why (or why not)?

The questions were equally motivated by systems thinking (Snowden, 2010) that the way to trigger change in complex systems is to support emerging patterns of positive outcomes resulting from AAS intervention, and at the same time dampen down changes detrimental to
the programme’s beneficiaries. This is similar to Rogers’ (2008) idea that programme theory can may be used to identify emergent outcomes that have the potential to make a big difference. To work in this way, the programme needed a method of quickly identifying emerging outcomes, both expected and unexpected.

**The Outcome Evidencing method**

We combined elements of Outcome Harvesting (Wilson-Grau & Britt, 2012) and Scriven’s (1976) Modus Operandi methods to meet AAS’ evaluation challenge. Outcome Evidencing has ten steps shown in Figure 1 and described below.

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**Figure 1: Ten steps of an Outcome Evidencing process**

1. **Agree the evaluation questions and the use of the evaluation results**
2. **Identify arenas of change**
3. **Identify and describe outcomes**
4. **Identify outcome trajectories**
5. **Identify most significant outcomes and critical linkages**
6. **Critically reflect on who is/is not experiencing change, and why**
7. **Identify immediate implications**
8. **Plan and carry out substantiation**
9. **Analyse and use the findings**
10. **Repeat the cycle**

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Search and describe outcomes

Collectively design evaluation in a workshop — **build a case**

Carry out the evaluation — substantiate the case
**Step 1: Agree the evaluation questions and the use of the evaluation results**

Step 1 involves programme staff agreeing the evaluation questions and how the evaluation results will be used. The AAS question was: “what are the areas of change to which the programme is contributing, and how is it doing so?” AAS uses the results to justify its funding and to help achieve impact by early identification of promising areas and early understanding of what the programme is doing that is working.

**Step 2: Identify key areas of change**

In Step 2 knowledgeable programme staff identify areas of change to which the programme is contributing. These areas of change can be understood as emerging ‘socio-technical niches’. Niches are spaces where people experiment with novelty in technology and/or institutions (Klerkx et al., 2012). It is these niches that the programme wishes to identify early and support. Niches are a core concept of strategic niche management (Kemp et al., 1998). According to this theory, when niches are properly constructed and linked they can act as building blocks for broader societal changes towards sustainable development (Schot & Geels, 2008). Hence strategic niche management provides some detail to the AAS’ programme theory described above, specifically that the programme creates, supports and guides socio-technical niches to be building blocks that come together to help achieve the programme’s goal. Focusing rapid evaluation on if and how programme intervention is contributing to niches was a way of answering the second evaluation question relating to the credibility and workings of the AAS programme theory. Evaluation findings can guide how the programme intervenes in the future to link the niches to bring about broader change.

**Step 3: Identify and describe outcomes**

Step 3 is to identify and describe outcomes occurring within the identified areas of change. This is done through asking field staff and looking for outcomes recorded in process documentation, particular records kept by field staff. Either way, the outcomes should be described in terms of a single phrase that can be written on card to allow for subsequent clustering in a workshop. Other basic information should also be recorded for each outcome on a simple template. Given that more than 50 outcomes might be identified, filling out any template should not be too onerous.

The next three steps take place in a participatory workshop attended by staff and stakeholders involved with implementing the programme in the field. The workshop identifies outcome trajectories by which the programme is contributing to areas of change. The outcome trajectories, described as theories of change, identify and explain the causal links connecting programme intervention to outcomes contributing to the areas of change. The workshop identifies critical parts of these theories of change for substantiation and identifies sources of evidence.

**Step 4: Identify outcome trajectories**

Outcome trajectories are the patterns of change that the programme is generating within the areas of change. They are similar to Scriven’s Modus Operandi. Scriven argued that interventions, like criminals, have a modus operandi that is recognisable. Just as identifying criminals’ modus operandi can help catch them, so identifying programmes’ modus operandi can help improve them by understanding how the programme is or is not working. In Outcome Evidencing, identifying outcome trajectories happens in an annual workshop. Participants first
cluster outcomes that they think are related. They then build a causal diagram as a way of collectively agreeing on what those relationships are, and in doing so add in or reject some outcomes. The outcomes and the links between them constitute outcome trajectories. Outcome trajectories are characteristic causal patterns of outcomes, with momentum, contributing to larger or more aggregate impact within and across the identified areas of change.

From a realist evaluation perspective, trajectories of change are mid-level theories of change that take place within a particular context and involve a causal mechanism or mechanisms that produce an outcome or outcomes (Westhorp, 2014). Causal mechanisms are what intervenes between the delivery of programme service and the occurrence of outcomes of interest (Weiss, 1997). A mechanism is the response programme activities generate in those involved. The responses happen in peoples’ heads and are generally hidden and sensitive to context. Mechanisms have causal power. Identifying outcome trajectories is a way of identifying and describing underlying mechanisms. Box 1 describes causal mechanisms in more detail.

**Box 1. Examples of causal mechanisms**
The concept of causal mechanisms is fundamental to realist evaluation but is also a cause of misunderstanding (Westhorp, 2014). Gravity is an example of a causal mechanism in the physical world. Gravity is what causes an apple to fall from my hand to the ground. Whether the apple falls or not depends on whether I release my grip. Letting go of the apple is the trigger. Social norms are an example of a mechanism in the social world (Elster, 2007). Social norms suggest a certain way of acting in particular circumstances. For example, whether I act in accordance to the expected behavior of not talking on my mobile in a train carriage will depend on triggers such as a disapproving glance from a fellow passenger or a sign asking passengers to respect others’ wish for quiet. The outcome of triggering a mechanism depends on context. If I release an apple at the bottom of a swimming pool it will float because buoyancy replaces gravity as the dominant mechanism. Whether I make a phone call in the railway carriage will depend on the urgency of the situation. Both gravity and social norms are real, but their working is not directly observable. The ‘under the surface’ nature of mechanisms is a fundamental characteristic.

**Step 5: Identify most significant outcomes and critical linkages in the outcome trajectories**
The next step is to identify the critical outcomes and linkages within outcome trajectories upon which the programme’s claim to have made a contribution most depend. Outcome trajectories are theories of change. According to Popper (1992: 94 as quoted by Pawson, 2013: 9) theory is built and verified with the accumulation of explanation, rather than on the bedrock of observational facts.

“The empirical basis of objective science has thus nothing ‘absolute’ about it. Science does not rest upon rock bottom. It is like a building erected on piles. The piles are driven down from above into the swamp, but not down to any natural or ‘given’ base; and when we cease our attempts to drive our piles into a deeper layer, it is not because we have reached firm ground. We simply stop when we are satisfied that they are firm enough to carry the structure, at least for the time being.”
We think Popper’s swamp-building analogy helps explain the importance of this step. Some piles in the outcome trajectories are more crucial for understanding and substantiating programme impact claims than others: these require greater scrutiny. The scrutiny helps clarify the programme’s unique modus operandi - the distinctive set of underlying causal mechanisms that the programme is triggering. If the programme’s claim to contributing to significant outcomes and critical linkages stands scrutiny, if firm enough ground can be reached, the building can continue. If not, the building needs to take on a different shape and donors informed of the change.

**Step 6: Critically reflect on who is experiencing change, and who isn’t**

AAS uses research to trigger or support processes of innovation. Innovation processes benefit participants more than non-participants (Rogers, 2010). AAS’ goal, shared with many other programmes, is to benefit the poor and marginalised who are usually by-passed by mainstream development activity. Hence we include a step that involves analysing outcome trajectories in terms of social and gender equity, inclusion and power. This information helps AAS catalyse, support and modify outcome trajectories to favour poor, vulnerable and marginalised groups, and correct the course of, and even curtail, potentially harmful ones.

Carrying out this step requires a context-specific understanding of inequalities and gender norms, roles and dynamics. Ideally gender specialists should facilitate and inform this step. Workshop participants in groups analyse and discuss outcome trajectories and the most significant changes along them from a social and gender equity perspective by answering the following questions:

- what vulnerable or marginalised groups are being, or could be, directly or indirectly affected by the change?
- does the outcome trajectory:
  - promote equal opportunities for vulnerable and marginalised groups? Yes/How is that happening? or No/Why not?
  - strengthen positive norms that support social and gender equality and an enabling environment? Yes/How is that happening? or No/Why not?
  - challenge norms that perpetuate social and gender inequalities. Yes/How is that happening? or No/Why not?

**Step 7: Identify immediate implications**

The workshop produces learning and insight about which there is sufficient agreement to be acted upon immediately. To make sure this happens a workshop report identifying these measures is written and circulated to relevant people as soon as possible. Another strategy is to hold the Outcome Evidencing workshop immediately before annual planning so that the people involved in both can take the learning from one to the other.

**Step 8: Plan and carry out substantiation; analyse the results**

The workshop provides sufficient information to plan and carry out the substantiation of the outcome trajectories. Substantiation is carried out by an evaluator, who may be internal or external. Internal, or ‘self-evaluation’ has been found to be more self-critical and the results more useful to staff than when an external evaluator is used (Douthwaite et al., 2003) whereas external evaluation may carry more weight with an external audience when accountability is more important than learning. Developing and implementing the plan requires a number of
decisions to be made as to which key informants to interview, which documentation to check and the evaluation report length and structure.

The substantiation verifies ways in which people are using programme resources to generate outcomes. This is then compared to AAS’ existing programme theory and action taken if required.

**Step 9: Analyse and use the findings**
The evaluator who has carried out the substantiation and other staff leading the Outcome Evidencing process analyse the findings from the substantiation to complete the evaluation report. Outcome Evidencing was designed to be repeated annually or bi-annually within a programme that needed the results to inform its adaptive management. Outcome Evidencing can also be used for one-off evaluations. In either case the authors of the evaluation report have a responsibility to promote the use of the findings, including comparing the findings to existing programme theory and making adjustments as necessary.

**Step 10: Repeat the Outcome Evidencing cycle**
Repeating the Outcome Evidencing cycle annually allows AAS to explore how the outcome trajectories first identified have evolved and grown. This is done in subsequent repetitions of Step 3 by collectively deciding if new outcomes map onto existing outcome trajectories, and if they do whether they add to or challenge the outcome trajectory theory of change. New outcome trajectories may emerge in this process if new outcomes do not map onto existing trajectories. Repeating Outcome Evidencing allows the programme to build an increasingly strong case for the changes to which it is contributing. New outcomes and causal explanation can serve to confirm or challenge initial causal claims (Barnett & Munslow, 2014) and programme theory. This builds an increasingly sound basis for any future ex-post impact assessment.

**Experience using Outcome Evidencing**
We piloted Outcome Evidencing first in Bangladesh in 2014. The AAS Country Programme Leader identified two main areas of change (Step 2) resulting from community and hub-level engagement respectively. For the first area, community facilitators in each of the sixteen AAS focal villages produced a list of outcome descriptions gleaned from documentation generated by village-level participatory monitoring and evaluation. The lists were then presented, revised and consolidated in a workshop where community facilitators reviewed, grouped and classified the outcomes. This workshop produced more than 50 outcome statements. Key members of the AAS country team then went through another round of review and consolidation to finally formulate 16 outcome descriptions.

We brought the change agents together in a workshop in May to complete Step 3 and carry outSteps 4 and 5. The change agents were the staff facilitating community engagement, AAS staff working in the hub and key people directly involved with AAS in Bangladesh.

The links participants identified among the 16 outcomes, and the four outcome trajectories they subsequently identified, are shown in Figure 2. The first three trajectories are the result of carrying out participatory action research (PAR) at community level.
1. Farmers doing research, in particular through engaging with researchers and village facilitators. Outcomes associated with this pathway included changes in knowledge, skills, attitudes and practices in farmer researchers.

2. Farmers becoming self-confident leading to outcomes such as farmer-researchers taking up leadership roles and becoming recognised by other organisations.

3. Women and men working together contributing to outcomes such as women with more say in decision-making and more freedom to join learning events and go to the market.

4. Influencing partners as a result of AAS’ engagement with hub-level partners contributing to outcomes such as partners developing greater ownership and understanding of AAS work including adopting elements of the RinD approach.

Figure 2. Outcome trajectories as identified during the workshop in Bangladesh

The next step of the workshop was to break participants into groups to develop a theory of change for each of the four identified outcome trajectories. To do this we asked the participants to:

1. identify what they thought the programme had contributed through implementing the RinD approach that had resulted in outcomes;
2. specify the causal links between the outcomes;
3. predict the likely future direction of the trajectory.

Participants built the respective theories of change by drawing and explaining a causal diagram. Participants in other groups offered challenge and validation during group
presentations. Figure 3 shows the diagram produced by the group that worked on the capacity to do research outcome trajectory. For simplicity the diagram does not show feedback loops, of which there are several, for example outcomes resulting from increased self-confidence further building confidence, motivation and recognition.

Figure 3. A multi-cause diagram depicting the theory of change for the capacity to do research trajectory

The final part of the workshop was to plan the verification of the outcome trajectories as described in the causal diagrams and assign responsibilities. We asked participants to identify and further describe the most significant outcomes along the trajectories in terms of actual people and organisations doing things differently, to identify existing documentary evidence of these changes and key people to interview at community and hub-level for corroboration. Table 1 provides an extract of the output produced by one group.
Table 1. Identifying most significant outcomes and how to verify them for the “influencing partners” trajectory

<table>
<thead>
<tr>
<th>1. What does the most significant outcomes look like?</th>
<th>2. What evidence do we have in hand?</th>
<th>3. What are the key people to interview?</th>
<th>4. What evidence needs to be collected?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most significant outcome 1.2: Staff from partner organisations showed interest in participating in different AAS programme events</td>
<td>Staff records from: - BRAC - SHUSILON - CIMMYT - Blue Gold - CREL - IWMI - Diversity - CARE</td>
<td>- Community people (Khulna) - Field level staff (Khulna) - National level staff (Dhaka)</td>
<td>Documentation (Relevant meetings, training workshops, etc.) Publications Dissemination (Key AAS outputs)</td>
</tr>
</tbody>
</table>

We did not include ‘explicitly reflect on who is experiencing change, and who isn’t’ (Step 6) in the first workshop. We included this step later on explicitly recognising the need to critically reflect on ‘who’ was experiencing change and to be sure AAS was reaching the poor and marginalised.

We hired an external evaluator to carry out the substantiation step for the community engagement area of change. He worked with the AAS team to select significant outcomes per outcome trajectory and the villages where the outcomes were most likely to be present (Table 2). The evaluator visited the majority of the focal villages to build the case for the respective outcome in particular, and other outcomes and the overall trajectory of change in general. The final report included clear implications for the programme and recommendations for future action. Box 2 provides an excerpt from the final report of the evaluation of the ‘farmers doing research’ trajectory of change.
There is strong evidence for outcomes on this trajectory. The two case studies (Borea and Habati villages) point to numerous specific instances of farmers mastering components of the Community Life Competency Process - CLCP (an approach introduced by AAS involving visioning, self-assessment, prioritising, action planning) and applying their results to other crops and to farmers sharing their results formally and informally. The participatory monitoring and evaluation (PM&E) reports prepared in June 2014 clearly indicate that farmer researchers have mastered the basics of a scientific approach to testing seed varieties, are applying what they learn to other crops, and are sharing their results within their farmer researcher groups, with neighbors through informal networks, with support agencies via the Research Technical Support teams and more widely within their own and neighbouring communities through highly successful farmer field days. Several examples taken from the PM&E reports are provided below and similar examples can be found for all 16 villages.

The following statements, offered as examples, were made by farmer researchers in Bengali to Programme Officers, who translated them into English.

Akra: “Now it is easy to arrange different events like farmer field day, learning session, exposure visit by our leadership”.

Kazla: “Other-neighbour-farmers-(non-AAS) communicated with us (AAS farmer) about the research technology like line to line spacing, fertiliser dose, good quality seed and we (AAS farmers) assisted them in this regard. A good networking developed among all of AAS communities through knowledge fair”.

Tarali: “We have been communicated with RTS member, DAE office and other development organisation for technical purpose related to PAR’ (in this context, PAR refers to the technical issues farmer groups are researching).
Action plans in the PM&E reports for 2014 provide strong indications that farmer researchers will continue to progress along this trajectory by applying the results they obtain from their homestead trial plots to larger plots for commercial purposes and plan to scale out their research to address other topics. For example:

In Borea, the 2014 action plan calls for:
- carp fish and prawn culture in pond; linkage with Department of Fisheries and other WorldFish projects for technical support and training.

In KDC the 2014 action plan calls for more focus on fisheries:
- fisheries pond aquaculture; improved gher [dike] aquaculture: training on pond preparation, stocking and post stocking management.

**Outcome Evidencing in other hubs**
We followed a similar Outcome Evidencing process in the other four hubs, with some further adaptations according to local context and capacity. Table 3 summarises the approach used in each hub to identify and verify outcomes and outcome trajectories.

**Table 3. Outcomes identification and classification processes in hubs**

<table>
<thead>
<tr>
<th>Hub</th>
<th>Method of identifying and clustering outcomes</th>
<th>Method of verification</th>
</tr>
</thead>
</table>
| Southern Bangladesh Polder Zone | - >50 outcomes identified at community level in a workshop  
- 16 outcome descriptions identified by AAS team.  
- 4 outcome trajectories identified in Outcome Evidencing workshop | External evaluator               |
| Malaita – Solomon Islands | - 17 outcome descriptions identified through Most Significant Change at community level complemented by other outcomes identified by AAS team.  
- 5 outcome trajectories identified in Outcome Evidencing workshop | Internal evaluator               |
| Barotse – Zambia         | - 70 outcomes identified from learning reports produced by stakeholders and partner organisations.  
- 6 outcome trajectories identified in first Outcome Evidencing workshop | External evaluator               |
| Tonle Sap - Cambodia     | - 12 outcome domains identified from learning reports from focal communities and then revised and verified by AAS team  
- 3 outcome trajectories identified in Outcome Evidencing workshop | Internal and external evaluators |
| Visayas and Mindanao - Philippines | - 5 outcome domains identified and described by members of AAS team embedded in communities.  
- 80 outcomes identified in Outcome Evidencing workshop  
- 3 outcome trajectories identified in Outcome Evidencing workshop, including 14 sub-trajectories | Internal evaluator               |

All hubs carried out an Outcome Evidencing workshop to identify outcome trajectories, identify evidence and develop a plan to verify them. All hubs used a mixture of existing documentation and change-agent recall to identify outcomes. Different hubs used different approaches to
processing these outcomes prior to the Outcome Evidencing workshop. Zambia and the Philippines clustered relatively large numbers of unprocessed outcomes in the Outcome Evidencing workshop while the other hubs carried out some form of amalgamation, usually by the AAS team, before the workshop. There was also a difference in whether hubs chose to use an external evaluator or use internal resources to verify the outcome trajectories (Table 3).

The Philippines was the last hub to complete their Outcome Evidencing and were able to learn from experience from the other hubs. Their process provides an interesting contrast to that followed in Bangladesh.

The Philippines AAS team spent much more time in their respective focal communities than other hub AAS teams, making them the primary change agents. In other hubs the primary change agents were more junior staff contracted to play the role, or staff of partner organisations. This first-hand experience meant the Philippine AAS team was able to identify five more defined areas of change:

1. small-scale fisheries management in Barangay Mancilang, Madridejos, Cebu;
2. emerging community based small scale fisheries governance in Balingasag, Misamis Oriental;
3. mango production in Barangay Pinamgo, Bien Unido, Bohol;
4. rehabilitation of Abaca production - three communities in Sogod, Southern Leyte;
5. vegetable home gardening in Barangay Galas, Dipolog City.

With these areas in mind the team organised an Outcome Evidencing workshop to which they invited other respective change agents both from community and hub-levels. Twenty-eight people attended the workshop in which they identified 80 outcomes within and beyond the initial five areas of change. These were clustered according to actor groups involved which were: communities; partners and the AAS team. Two groups then worked with the clustered outcomes to build a causal diagram/theory of change for each of the first two actor groupings. This led to the identification of three main outcome trajectories:

1. AAS team is showing ability to influence/develop linkages and partnerships and work in/with communities;
2. partners are recognising that the RinD approach is markedly different from their approaches and starting to adopt aspects of it;
3. communities recognising their strengths, resources and gaining better linkage with institutions to undertake actions to improve their lives.

The causal diagrams also allowed for the identification of key outcomes for verification, existing documentary evidence and key informants to interview. Table 4 shows the key outcomes and sources of documentary evidence identified for the partner outcome trajectory.
Table 4. Outcomes and evidence identified for the partner outcome trajectory in the Philippines

<table>
<thead>
<tr>
<th>Outcomes identified through drawing a causal diagram</th>
<th>Specific outcomes selected for validation</th>
<th>Evidence that the outcomes have occurred and of AAS contribution to them</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stakeholders increasingly committed to tackling hub development challenge</td>
<td>Endorsement of the AAS Programme by the Regional Development Council (RDC)</td>
<td>RDC endorsements in Regions 7, 8, 10 Letter from the Region 10 Director of the Department of Science and Technology (DOST) to the under-secretary Minutes of RDC meetings</td>
</tr>
<tr>
<td>There is emerging buy-in to RinD approach by partners and stakeholders</td>
<td>Different partners investing in activities that are oriented to tackle the hub development challenge</td>
<td>Partners’ investments in activities to tackle the hub development challenge</td>
</tr>
<tr>
<td>Partnership and network around AAS programme are expanding</td>
<td></td>
<td>Memorandum of understanding, meeting report, and plan of work and budget of WorldFish-PCAARRD Technical Working Group</td>
</tr>
<tr>
<td>Partners using AAS outputs</td>
<td></td>
<td>Memoranda of agreement with Department of Agriculture projects for work on capacity building for AAS, climate change and Tilapia</td>
</tr>
<tr>
<td>Partners recognising the importance of participatory approaches</td>
<td></td>
<td>Memoranda of understanding with DOST Regions 8, 9 &amp; 10</td>
</tr>
<tr>
<td>Key staff of partner organisations are becoming more aware of social inclusion issues and are more conscious of engaging the poor and marginalised particularly in conducting research activities</td>
<td>Stakeholders appreciate the RinD process of identifying community needs and use outputs of this process in targeting beneficiaries</td>
<td>Focal group discussions and pre-testing of planting material with Abaca farmers in Sogod VisMin Hub Stakeholders’ Consultation Workshop (SCW) SCW for the development of an integrated plan for Abaca rehabilitation in Sogod Letter of DOST 10 RD Alfonso Alamban to DOST USec Carol Yorobe Letter of DOST 8 RD Edgardo Esperancilla to Dr Maripaz Perez of WorldFish</td>
</tr>
<tr>
<td></td>
<td>Transformation of individual commitments to institutional commitments through continuous engagement by the AAS team</td>
<td>Certificate of services rendered by local community facilitators (LCF) LCF contracts MOAs with SUCs and partners Community immersion team (CIT) reports Workshop proceedings</td>
</tr>
<tr>
<td></td>
<td>Partners developing a shared vision and acting on a common plan of action thus bringing together fragmented network that AAS facilitated</td>
<td>Proceedings: SCW for the development of an integrated plan for Abaca rehabilitation in Sogod Documentation of the training on Abaca production Knowledge, sharing and learning events</td>
</tr>
</tbody>
</table>

The final evaluation report was written by members of the AAS team. Box 3 presents an excerpt describing and verifying the first two outcomes in the partner trajectory (Table 3).
original report was extensively referenced with hyperlinks to documentary evidence held on an internal site.

Box 3. Edited excerpts from final Outcome Evidencing Report for the Philippines for the partnership outcome trajectory

**Endorsement of the AAS Programme by the Regional Development Council (RDC)**
The RDC is the highest policy-making body and serves as the regional counterpart of the National Economic and Development Authority (NEDA) chaired by the President of the Republic. RDC’s primary responsibility is to coordinate and set the direction of all economic and social development efforts in the region. It also serves as a forum where local efforts can be related and integrated with national development activities.

The AAS Programme has been endorsed by the RDCs of Region 7, 8, and 10. This was facilitated by our partners who are members of the RDC. Without our partners having sponsored the presentation of AAS in the RDCs’ sectoral committees which, in some occasions they head, our entry into the RDCs could have been difficult. The principles we shared with the Regional Offices of DOST facilitated our access into RDCs. In some instances Department of Science and Technology (DOST) Regional Directors defended the programme in full RDC sessions. The table shows the status of endorsement.

**Status of endorsement of AAS in the RDC**

<table>
<thead>
<tr>
<th>Region</th>
<th>Status</th>
<th>Resolution</th>
<th>Sponsor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Region 7</td>
<td>AAS endorsed by RDC 7 Economic Development Committee (EDC)</td>
<td>RDC Resolution 1 (s. 2014), “Endorsing to Potential Partner Agencies and Convergence Groups in Central Visayas the Consultative Group of International Agricultural Research (CGIAR)-Research Programme on Aquatic Agricultural Systems for Replication in Other Areas in the Region”</td>
<td>Regional Director of DOST 7</td>
</tr>
<tr>
<td>Region 8</td>
<td>AAS presented to full council of RDC 8</td>
<td>RDC VIII Resolution No. 21 (s. 2014), “Endorsing the Aquatic Agricultural Research Programme to the National Government Agencies and Local Government Units”</td>
<td>Regional Director of DOST 8 and Chair of the RDC 8-Social Development Committee</td>
</tr>
<tr>
<td>Region 10</td>
<td>AAS endorsed by RDC 10-EDC</td>
<td>RDC X Resolution No. 33 (s. 2014), “Endorsing the Consultative Group on International Agricultural Research Programme on Aquatic Agricultural Systems”</td>
<td>Regional Director of DOST 10</td>
</tr>
</tbody>
</table>

Regional development planning is necessary to address the uneven economic and socio development of the country, and these endorsements open the gates for AAS to engage as active participant in national development.

**Different partners investing in activities that are oriented to tackle the hub development challenge**
The hub development challenge (HDC) and a strategic framework to tackle it was agreed with stakeholders through a series of regional consultation workshops in 2012 culminating in the
stakeholders’ consultation workshop (SCW) and design workshop in 2013. The collective development of both allowed stakeholders to explore collaboration including the support of the endeavors tackling the HDC. At least $390,000 has been invested (both in cash and in kind) by at least nine partners since 2013.

The AAS team in the Philippines reflected on the results and came up with important learning and affirmation. For example, from the partnership trajectory they concluded that it is possible within a relatively short period to facilitate research and development organisations to work towards a common goal through a number of initiatives. They realised that what it takes are communities that can organise and express their development requirements and an ‘honest broker’ able to link communities’ visions and dreams and organisational mandates. They concluded that research organisations can play this role because of the neutral space that research provides for people to work together. On the other hand, the Outcome Evidencing exercise helped them realise the resources required carrying out the ‘honest broker’ role takes resources away from research and a challenge the team faces is getting the balance right.

Like any evaluation method, Outcome Evidencing runs the risk of confirmation bias. This was a particular concern given we were aware that investment being made in AAS was contingent on demonstrating the RinD approach was working. However, part of the RinD approach is that it has in place a monitoring, evaluation and learning system that allows it to learn from what is and is not working so as to adjust implementation accordingly. Outcome Evidencing was able to pick up on negative outcomes. For example, a programme outcome identified in Zambia was the reduction in the illegal use of mosquito nets for fishing. However, on further reflection in the workshop it emerged there was now an increase in the use of pesticide to poison the fish, a practice that was harder to detect. This led to the realisation that better education about the damage done by illegal fishing methods was not working without illegal fishermen having some other way of providing for their families.

The other guard against confirmation bias is building staff and key stakeholder capacity to reflect critically as a core programme value.

**Reflection on novelty of Outcome Evidencing**

As already mentioned, Outcome Evidencing is a hybrid of outcome harvesting and the modus operandi methods. Wilson-Grau and Britt (2012) describe Outcome Evidencing as an evaluation approach that starts with emerging outcomes and works back to establish if and how programme interventions have contributed by reconstructing and validating causal pathways. The steps in the outcome harvesting method are summarised in Box 4.
Box 4. Outcome harvesting in brief (Adapted from Wilson-Grau & Britt, 2012:4).

1. Design the Outcome Harvest: agree evaluation questions to guide the harvest on what information is to be collected and included in the outcome description.

2. Gather data and draft outcome descriptions: harvesters glean information about changes that have occurred and how the change agent contributed to these changes. Information about outcomes may be found in documents or collected through interviews, surveys and other sources. The harvesters write preliminary outcome descriptions.

3. Engage change agents in formulating outcome descriptions: harvesters engage directly with change agents to review and classify the draft outcome descriptions and identify and formulate new ones.

4. Substantiate: harvesters obtain the views of independent individuals knowledgeable about the outcomes and how they were achieved; this validates and enhances the credibility of the findings.

5. Analyse and interpret: harvesters organise outcome descriptions through a database in order to make sense of them, analyse and interpret the data and provide evidence-based answers to the evaluation questions.

6. Support use of findings: drawing on the evidence-based, actionable answers to the evaluation questions, harvesters propose points for discussion to harvest users, including how the users might make use of findings. The harvesters also wrap up their contribution by accompanying or facilitating the discussion among harvest users.

The main difference between Outcome Evidencing and outcome harvesting is the focus on identifying and evidencing outcome trajectories, rather than outcomes per se. This focus on patterns of outcomes borrows from the Modus Operandi approach (Scriven, 1976). Outcome Evidencing combines steps 3 and 5 of outcome harvesting – change agent description of the outcomes and their analysis and interpretation – in a workshop involving participatory identification of outcome trajectories. The substantiation step, step 4, had become verification of the theories of change developed to describe the outcome trajectories. Outcome Evidencing does not use ‘independent but knowledgeable people’ to validate outcome claims because when evaluating emerging outcomes, AAS’ experience is that the people knowledgeable about them were also likely to be involved with the programme in one way or another, and therefore not independent. Instead Outcome Evidencing uses evaluators for this step.

Outcome Evidencing’s claim to novelty is the adaptation of outcome harvesting to include elements of the Modus Operandi approach for the purpose of prospecting for and making sense of emerging outcomes, both expected and unexpected, within a project or programme lifespan. Unlike outcome harvesting it includes a specific step to look at inclusion and winners and losers.

In this paper we have attempted to give a sense of the practicalities of developing and using a complexity-aware evaluation method in the field. The stepwise method we describe at the beginning is an ideal type constructed from learning from five pilots in five hubs. Outcome Evidencing is still in its formative phase and will no doubt adapt and improve as it is used more. Whether it emerges as a new method in its own right or is seen as an adaptation of outcome harvesting remains to be seen. Either way, our hope is that it proves useful.
Conclusions

This paper describes the development of the Outcome Evidencing method to help the AAS programme meet learning and accountability requirements as it intervenes in geographic hubs, understood as complex systems. The approach identifies emerging outcomes, both expected and unexpected, happening within programme areas of change. It then seeks to understand, describe and verify these outcomes to support learning. The method is centred on a workshop that makes sense of those outcomes in terms of identifying immediate implications. The workshop also identifies outcome trajectories for subsequent substantiation. Comparing substantiated outcome trajectories with programme log frames, or equivalent, allows the programme to question its underlying causal premises. The method can be used for one-off evaluations that seek to unpack the black box answer evaluation questions relating to what aspects of programme intervention worked, for whom, to what extent and why. However, it is likely to be most useful as a central part of programme monitoring and evaluation. Repeated cycles of Outcome Evidencing build a case for programme contribution over time that can be evaluated as part of any future impact assessment of the programme or parts of it. Outcome Evidencing is an adaptation of the outcome harvesting method to include elements of the Modus Operandi Method. The main difference to Outcome Evidencing is it seeks to substantiate programme contribution within theories of change rather than programme contribution to discrete outcomes.
References


Small-scale farmers’ perspectives on what enhances capacity to innovate

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Abstract: Agricultural research and development (ARD) agencies are now more aware of the importance of enhancing the capacity of small-scale farmers to innovate and to become better able to adapt to new conditions, problems and opportunities. Challenges for these agencies include: i) monitoring and evaluating changes in capacity to innovate (C2I) at individual and community level as a result of their interventions and ii) using the monitoring and evaluation (M&E) process as a means for all stakeholders in ARD to learn about what favours and constrains local innovation. The intervening ARD actors usually develop the M&E approaches, criteria and indicators to use. In order to better understand the factors that influence C2I from the perspective of small-scale farmers, a mini-study was carried out among 12 such farmers who showcased their innovations at the West African Farmer Innovation Fair in May 2015. The study explored what they saw as the main factors that strengthened local C2I. Semi-structured interviews revealed that many factors identified by the farmers were similar to those identified by intervening agencies, but other factors were mentioned only by farmers, e.g. the role of supportive family members, neighbours and others in their social networks in the innovation processes. Although very limited in scope, this mini-study indicated that there is more to C2I than intervening ARD agencies may expect. This paper calls for attention to this essential yet neglected aspect – the perspectives of small-scale farmers – in evaluating programmes that seek to build C2I as part of their theory of change.

Key words: Agricultural innovation systems, capacity to innovate, emic perspective, farmer-led research, local innovation, monitoring and evaluation

Introduction
Agricultural research and development (ARD) agencies are now becoming increasingly aware of the importance of enhancing the capacity of small-scale farmers and their communities to innovate (e.g. FAO, 2014; Leeuwis et al., 2014; Atta-Krah et al., 2015) and thus become better able to adapt to new conditions, problems and opportunities – in other words to become more resilient. A relatively new challenge for these agencies is how to monitor and evaluate changes in this capacity as a result of their interventions. How can outcomes be measured in terms of changes in capacity to innovate at individual, family and community level? At the same time, how can one use a process of monitoring and evaluation (M&E) as a means for all stakeholders in ARD – including the farmers and farming communities – to learn about what is stimulating and favouring and what is undermining or constraining capacity to innovate?

Developing relevant M&E approaches, methods and tools starts with clearly defining what C2I entails and what the key factors and parameters are that enhance or influence this C2I, in order to identify key indicators around which the M&E could be organised. Three system-oriented research programmes of the CGIAR group of international agricultural research institutes – Humidtropics, Dryland Systems and Aquatic Agricultural Systems (AAS) – had
included enhanced capacity to innovate (C2I) as an intermediate development outcome in their respective theories of changes. Leeuwis et al. (2014) therefore attempted to define C2I from the perspective of these research programmes, drawing on the work of a range of stakeholders, including civil society organisations. They identified some core capacities at the level of individual stakeholders and further capacities at the level of facilitators of system innovation that, together, would form a system’s capacity to innovate. Derived from their definition, the core capacities that contribute to an enhanced C2I at the level of farmers and farming communities would be:

- the capacity to continuously identify and prioritise problems and opportunities in a dynamic systems environment;
- the capacity to take risks, experiment with social and technical options, and assess the trade-offs that arise from these;
- the capacity to mobilise resources and form effective support coalitions around promising options and visions for the future;
- the capacity to link with others in order to access, share and process relevant information and knowledge in support of the above; and
- the capacity to collaborate and coordinate with others during the above, and achieve effective concerted action.

Leeuwis et al. (2014) stress that the facilitators of system innovation need to have a conceptual understanding of how change comes about and how to intervene effectively in order to enhance a system’s C2I. They were looking at the capacity of a larger innovation system – involving not only farmers and farming communities but also other actors in research, extension, private sector and government administration. Based on this view of core capacities that need to be strengthened, the CGIAR system-oriented research programmes began to design how they would measure changes in C2I within an innovation system.

This entry into designing an M&E system comes from the perspective of those seeking to facilitate innovation at a fairly high level of an agricultural innovation system. The international network PROLINNOVA (www.prolinnova.net) focuses on farmers at the grassroots level who are developing their own innovations – new and better ways of farming and managing natural resources locally – not because they are ‘pushed’ by a project or by research or extension staff but rather on their own initiative, drawing on their own creativity to combine information and ideas from multiple sources, including their own ideas. In this approach to promoting innovation, the innovators are not primarily those who adopt what outsiders are instructing them to do. The C2I lies not only in the 2.5% of the farming population called “innovators” in Roger’s (1962) influential model on diffusion of innovations but rather, to differing degrees, among all farmers in the course of their “performance” (Richards 1989) in day-to-day farming. They innovate for a variety of reasons and differ from each other depending on their situation, needs and opportunities and can be divided into several categories on this basis (see Box 1 for a categorisation developed by the authors of this paper). PROLINNOVA seeks to recognise and enhance C2I in all farmers – also the very poor – and to help farmers ‘perform’ better through improved communication with each other and with outside actors and through greater self-confidence to take and keep the lead in participatory research and development.
Box. Which farmers innovate and why?

The work of the PROLINNOVA network and similar initiatives (e.g. in the ISWC, JOLISAA and PFI\(^1\) programmes) and research by anthropologists (e.g. Nielsen, 2001) have revealed a wide array of farmer innovators in different socio-economic situations and with different motivations. Some reasons for innovation that have been encountered and have also been articulated by farmers themselves are:

- Innovation out of dire necessity, motivated by extreme poverty, e.g. immigrants who have been allocated heavily eroded land and are struggling to produce something for their family to live on from this land are obliged to innovate (for examples from ISWC, see Reij & Waters-Bayer, 2001);
- Innovation out of curiosity or ‘by accident’, often done by small-scale and resource-poor farmers, including women, but not very obvious to outsiders (e.g. Abay et al., 2001). In northern Ghana, Tambo (2015) found that 35% of the farmers innovated out of curiosity;
- Innovation to deal with a specific challenge or problem, such as the woman innovator in Kabale, Uganda, who developed a low-cost solution to kill ticks and mites, derived from a leguminous tree that extensionists in the area promoted for improving soil fertility (Critchley & Lutalo, 2006);
- Innovation to improve the local economic or ecological situation, such as the numerous farmer innovators encountered by PROLINNOVA who set up backyard botanical gardens to domesticate fast-disappearing wild plant species (Abay et al., 2010), or a community in Senegal that set up a system for providing food for poorer families (Agrecol-Afrique, 2013);
- Innovation as a pastime – these are usually better-off farmers who have the time and money to try new ways of doing things and, because they can afford to take risks, can innovate in a bigger and more obvious way. For them, innovation is almost a ‘hobby’ or ‘game’. They are perhaps closest to what Rogers (1962) refers to as “innovators”.

This categorisation does not mean that individuals or groups that innovate continue doing it for the same reason as when they started. Often, farmers who initially innovated out of dire necessity and managed to improve their livelihoods then started to try out new things simply out of curiosity. Similarly, better-off farmers who can afford to innovate as a pastime, if faced with a challenge, use their innovative capacity to find ways of getting around it. If C2I among farmers has been nurtured and strengthened, exploring new possibilities becomes second nature to them.

As a network trying to recognise and promote endogenous innovation processes in agriculture and to support farmer-led processes of research and development, PROLINNOVA saw a necessity to explore the ‘insider’ perspective of farmers on C2I. How do innovative farmers, groups or communities regard themselves? What do they see as the main attributes of an outstanding local innovator? What do they see as the main factors that favour or constrain their own innovation processes? How do they assess as individuals, groups or communities whether they have become stronger in terms of C2I (in whatever way they may express this capacity themselves)? The PROLINNOVA International Secretariat therefore carried out a small pilot study to explore views of small-scale farmers recognised as outstanding innovators in order to find out what factors form and influence local capacity to innovate in their own reality.

\(^1\)ISWC: Indigenous Soil and Water Conservation (Reij & Waters-Bayer, 2001); JOLISAA: Joint Learning in Innovation Systems in African Agriculture (www.jolisaa.net); PFI: Promoting Farmer Innovation (Critchley et al., 1999).
This mini-study was supported by the CGIAR Research Programme on AAS, with co-funding from McKnight Foundation.

**Pilot study on local perspectives on capacity to innovate**

In May 2015, 50 small-scale farmer innovators from eight countries in West Africa gathered in Ouagadougou, Burkina Faso, to take part in the West African Farmer Innovation Fair. This provided a unique opportunity to start finding out what the elements and factors are that determine local C2I from the perspective of such farmers. Small multi-stakeholder teams in each country had selected these farmers as being particularly innovative. In the fair, they were able to present and share their innovations, learn from other innovators and interact with professionals in formal ARD, including policymakers, as well as the general public visiting the fair. More information on the fair can be found at www.fipao.faso-dev.net.

The pilot study was conceived and planned by members of the PROLINNOVA support team based at the International Secretariat in the Netherlands. Given the explorative nature of the study the team decided to base it on focused, semi-structured interviews so as to elicit the views of the farmer innovators on aspects related to local (small-scale farmer) innovation and C2I. The interviews were conducted by a Belgian-Senegalese researcher, a team member with longstanding experience in supporting farmer-led innovation development in Africa. In some cases, he could conduct the interviews in the local language of the farmer innovators; in other cases, he had to work through translators.

Using short descriptions prepared by the fair organisers about each of the 50 farmers selected by national committees to exhibit their innovations at the West African Farmer Innovation Fair, the study team selected 12 innovators for the interviews. It sought as diverse a group as possible in terms of the country of origin, sex and age of the innovator and type of innovation. It shared its initial selection with members of the national committees for their review. Only in the case of Ghana did the national committee propose an alternative innovator to be interviewed. The farmer innovators selected were five women and seven men, who were interviewed in the midst of the fair for 1–2 hours each.

**Table 1. Main characteristics of small-scale farmer innovators interviewed during the West African Farmer Innovation Fair (n.k. = not known)**

<table>
<thead>
<tr>
<th>No.</th>
<th>Country of origin</th>
<th>Age</th>
<th>Sex</th>
<th>Innovation presented at fair</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Benin</td>
<td>28</td>
<td>F</td>
<td>Using compost in zaï pits and on broadcast plots (production technique)</td>
</tr>
<tr>
<td>2</td>
<td>Burkina Faso</td>
<td>38</td>
<td>F</td>
<td>Biopesticide for vegetable plants (plant treatment product)</td>
</tr>
<tr>
<td>3</td>
<td>Burkina Faso</td>
<td>62</td>
<td>M</td>
<td>'Manegre’ or cellar or storage silo (technologies for preserving potato, onion and yam)</td>
</tr>
<tr>
<td>4</td>
<td>Cameroon</td>
<td>41</td>
<td>M</td>
<td>Awareness-raising and facilitation: creating a producers’ association (institutional innovation)</td>
</tr>
<tr>
<td>5</td>
<td>Ghana</td>
<td>54</td>
<td>M</td>
<td>Fish feed (production technique)</td>
</tr>
<tr>
<td>6</td>
<td>Mali</td>
<td>52</td>
<td>F</td>
<td>Biopesticide (plant treatment product)</td>
</tr>
<tr>
<td>7</td>
<td>Mali</td>
<td>38</td>
<td>M</td>
<td>Incubator made of <em>banco</em>, i.e. mud mixed with straw (poultry production technology)</td>
</tr>
<tr>
<td>8</td>
<td>Niger</td>
<td>28</td>
<td>F</td>
<td>Community radio (communication technique)</td>
</tr>
</tbody>
</table>
The study team had developed a short interview checklist in French to ensure consistency in terms of the information gathered. The checklist had five central questions, each of which was meant to generate discussions relevant for understanding farmers’ views on C2I:

1) What are the characteristics of a good farmer innovator?
2) What supports and facilitates local innovation processes?
3) What limits or constrains local innovation?
4) What would you recommend to strengthen local innovation processes?
5) What would you recommend to address constraints to local innovation?

In the first part of the interview, the farmer was invited to talk about his/her specific innovation (what it is, how it works, what it does and what results it brings) as well as about the process of developing the innovation over the years (why, what, how, when). This was followed by a deeper probing into the farmer’s view on his/her C2I (without using this term) and finding out what had helped and/or hindered him/her in the process and what he/she thought could support and facilitate the innovation process. The key question in this regard posed to the innovators was: “what does a farmer innovator need to have in order to be or become a better or more efficient innovator?”

The study team compiled all responses and further comments made by the 12 farmers pertinent to each of the main questions in the checklist and recorded these in tables per farmer and per question. It identified the main issues most frequently mentioned by farmers under each question and, from this listing in descending order of frequency of mention, drew out the views of the farmers related to C2I and their suggestions for enhancing the process of local innovation.

**Findings of the pilot study**

As this was an exploratory study to discover different elements of farmer innovators’ perceptions on C2I and involved a very small sample of only 12 farmers, it did not lend itself to quantitative analysis beyond the use of frequency tables. The responses of the farmers are clustered here according to the five central questions mentioned above:

1) **Characteristics of a good farmer innovator.** When describing good farmer innovators, the interviewed farmers referred to personality traits of innovators, their interest and skills in ‘research’, their willingness to share and their ability to communicate and collaborate with others. As indicated in Table 2 they gave importance to personal characteristics that reflected research capacities in terms of analytical skills and the systematic comparison of alternatives, if needed, through experimentation. They emphasised the importance of communication skills for farmers to be able to access new ideas from various sources.
Table 2. Analysis of farmers' views on key characteristics of effective innovators

<table>
<thead>
<tr>
<th>Key characteristics</th>
<th>Times mentioned</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Personality traits</strong></td>
<td></td>
</tr>
<tr>
<td>Pro-active, self-confident, persevering</td>
<td>12</td>
</tr>
<tr>
<td>Desire for continued development in his/her work</td>
<td>6</td>
</tr>
<tr>
<td>Dares to take risk, not afraid of critics</td>
<td>1</td>
</tr>
<tr>
<td>Follows intuition</td>
<td>1</td>
</tr>
<tr>
<td><strong>Interest and skills in “research”</strong></td>
<td></td>
</tr>
<tr>
<td>Observation; analysis of problems and options; comparing / weighing alternatives; experimentation; able to link past practice with current conditions</td>
<td>9</td>
</tr>
<tr>
<td><strong>Interest in and capacity to communicate and share</strong></td>
<td></td>
</tr>
<tr>
<td>Communicating with and convincing others</td>
<td>7</td>
</tr>
<tr>
<td>Looking for/accessing new ideas; language capacity to access information</td>
<td>5</td>
</tr>
<tr>
<td><strong>Openness and capacity for (facilitating) collaboration</strong></td>
<td></td>
</tr>
<tr>
<td>Open to others; collaborating with others to experiment; bringing people together; dialogue within family</td>
<td>4</td>
</tr>
</tbody>
</table>

2) **Factors supporting and facilitating local innovation processes.** The responses of the farmers (Table 3) revealed the particular importance they attached to the support received from people in their immediate social networks such as family members, neighbours and cooperative members. They also regarded advice, training and funding from external agencies as important elements of support. They rarely mentioned supportive policies at any level.

Table 3. Synthesis of farmers' views on key factors supporting local innovation

<table>
<thead>
<tr>
<th>Key factors</th>
<th>Times mentioned</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Individual</strong></td>
<td></td>
</tr>
<tr>
<td>Own interest, insight, open spirit</td>
<td>8</td>
</tr>
<tr>
<td>Own funds generated from innovation</td>
<td>7</td>
</tr>
<tr>
<td><strong>Family</strong></td>
<td></td>
</tr>
<tr>
<td>Assistance, encouragement from family members</td>
<td>1</td>
</tr>
<tr>
<td><strong>Community</strong></td>
<td></td>
</tr>
<tr>
<td>Integration in farmers' group; experimentation in a group</td>
<td>2</td>
</tr>
<tr>
<td>Encouragement from neighbours; villagers asking advice</td>
<td>3</td>
</tr>
<tr>
<td>Spread of innovation by cooperative or other villagers</td>
<td>2</td>
</tr>
<tr>
<td>Support, encouragement, technical advice by farmer cooperative or group members</td>
<td>2</td>
</tr>
<tr>
<td><strong>External agencies</strong></td>
<td></td>
</tr>
<tr>
<td>Training support; visit by technical staff; advice in organising and managing group</td>
<td>8</td>
</tr>
<tr>
<td>Recognition by government agency</td>
<td>1</td>
</tr>
<tr>
<td>Provision of equipment</td>
<td>4</td>
</tr>
</tbody>
</table>
3) **Factors limiting or constraining local innovation.** The farmers mentioned six main factors as constraints in developing their innovations, as summarised in Table 4, which were – in descending order of frequency of mention – i) limited access to resources (land, labour, materials etc); ii) limited access to capital; iii) negative attitude of some external actors such as formal researchers; iv) lack of knowledge and skills such as literacy; v) inability to use certain kinds of equipment; and vi) opposition from parties within the community who feel that local innovation is a threat to their interests and established ways of doing things.

Table 4. Synthesis of farmers’ views on key factors constraining local innovation

<table>
<thead>
<tr>
<th>Key factors</th>
<th>Times mentioned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resource-related constraints</td>
<td>9</td>
</tr>
<tr>
<td>Access to land; access to other materials required (availability, distance, costs)</td>
<td>5</td>
</tr>
<tr>
<td>Lack of labour</td>
<td>2</td>
</tr>
<tr>
<td>Others: protection of plots from animals (fences), rainfall</td>
<td>2</td>
</tr>
<tr>
<td>Funding</td>
<td>6</td>
</tr>
<tr>
<td>Lack of funds; short-term funding only; high bank interest rates</td>
<td>6</td>
</tr>
<tr>
<td>Role and attitude of external agencies</td>
<td>7</td>
</tr>
<tr>
<td>Lack of recognition by researchers; their attitude of superiority; danger of researchers or other experts hijacking the farmers’ innovations</td>
<td>4</td>
</tr>
<tr>
<td>Lack of research support to improve innovation; research support expensive and risky</td>
<td>2</td>
</tr>
<tr>
<td>Lack of pathways to disseminate innovations</td>
<td>1</td>
</tr>
<tr>
<td>Opposing commercial interests</td>
<td>4</td>
</tr>
<tr>
<td>Local officials whose vested interests are threatened; opposition from entrepreneurs who control the market; scarce materials controlled by entrepreneurs/middlemen</td>
<td>4</td>
</tr>
<tr>
<td>Lack of knowledge or skills</td>
<td>4</td>
</tr>
<tr>
<td>Poor mastery of equipment needed for experiments; inability because of illiteracy to monitor and evaluate innovation well; lack of training in various aspects that could improve the process of innovation</td>
<td>4</td>
</tr>
<tr>
<td>Community attitude</td>
<td>3</td>
</tr>
<tr>
<td>Sabotage by community members; reluctance; group members not following</td>
<td>3</td>
</tr>
</tbody>
</table>

4) **Recommendations to strengthen local innovation processes.** As indicated in Table 5 many of the farmers gave high priority to the wider recognition by other development actors that local innovation is relevant for development. They called for changes in project design, M&E, reporting and impact assessment that make space for ‘genuine’ participatory research. They mentioned the importance of creating opportunities for learning, sharing
and networking such as innovation fairs, exchange visits and training sessions to enhance local innovation.

Table 5. Synthesis of farmers' recommendations for strengthening local innovation

<table>
<thead>
<tr>
<th>Key recommendations</th>
<th>Times mentioned</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Promote relevance of local innovation</strong></td>
<td>10</td>
</tr>
<tr>
<td>General: Change in mentality of local authorities and leaders to accept local innovation; general promotion of local innovation; local innovation as relevant as formal research; lobby with donors for promoting local innovation; give recognition and space to farmer innovators</td>
<td>7</td>
</tr>
<tr>
<td>Specific: Encourage women to innovate; improve documentation of local innovation; involve innovators in schools and in teaching</td>
<td>3</td>
</tr>
<tr>
<td><strong>Provide funding</strong></td>
<td>1</td>
</tr>
<tr>
<td>Create funding support for innovators</td>
<td>1</td>
</tr>
<tr>
<td><strong>Change role of external agencies</strong></td>
<td>6</td>
</tr>
<tr>
<td>Research knowledge should support farmers in the field, all actors to collaborate with innovators in participatory research</td>
<td>2</td>
</tr>
<tr>
<td>Transparent project design; improved project monitoring and evaluation; correct reporting; prevent power politics interfering with development; post-project assessments built in to measure impacts</td>
<td>4</td>
</tr>
<tr>
<td><strong>Facilitate access to and sharing of knowledge</strong></td>
<td>8</td>
</tr>
<tr>
<td>Training</td>
<td>2</td>
</tr>
<tr>
<td>Farmer innovation fairs; exchange visits; space for innovators to explain their work; networking between innovators</td>
<td>6</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td>2</td>
</tr>
<tr>
<td>Reflection is needed on how to support local innovation and innovators</td>
<td>1</td>
</tr>
<tr>
<td>Promote spread and use of specific innovations</td>
<td>1</td>
</tr>
</tbody>
</table>

5) **Recommendations to address constraints to local innovation.** As can be seen in Table 6 the recommendations of the farmer innovators generally went in the same direction as under point 4 (above), but two recommendations stand out: i) removing barriers to accessing the resources (land, labour, transport etc.) needed by farmer innovators to carry out their work and ii) changing the roles of external agents to be truly collaborative and supportive of farmer innovation processes, specifically that researchers should support local innovation processes through engaging in joint research, adding value and providing training and coaching in relevant topics. In this regard farmers mentioned the need for training to bring about attitudinal change in external agents so that they can better support local innovation processes.
Table 6. Synthesis of farmers’ recommendations to address constraints to local innovation

<table>
<thead>
<tr>
<th>Key recommendations</th>
<th>Times mentioned</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Undertake initiatives to address resource-related constraints</strong></td>
<td></td>
</tr>
<tr>
<td>Use of local transport (not depend on external sources); find ways to get access to land; ensure availability of material (e.g. planting material) to continue innovation</td>
<td>6</td>
</tr>
<tr>
<td><strong>Promote relevance of local innovation</strong></td>
<td></td>
</tr>
<tr>
<td>Local awareness raising on relevance of local innovation; argue complementarity between local innovation and science-based innovation</td>
<td>3</td>
</tr>
<tr>
<td><strong>Give attention to level and form of funding</strong></td>
<td></td>
</tr>
<tr>
<td>Government payments to farmer innovators (as given to government extension staff); rewarding innovators when their innovations are widely spread; creating funding window to support local innovation</td>
<td>4</td>
</tr>
<tr>
<td>Funding support preferably in relatively small amounts but for longer periods of time</td>
<td>1</td>
</tr>
<tr>
<td><strong>Change role of external agencies</strong></td>
<td></td>
</tr>
<tr>
<td>Value addition by researchers to local innovation for easier spreading by agencies; research results better linked to farmer innovators; more participatory research</td>
<td>9</td>
</tr>
<tr>
<td>More interaction with innovators to address challenges; do not leave innovators to work in isolation; include farmer innovators in all development strategies</td>
<td>4</td>
</tr>
<tr>
<td>Training and coaching in financial management; training linked to local innovation to add value</td>
<td>2</td>
</tr>
<tr>
<td>Training for researchers and extension agents to open them up for recognising local innovation and to change their attitude</td>
<td>1</td>
</tr>
<tr>
<td><strong>Promote community action</strong></td>
<td></td>
</tr>
<tr>
<td>Promote collective action at community level</td>
<td>2</td>
</tr>
<tr>
<td><strong>Create enabling legal and policy frameworks</strong></td>
<td></td>
</tr>
<tr>
<td>Ensuring intellectual property rights for farmer innovations; legal changes to allow community radio to operate and be funded by the government</td>
<td>2</td>
</tr>
<tr>
<td><strong>Create learning/training opportunities</strong></td>
<td></td>
</tr>
<tr>
<td>Learning centres for young farmers interacting with innovators, literacy training</td>
<td>2</td>
</tr>
</tbody>
</table>

Overall, the farmer innovators referred mostly to local factors that directly influence their work and livelihood. Although they clearly defined how they thought the agricultural support system (making specific mention of extension agents and researchers) could best interact with farmer innovators, they made hardly any reference to the role of government policy. It is quite possible that relevant policies in the area of ARD indeed do not impact on their work, particularly in cases where the state is relatively weak and where formulated policies may not be implemented. In other cases, the farmers may not be aware that certain government policies are in fact partly responsible for the non-supportive behaviour of the ARD professionals they encounter.
Discussion: implications for M&E to enhance C2I

The brief study provided some insights into the individual perceptions of outstanding local innovators invited to an international farmer innovation fair. At such an event, the individual farmers are in the limelight and it is natural for them to focus on their particular technologies or niches, although they were asked to reflect on what favoured and constrained their capacity to innovate in a more general sense. Thus their personal bias should be acknowledged in framing the findings in the discussions on C2I.

However, from the experience of PROLINNOVA partners engaged in longer-term interaction with farmer innovators in their community settings, the discussions in such settings throw light on local innovation also from the perspective of the group or community and refer more to the processes (rather than only the specific technologies) involved in experimentation, innovation and wider sharing. It was more difficult in the setting of a large fair in a country that is foreign (for most of the interviewees) to probe beyond issues related to the outstanding innovations that had been their ‘entry passes’ to the fair.

Nevertheless, the study did reveal what these farmers viewed as being important in terms of favouring C2I at their level. Many of the key factors identified by the farmers that strengthened or constrained local capacity to innovate were similar to the factors that had been previously identified by field-based researchers and development actors, including those in the CGIAR system-oriented research programmes. However, the farmer innovators gave much more attention to the role of experimentation in innovation and acknowledged the role that supportive and appreciative family members, neighbours and others in local social networks played in the local innovation processes.

They also highlighted the importance of access to locally controlled resources to support their innovation processes (including locally controlled innovation funds). They pointed to aspects of their interaction with formal researchers and extension agents that indicate whether or not the local innovation system is functioning well. These aspects included: a) other ARD actors do not ignore local innovators and leave them to work in isolation; b) interaction between innovators and outsiders is in a participatory manner; c) outsiders add value to the innovators’ own work, at least by giving scientific validation to what they have developed; d) interaction between research scientists and farmer innovators becomes more frequent and continues to address new challenges; and e) interaction with staff in ARD agencies also involves training and coaching in financial management and in how farmers could derive more value from their local innovations.

The views of the interviewed farmers on what is important in terms of C2I at their level have important implications for programmes seeking to build C2I as part of their theory of change, particularly with regard to areas of interest, criteria and indicators to be taken into account when monitoring and evaluating these programmes. For example, one or more indicators in the M&E might reflect whether resources for experimentation and innovation are locally controlled, as the farmers explicitly highlighted the importance of this.

Nielsen (2001) stresses the anthropological distinction of the etic view (the view from outside) and the emic view (the perspective from inside), in this case the perspective of farmer innovators themselves. In order to have a balanced picture of how C2I has been and can be enhanced, it would be necessary to seek both the etic and emic views. Moreover, it is quite likely that local perspectives on farmer innovation and on how innovative behaviour reveals itself and has been strengthened are specific to a country or ethnic group (cf. Nielsen, 2001). For this reason, attempts to monitor and evaluate C2I always need to seek the internal
perspective at the site in question. Moreover, examining the change in capacity together with the farmers and farming communities becomes part of the process of reflecting and learning at that level about the importance of innovation for the community and how different actors at the grassroots level can better play their roles in contributing to innovation processes. This reflection process, in itself, can contribute to improving the functioning of the local innovation system.

Programmes seeking to facilitate C2I need to take the diversity among farmer innovators (see Box 1) into account, especially in monitoring C2I. The perceptions of diverse farmer innovators would need to be explored in depth in order to gain a balanced picture of what C2I is and how it can be enhanced and measured. Multiple and mixed methods would need to be applied to capture this diversity and to integrate it into an M&E system. Interviewing 12 outstanding farmer innovators at the West African Farmer Innovation Fair was an initial attempt to harvest an emic perspective. These farmers represented only a part of the diversity of innovators among small-scale farmers in West Africa. Judging by their innovations and the reasons the farmers gave for having developed them, these farmers were mainly in the third and fourth categories of innovators listed in Box 1: those who were innovating to deal with a specific challenge or problem, and those who were innovating to improve the local economic and ecological situation.

The interviews stimulated these individual farmers to reflect on what helped and hindered farmer-led innovation processes. Other methods that would stimulate wider, community-based reflection and learning could involve focus-group discussions with self-formed groups of farmer innovators in a given community, plus joint discussions by farmer innovators and other community members on this topic. It would also be possible to ask resource persons in the community to identify different types of farmer innovators in their midst and then to carry out case studies of the innovation pathways and factors that led to the enhanced C2I of these different types of innovators. All of these methods would require that the facilitators of such farmer-led M&E processes are skilled in building rapport with small-scale farmers and their communities, in stimulating discussion and probing, and in finding appropriate spaces to be able to have unhurried conversations with various stakeholders at community level, including women, elderly and youth.

Finally, it should be emphasised that the small study presented in this paper is exploratory work that needs further and deeper investigation. It is simply meant to flag the importance of including farmers’ perceptions on C2I in designing relevant M&E systems. The small sample of farmers’ perceptions does not allow for specific suggestions as to how such systems should be designed and which indicators could be used. The PROL INNOVA network plans to use this approach and the initial findings to continue to develop a system of monitoring C2I that is inclusive, regarding the perspectives of farmer innovators to be just as important as those of other ARD stakeholders. The network hopes this will contribute to understanding and strengthening C2I at grassroots level.

Acknowledgements
The authors gratefully acknowledge the 12 farmer innovators for their willingness to participate in the interviews and to share their opinions and experiences. They also thank McKnight Foundation and AAS for co-funding this study and AgriProFocus, the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), the Collaborative Crop Research Program of McKnight Foundation, Misereor and the Swiss Agency for Development and Cooperation (SDC) for generously co-funding the West African Farmer Innovation Fair.
References


Monitoring & evaluation for research for development - building a results-based management system for climate smart agriculture

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Abstract: Making farming systems more climate smart requires taking different disciplines, sectors and scales into account, at the same time as facilitating farming system innovation within the context of climate change. Here we present a research-for-development programme’s case of the evolution from a logframe approach to an outcome and results-based management oriented Monitoring, Evaluation and Learning (MEL) system. The CGIAR Research Programme on Climate Change, Agriculture and Food Security (CCAFS) is designing an impact pathway-based MEL system that combines classic indicators of research quality with innovative process and outcome indicators of developmental change. CCAFS has developed a methodology for evaluating with stakeholders factors that enable or inhibit progress towards behavioral outcomes in study sites and regions. Impact pathways represent the programme’s best understanding of how engagement can bridge the gap between research outputs and outcomes in development. Strategies for enabling change include a strong emphasis on partnerships, social learning, gender and social inclusion, capacity building, communication and a MEL that focuses on progress towards outcomes. The importance of working with next-users in the development of impact pathways is highlighted as well as consistent engagement with partners and users of research outputs throughout the life of the programme. Theory of change can be used to balance the drive to generate new knowledge in agricultural research with the priorities and urgency of the users and beneficiaries of research results. Research alone may not lead to impact, but it can generate knowledge that can be put into practice to generate development outcomes.

Keywords: Impact pathway, innovation, theory of change, research for development, climate-smart agriculture.

Introduction

While global poverty has been reduced over the past 25 years, much remains to be done to reach the targets for 2030 as articulated in the Sustainable Development Goals (UN, 2015a). With an expected extra 2-3 billion people to feed over the next 40 years, this will require targeted efforts to achieve making 70% more food available to consumers to keep up with rapidly rising demand (WWAP, 2012). Climate change is already affecting agriculture in many developing countries and the effects will become increasingly challenging in the future. Climate change impacts are increasing the vulnerabilities of populations that are already struggling with food insecurity and poverty, even in the relatively conservative scenario of a global two degree rise in temperature (Thornton et al., 2014a).

Agricultural research for development (R4D) has played a significant role in reducing food insecurity over the last decades and will continue to play a critical role in addressing the above challenges (Raitzer, 2008). But it has not realised its full potential: the world food system continues to face challenges of persistent food insecurity and rural poverty in many parts of the developing world (FAO, 2014). Many studies have shown that ‘scientifically proven’
technologies alone are not the only key to achieving an impact (Hartman & Linn, 2008; Pachico & Fujisaka, 2004).

In this paper we outline a R4D approach based on theory of change and impact pathway thinking for programme implementation, monitoring, evaluation and learning (MEL). This was undertaken by the CGIAR\(^1\) Research Programme on Climate Change, Agriculture and Food Security (CCAFS). We describe the CCAFS case, where a theory of change approach combined with impact pathways and learning were employed to build an outcome-focused results-based management (RBM) for R4D. We discuss the experience, focusing on programme design and systems for planning and reporting. The paper concludes with lessons for required institutional change and for MEL practitioners, researchers and policy makers.

**Background and Approach**

CGIAR science is carried out by 15 research centres with 10,000 scientists working in 96 countries and a host of partners in national and regional research institutes, civil society organisations, academia, development organisations and the private sector (CGIAR, 2015). Its work contributes to the global effort to tackle poverty, environmental degradation, hunger and major nutritional imbalances (Raitzer & Kelley, 2008).

The challenges of demonstrating wide-reaching impact through R4D are compounded by a rapidly growing human population, climate change and other complexities of our time. To address this challenge CGIAR has broadened its portfolio of new initiatives for strategic research as part of a far-reaching reform process. A key part of the reorientation of the R4D portfolio was the move from an output to an outcome focus. Success is now measured in terms of research’s contribution to behavioral changes, manifested in changes in knowledge, attitudes, skills and practices of a wide set of non-research next users, including development practitioners, farmers and policy makers. In 2014 CCAFS was one of four programmes tasked with developing a comprehensive results-based management approach for R4D. Accordingly CCAFS developed an approach to implementing RBM focusing on outcome delivery (Figure 1). The theory of change defines several activities, such as developing the impact pathways for thematic research and regional work, trialing RBM with a subset of projects, training key partners in building impact pathway, and analytical systems support. These led to tangible outputs such as facilitation guidelines (CCAFS, 2015a), a RBM MEL strategy (CCAFS, 2015b), and an online platform. This involved engagement with key next-users such as programme partners, with the intention that these outputs would be both useable and an incentive to overcome existing barriers in the system and as such would facilitate changes in current practices via proactively changing organisational norms. For example, project leaders were trained in designing their projects from a demand driven and outcome focused perspective. They needed to ensure that the research outputs would be enabling and incentives to support the practice changes that are required to achieve positive impact through their projects.

CCAFS started life using a logframe approach (LFA), but it became increasingly clear that the programme’s vision of contributing towards development outcomes increasingly required an approach that acknowledged the importance of stakeholder engagement and capacity development. While a wide range of MEL approaches and methodologies with an outcome

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\(^1\) CGIAR is a global partnership that unites organisations engaged in research for a food secure future.
focus exist, none provides a blue-print solution. To adapt these approaches to a new programme, the right mix of elements needs to be selected, creating a conceptual framework in support of the programme’s specific theory of change and MEL requirements. Springer-Heinze et al. (2003) advocate a holistic approach to impact evaluation and programme monitoring with quantitative and qualitative elements, based on an impact pathway that can accommodate different stakeholder views, allows for reflection and emphasises institutional capacity. Mixed methods provide opportunities to address the respective shortcomings of any single method as applied in practice.

Figure 1. CCAFS’ Theory of Change for its RBM approach and components

Findings and Analysis

Moving beyond the logframe approach
A logframe approach (LFA) has been widely used for project management; it adheres to a relatively rigid framework. It tends to prescribe a hierarchy of objectives converging on a single goal, a set of measurable and time-bound indicators of achievement, checkable sources of information, and assumptions of other impinging factors (Gaspar, 2000). In R4D the assumption is that development agencies, communication units, ministry staff and other people who could use the findings are able to source the scientific evidence, understand it, know how to implement and apply it, and convey this to people who they think need them. While this has been a useful approach, it is debatable whether it is entirely suitable for ensuring the use of research results and their translation into outcomes (Crawford & Bryce, 2003). The LFA does not pay enough attention to involving key stakeholders and their networks to achieve impact, provide managers with information to learn and report to donors, and establish a research framework to examine the change processes that projects seek to initiate (Douthwaite et al., 2008).

In line with donor requirements, CCAFS initiated its programmatic management approach on the basis of a logframe in 2009. Annual milestones were defined that were largely focused on producing scientific outputs and evidence of their achievement, which would then lead to
developmental impact. CCAFS has gone through several iterations of the logframe that was employed for planning and reporting (CCAFS, 2015c). In 2010 a limited version was used (CCAFS, 2010) while more elements were added in the following years. Planning and reporting elements were predetermined to some extent by requirements from CGIAR, though for internal purposes additional elements were added in response to the limitations that were identified from year to year.

**Trialing results-based management with theories of change in CCAFS**

In 2013, CCAFS’s portfolio expanded to include project work in two new target regions and opportunities arose to implement and test a theory of change approach (Jost & Sebastian, 2014; Jost et al., 2014a). A new portfolio of six multiannual regional projects was set up and these were tasked with designing their approaches using a theory of change approach within a results-based management trial (Schuetz et al., 2014a).

There is no single definition of a theory of change, and no set methodology, as the approach assumes flexibility according to its respective user needs (Vogel, 2012). A theory of change provides a detailed narrative description of an impact pathway (a logical causal chain from input to impact, see Figure 2) and how changes are anticipated to happen, based on assumptions by people who participated in describing these trajectories. As such they provide an ex-ante impact assessment of a programme’s anticipated success. Theory of change is at its best when it combines logical thinking and critical reflection; it is both process and product (Vogel, 2012).

RBM builds on the same logical causal chain as the LFA but is more explicit about output-use. Within R4D output-use refers to strategies that directly engage the next-users in the research process, e.g. through stakeholder platforms and user-oriented communication products. At the turn of the century, many development agencies and donors, including USAID, IDRC, UNDP and the World Bank, reformed their performance management systems and M&E approaches, to a RBM approach (Binnendijk, 2000; Bester, 2012; Mayne 2007a and 2007b). These experiences with RBM have informed further development of the approach.

**Figure 2. Theory of change logical causal chain**

It is a particular challenge to show that R4D contributes to the desired behavioral changes (i.e. outcomes), that enable long-term positive impacts, as it requires qualitative monitoring rather than dealing with quantitative means of measuring alone (Young & Mendizabal, 2009; Springer-Heinze et al., 2003). Evaluators generally agree that it is good practice to first formalise a project’s theory of change, and then monitor and evaluate the project against this ‘logic model’ (e.g. Chen, 2005). The theory of change is a mental model made explicit by
involving as many people as possible in its design. Key principles of the Participatory Impact Pathways Analysis method also include reflecting on these models, regularly validating the assumptions that were made and adjusting programme management accordingly (Douthwaite et al., 2013).

Within the CCAFS RBM, this theory of change approach to project planning helped position the R4D agenda further along the impact pathway (Schuetz et al., 2014a). Projects expanded their skill sets by bringing on board other partners that would help implement output-to-outcome strategies and thus create more clearly defined causal logical chains (Figure 2; Schuetz et al., 2014b and 2014c). This is not to take over the work of development agencies, but it is to ensure that research findings are adequately contextualised to be a good fit for the demand and given purpose. The CCAFS RBM projects have thus challenged the common thinking that good science and publications are enough and by themselves will lead to impact - rather, they are necessary but not sufficient.

**Building capacity and learning within the programme for a theory of change approach**

The RBM trial project teams were thrown in at the deep end. Used to a more traditional LFA, they were tasked with shifting to a theory of change and learning-based approach for planning their projects within the trial. It was quickly apparent that capacity to plan projects using this new approach had to be built within CCAFS and its partners.

Using theory of change approaches within R4D requires building the capacity of scientists to do research differently and work with non-research partners for impact, but also of institutions to facilitate such a shift. Several authors highlight the importance of building capacity for institutional learning (Hall et al., 2003; Horton & Mackay, 2003; Eade, 1997; Springer-Heinze et al., 2003). Johnson et al. (2003) show that participation of non-research stakeholders early on in the research process is important, as it can inform institutional learning in research organisations to change priorities and practices. It can also enhance the relevance of agricultural technologies and the capacity of these stakeholders to design their own action research processes (Johnson et al., 2003). Horton and Mackay (2003) outline the links between M&E, learning and institutional change and highlight the importance of institutional learning as a means of developing the capacities of the organisation and of individual researchers, and empowering non-research partners as key stakeholders in the process.

CCAFS worked with expert facilitators and trainers from Participatory Impact Pathways Analysis to implement a one week training course on using theory of change for project and programme planning (Alvarez et al., 2014). Initially about 20 participants were chosen strategically so that capacity would be available in CGIAR Centers at the point in time when CGIAR proposals would need to be developed following theory of change principles. In addition to project representatives, CCAFS science officers representing all themes and regions participated to build in-house capacity. The training, in combination with theory of change facilitation guides (version 1: Jost et al., 2014b; version 2: Schuetz et al., 2014d) and learning notes (CCAFS, 2015a), helped highlight the opportunities (and constraints) of rolling out RBM to a whole R4D programme. An online community of practice (and wikispace) was established and allowed for continued documentation and exchange of experiences.
CCAFS’ Results-based management trial - insights from researchers and partners

CCAFS’ approach to RBM is centred on adaptive management, regular communications between programme and projects and facilitated learning within projects. Besides periodic virtual meetings, trial participants were surveyed for a more in-depth and standardised reflection and for capturing lessons and achievements from their experience (Schuetz et al., 2014b and 2014c). These lessons and the programmatic perspective by the CCAFS Management Committee were documented in reports (Thornton et al., 2014b, CCAFS annual progress report) and a series of learning notes (CCAFS, 2015a). The approach to developing the impact pathways was simplified over time, mostly by reducing the number and type and number of indicators and level of complexity so that the wider group of people who were expected to work with them would continue to buy-in to the approach (Schuetz et al., 2014d). For example we focused on indicators at the outcome level and dropped any further development of detailed output progress indicators.

There are many people within CGIAR Centres and CCAFS partners who are willing to take on the challenge of developing new ways of collaborating and working beyond delivering outputs towards outcomes (Schuetz et al., 2014b). After one year of the trial, projects had made considerable progress. Project leaders and teams, for example, became more reflective in their project planning and reporting, identifying opportunities to adapt to new insights and questioning users, use and usefulness of research outputs to facilitate and encourage development outcomes. Another area where we saw some progress was the improvement of narrative qualitative descriptions of progress towards, and achievements of, outcomes. However, making fundamental shifts in the way of working takes time and (initially at least) additional resources. It requires iterative and continuous processes. Staffing, or the profile of project team members and project team composition are emerging as key factors for success. Project staff have acknowledged that they may require additional skills beyond disciplinary expertise, such as skills in coordination, facilitation, engagement, communications, participatory and learning-oriented M&E. We are exploring how additional support can be provided in areas such as engaging with stakeholders and using RBM.

Rolling out results-based management for CCAFS as a whole

Opportunities for changing the programmatic approach to project planning, implementation and MEL emerged when CCAFS was approaching the end of its first phase in 2014. Theories of change were developed and defined for all four research and five regional programmes in CCAFS as a first step in putting together the new programme portfolio (Schuetz et al., 2014e). Figure 3 provides an illustration of one research theme’s theory of change component with its regional elements, indicators and outcome targets.
While it took a considerable amount of effort, the iterative development of the CCAFS theory of change was done with a view to attempting to be as efficient as possible. At the start most interactions were virtually facilitated and built on previous engagement and regional priorities. For completion, key next-users and stakeholders participated in five regional face-to-face meetings (Schuetz et al., 2014e and 2014f).

The theory of change development and facilitation process and the guidance documentation were revised to make them leaner, more contextualised and easier to implement (Schuetz et al. 2014d). The theory of change building process is one key component in the CCAFS MEL system that was developed to support the new approach in a comprehensive manner (CCAFS, 2015b).

Building on the above, a CCAFS Monitoring, Learning & Evaluation Strategy was developed (Schuetz et al. 2014g), with the overall goal of developing an “evaluative culture” within CCAFS that encourages self-reflection and self-examination, seeks evidence, takes time to learn and encourages experimentation and change so that MEL becomes an integrated mechanism. The strategy includes a conceptual framework, guided by overall programme principles for partnership, engagement and communications in a modular way, to best meet the demands of the programme as a whole, its projects and the wider CGIAR system (Thornton et al., 2014c). For project implementation this led to some built-in and on-going monitoring and documentation of project activities on the outputs use, i.e. on engagement, partnerships and communication. Some elements are prescribed by CGIAR governance bodies, including the carrying out of baselines, independent impact assessments and periodic external evaluations. Programmatic flexibility exists within the day-to-day operational MEL, as a system is required that allows enough flexibility and adaptability to be applied to the different types of projects and programmes.
Implications for policy, practice and research

Working with theories of change and impact pathways has major implications for MEL (Schuetz et al., 2015). It implies a move to contribution rather than attribution, i.e. to show our contribution we acknowledge the role and inputs of partners and other actors both in achieving outcomes and in providing evidence for those outcomes i.e. lots of factors caused the change, rather than trying to claim a change due to our intervention alone (AIDLEAP, 2015, CCAFS glossary). Building in triple-loop learning2 helps enable people to distil key lessons from reflection (hindsight) and make best use of those lessons (insights) for future planning (foresight) and can make a major contribution to reflection and to supporting adaptive management, so that project teams can better deal with uncertainty. At the same time, not everything can be measured; this highlights the need for narratives that can complement and support more quantitative information.

As part of creating a programme-enabling environment, CCAFS embraced the three-thirds principle, whereby one third of effort is spent on engaging with partners to decide what needs to be done and how; one third on doing the actual research, often in partnership; and one third on sharing results in appropriate formats and strengthening capacity of next users to utilise the research to achieve outcomes and impact. This implies different budgeting and funding structures, so that appropriate levels of resources are allocated to capacity building, communications and engagement with the wide range of different partners likely to be needed (CCAFS, 2014). These elements need to be budgeted for explicitly within a project life-cycle, rather than as an after-thought. At the same time, there is still much work to be done on how to monitor outcomes effectively, evaluate the real share of contribution towards the observed change and assess value for money. Similarly, delivery of outcomes, especially at scale, may take time for research-for-development programmes. Longer funding cycles could be expected to facilitate this considerably.

The CCAFS experience has highlighted several operational principles for RBM implementation. First, there is a need to focus on people and users, on utilising M&E as a tool to help achieve outcomes and on accountability - it is the people within organisations that make behavioural and practice changes happen. Second, there should be an emphasis on learning through M&E activities, i.e. an M&E system for R4D needs to integrate both monitoring and impact evaluation real time. Robust knowledge needs to be generated that can feed into developmental policy and investment decision making and this in turn requires a cumulative and catholic approach to choice of impact assessment methods at different levels (Maredia, 2009). Third, adaptive management needs to be encouraged as a key element of RBM. As a tool that is based on learning processes it can improve long-run management outcomes. The challenge in using it is to find the balance between gaining knowledge to improve management in the future and achieving the best short-term outcome based on current knowledge. Fourth, planning, reporting and evaluation procedures need to be as simple as possible while still providing (most of) the information needed for effective and timely programme management. In this the development and implementation of an online platform was an investment to support and guide programme participants in their contribution to the

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2 Triple loop learning is a series of learning steps, from receipt of information (single loop), to reflecting on what activities will be more effective (double loop), through to behaviour change as a result of that reflection by multiple stakeholders (triple loop) (Carlile et al., 2013).
programme’s results-based management system and developed their capacity at the same time.

Sharing findings along the way is a good way to foster the inclusive involvement of as wide a range of stakeholders as possible in project planning and implementation. Encouraging researchers to get early drafts of findings out to potential users for feedback from early on is one way to build a learning culture and to encourage open-mindedness. Lessons have come from surveys (e.g. with the trial project teams) and via collective reflections and evaluations (e.g. from the workshop series with participants and the programme management team).

Rigid application of just one specific approach will most likely not work. Whether it is the adoption of a technology, an M&E methodology, a learning approach or a scientific result, it is often not the whole package that is attractive to users but specific pieces. We need to allow users to cherry pick while ensuring that the relevant linkages remain intact so that the context is not lost for others who may want other cherries.

Solutions that are good enough rather than optimal. In many domains of knowledge and practice there is no best practice or option, particularly when the problem is complex and resources are constrained. CCAFS made considerable changes once it had started to implement an approach based on theory of change and impact pathways and in time moved towards a leaner and simpler model. One of the key messages from the RBM trial process was the need for systems that cover most users’ needs, rather than aiming for completeness that could add unwanted complexity.

Addressing tensions across scale. CCAFS is still in the process of embedding theories of change for the different organisational units of the programme, to provide a flexible framework that allows for aggregation of output, outcomes and targets across the different units. For example, targets need to be framed locally with users and beneficiaries and voiced in such a way as to allow the flexibility to deal with uncertainty and emerging priorities and opportunities. New investments of time and effort may be needed to identify and work with non-traditional partners to promote behavioural change in shared IPs.

Providing value for money. Many members of the donor community now require that grantees demonstrate value for money. For instance, the Deutsche Gesellschaft für Zusammenarbeit states that its “work is systematically geared towards results, the yardstick by which we measure the success of our work. We want to help achieve tangible positive changes on the ground” (GIZ, 2015). Some have critiqued the whole notion of payment by results as applied to development and research-for-development on the basis that it provides perverse incentives that actually diminish cost-effectiveness (see Chambers, 2014). As noted above, there is much work still to do on appropriate measurement mechanisms, but this does not diminish the need to demonstrate accountability.

Balancing science and outcomes. Research is often curiosity-driven, and traditional indicators of success centre on peer-reviewed publications in high-profile academic journals. In today’s highly competitive research environment another crucial success factor relates to fundraising: the ability to write and win competitive research proposals. Neither of these motivations for research is guaranteed to deliver development outcomes. For CGIAR and its research programmes it is still early days, but preliminary results suggest that ‘successful
RBM’ relates to effective and efficient research leading to outcomes, with a minimum of perverse incentives (Thornton et al., 2015). The building of an impact pathway with a narrative theory of change forces researchers to give some thought to what lies between solid science, great technologies and their positive developmental impact. A mix of an outcome-focused theory of change with people and partners at the core and a RBM approach that allows us to monitor, reflect, evaluate and learn, are key elements for a programmatic MEL strategy - coupled with great science.

**Conclusions**

Requests by donors for a move towards outcome-oriented research programmes are having considerable impact on the way in which research is conceived, planned, implemented and evaluated. A key requirement for such work is flexibility - the flexibility to adjust so that the outcome orientation works as a support mechanism and enabler rather than a one-size-fits-all straitjacket without space for innovation, serendipity and creativity. Results-based management offers this kind of flexibility. The shift to a R4D approach based on theory of change is fostering massive change, much of it for the better in our view. However, it also comes with considerable challenges. Defining the necessary changes and developing new processes and mechanisms, including monitoring and more built-in evaluation in real time, requires effort and resources, which are often grossly underestimated and inadequately planned for. Some of these challenges arise because of the nature of research: the results are not known from the start, unlike in engineering where the outcomes are generally much less uncertain. Another challenge is that CGIAR is a R4D and not a development organisation, and it is still striving to balance the need to do great science with the need for impact. We need to avoid the results-based focus being to the disadvantage of the science and development being seen as being in competition with the science. Rather, they need to be seen as complementary, enabling and liberating.
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Adaptive management intentions with a reality of evaluation: getting science back into policy

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Abstract: Adaptive management was initially proposed to address system uncertainty in natural resource management. In theory, adaptive management integrates scientific experimentation in policy planning and implementation to discover and gather knowledge from across a system′s stakeholders. It systematically tests hypotheses with the results redirecting or improving policy, applying a paradigm of scientific problem solving.

This paper uses a case of water management in Australia′s Murray-Darling Basin. Water reform has been contentious as government attempts to reconcile historical over allocation of water to irrigation with the use of water to protect and restore wetlands of international biodiversity significance. In areas scientific knowledge of the system is either imperfect, incomplete or system responses are unpredictable. In this case there are legislative requirements for both adaptive management and evaluation. Evaluation looks to achievement of policy objectives, as determined through monitoring of system response and value judgements, in a structured framework of action, outputs, outcomes and objectives.

The intentions for adaptive management are compared to the reality, as determined through legislation, public speeches, government reports and semi-structured interviews with government policy makers and implementers. The findings demonstrate contradiction between intent and reality, with adaptive management subsumed by evaluation. The loss of adaptive management as a distinct concept is seen as a loss of science and discovery from the policy process. Despite intentions for adaptive management, the dominance of evaluation is discussed as limiting innovation, a ′muddling through′ process of improvement and meeting political and accountability needs.

Key words: Adaptive management, evaluation, science, uncertainty, politics, conflict, accountability

Introduction
Adaptive management is now widely accepted as a necessity in the management of natural resources, such as water, soil and biodiversity (Allan, 2009; Dovers, 2009; Pahl-Wostl, 2009; Pahl-Wostl et al., 2013). In theory, adaptive management integrates scientific experimentation in policy planning and implementation in order to develop new knowledge and gather knowledge from across a system′s stakeholders (Walters & Holling, 1990). It uses a systematic process of hypothesis testing with the resulting scientific discoveries redirecting or improving policy, applying a paradigm of scientific problem solving. However empirical examples of adaptive management are scarce in practice (Eberhard et al., 2009), and the very meaning of adaptive management remains debated (Allen et al., 2011; Scarlett, 2013).
In the 1990’s, with the lack of evidence of adaptive management, Lee suggested that adaptive management needed to be included in legislation to ensure it actually occurred (Lee, 1993) and these calls for prescription in legislation have continued since (Dovers, 2009). The argument is that adaptive management as a legal requirement will provide the additional impetus for organisations to overcome implementation challenges. In addition, a legislated definition of adaptive management could be expected to provide clarity and direction to what has become a confused and misunderstood enigma. The reasons for adaptive management being theoretically championed whilst being rare in practice are discussed in this article.

In 2012 adaptive management became a defined term in Australian water legislation in the Murray-Darling Basin Plan (Basin Plan), providing a fit case to examine the differences in intention and reality of adaptive management. This article uses the case of the Basin Plan to test the argument that prescription in legislation is required to overcome the challenges to adaptive management.

First, a brief literature review of adaptive management is provided, followed by a description of the method used and an introduction to the case. The intentions for adaptive management in the Basin Plan, as provided by legislation and policy documentation, are compared to the reality as determined through semi-structured interviews with government policy makers and implementers and published government reports. In analysis and discussion of the results it is demonstrated that the true barrier to adaptive management is not the absence of legal mandate, but confusion of adaptive management with evaluation, with this further marginalising science from policy development and implementation.

**Literature review**

*Adaptive management*

Adaptive management emerged from the field of ecology in the late 1970s. Over time its meaning has been debated, with adaptive management referred to as ‘experimental management’ (Walters, 1997), ‘learning by doing’ (for example, see Schreiber et al., 2004) and ‘structured decision making’ (Allen & Gunderson, 2011; Gunderson & Light, 2006). Forms or types of adaptive management distinguish between active adaptive management, with multiple hypothesis testing, statistically sound experimentation and technical modelling, and passive adaptive management that looks to observation and response in single treatments. The label of passive adaptive management was first used by Walters & Holling (1990) but does not imply a lack of effort or resourcing requirements. It is planned, participatory and requires monitoring and analysis to test a single best hypothesis with a single treatment. Over time the role of partnerships to bring together socially-held knowledge has been increasingly emphasised, further highlighting the misnomer of the label ‘passive’.

Active and passive adaptive management both emphasise systematic and planned hypothesis testing, involve stakeholders working across knowledge disciplines and remain strongly motivated by the need to increase knowledge of system function and address uncertainty (Hasselman, forthcoming). However, there are three broadly recognised types of uncertainty (Berkes, 2007; Brugnach et al., 2008). This includes uncertainty that results from imperfect knowledge (undiscovered science), incomplete knowledge (knowledge that cannot be held by an individual but is collectively held across stakeholders) and unpredictability (unforeseeable futures with unknown society and ecosystem responses). In addition to these three types of
uncertainty, Pagan and Crase (2005) also note unforeseen changes to community preferences and government objectives over time.

Active adaptive management seeks to reduce imperfect knowledge with experimentation to discover new knowledge and determine the optimal solution (Walters & Holling, 1990), viewing knowledge as absolute and uncertainty as something to remove. In comparison passive adaptive management seeks responsiveness to unpredictability. Management is seen as experimentation with socially-held knowledge, applying an approach that accepts unpredictability (Berkes 2007; Brugnach et al., 2008; Huitema et al., 2009).

The context to which adaptive management is applied is important; influencing which form of adaptive management is most suitable. These differences mean that adaptive management is hardly a single thing or panacea, but a pluralist concept and practice. The evolving history of adaptive management with its varying emphasis on experimental management, learning by doing and structured decision making, along with the varied contexts to which policy makers and implementers have sought to apply adaptive management has contributed to confusion about the meaning of adaptive management (Allen et al., 2011; Loftin, 2014). Following an extensive review, Hasselman (forthcoming) has proposed a definition of adaptive management that acknowledges the different types of underlying uncertainty that may be motivating adaptive management. This definition accepts the need for pluralism and context specific application and can be applied to the different forms of adaptive management.

Adaptive management is a systematic process for improving policy and its implementation. It seeks to address at least one type of uncertainty with varying emphasis on experimentation to discover new knowledge; deliberative processes to engage multiple perspectives in decision making; and monitoring of outcomes and changes with responsive adjustment of decisions and implementation.

In this definition adaptive management remains a scientifically based activity to increase collectively held knowledge and experience, in order to make better management decisions. The essence of adaptive management remains applied science with the learnings used to gain ecological outcomes. The ability to change decisions based on new information is just as critical to adaptive management as the ability to gain new knowledge or gather knowledge.

Evaluation

In natural resource management there are other approaches to learning, such as evaluation that play a significant role in policy implementation and development. Evaluation has been described as an appraisal or systematic assessment of merit and/or worth (Guba & Lincoln, 2001). It is considered applied social research that is both transdisciplinary and an autonomous discipline (Scriven, 2013). The purpose of evaluation has been variably identified as performance improvement, organisational learning, accountability, learning about persistent social problems and how to address them, informing decision making and to democratise decision making (Alkin, 2013; Greene, 2013).

Evaluation involves evidence collection, often referred to as monitoring, and a process of applying judgement to an evaluand; or the subject of the evaluation. Evaluations can be formative to improve a programme with feedback gained on processes and factors that may affect achievement of objectives, done during a programme or policy implementation. In comparison summative evaluations seek to determine a programme’s merit and worth, taken as the extent to which objectives have been achieved and the contextual factors that have
affected the results; often done after completion of a programme or policy (Patton, 2013). Regardless of the timing, both formative and summative evaluations look to achievement of stated policy or programme objectives.

Scriven (2013) argues that a widely held misunderstanding is “that the difference between evaluation and research is that research is aimed at the acquisition of new knowledge whereas evaluation is aimed at developing information for decision making.” Scriven instead draws a distinction between evaluative research and non-evaluative research, focusing on the distinction of value judgements used in evaluation.

**Evaluation in Australia**

In Australia, evaluation has been shaped strongly by public administration reforms in the 1980s, including the 1988 Evaluation Strategy (Rogers & Davidson, 2013). Australian evaluations have been described as concentrated on ongoing management of programmes, commonly using theory driven approaches such as programme theory or programme logic, with emphasis on stakeholder participation (Rogers & Davidson, 2013). Programme theory and programme logic approaches to evaluation work within frameworks of causal pathways that articulate how programme and project activities lead to achievement of desired outcomes, with these in turn leading to achievement of objectives (Funnell, 2000). Assumptions underpinning the causal relationships may be stated, with monitoring and evaluation seeking to test these assumptions. In the testing of assumptions, causal pathways are confirmed, achievement or contribution to achievement of outcomes is deduced and eventually objectives are proven as being met.

Inclusive participation in the evaluation process from planning through to final judgement is seen as having a role in validity and credibility, not just to promote use and implementation of findings. The result is a close integration between evaluation and management with an expectation for programme evaluation as driven by performance improvement and accountability, with results often structured as outputs and outcomes, as evidenced by indicators.

The performance improvement and accountability view of evaluation is most notable in the Australian Government’s Caring for our Country Programme, as commenced in 2007. This nationwide, large scale investment introduced mandatory requirements for monitoring, evaluation, reporting and improvement (MERI) and has significantly influenced government natural resource management since. MERI has become an accepted part of the evaluation lingo. MERI is defined as “simple concepts that, when applied, help us understand what is being achieved and help identify possible improvements, for projects and programmes” and evaluation specifically as “analysing the monitoring data and assessing what it means. Based on this, informed judgements can be made about the success of a project or programme and improvements can be identified” (‘Monitoring, Evaluation, Reporting and Improvement Strategy’, 2014). This has further established evaluation as performance management and accountability, as structured by generally linear programme logics of input-output-outcome level indicators. Evaluation is readily accepted as a part of good governance, serving a managerial mandate and providing accountability for the use of public resources.
Method

Case study – The Murray-Darling Basin
In 2012 adaptive management became a defined term in Australian legislation with the passing of the Murray-Darling Basin Plan (Basin Plan). At over 1 million square kilometres, or 14% of Australia’s land mass, the Murray-Darling Basin is Australia’s largest water catchment and river system (Figure 1). It supplies drinking water to over three million people, contains wetlands of national and international importance, including 16 Ramsar sites and a World Heritage site. The Murray-Darling Basin also contains 40% of Australia’s farms and produces over a third of Australia’s food, valued between $10 billion and $15 billion. Water reform has been contentious as government attempts to reconcile historical over allocation of water to irrigation with the use of water to protect and restore wetlands of international biodiversity significance. The following overview of governance arrangements of the Murray-Darling Basin is brief and limited to key points necessary for this paper. Others have elsewhere published more detailed accounts of the governance history, ecological and social challenges and conflict (Connell, 2007).
Currently water governance and management is done by six jurisdictions, being each of the four States and the Territory that the Murray-Darling Basin spans and the Commonwealth. The Basin Plan determines the maximum volume of water that can be sustainably extracted for urban, industrial and agricultural use (Sustainable Diversion Limits), provides the latest reform on water trading rules and sets a framework for the planning and use of environmental water. The Basin Plan is said to be based on the ‘best available science’, with this also recognising that there remain unknowns in the system. In parts of the Murray-Darling Basin, scientific knowledge of the system is either imperfect, incomplete or system responses are unpredictable. In particular, the ecological, social and economic responses to the Basin Plan are uncertain and remain points of contention and debate. To some the very idea of setting sustainable diversion limits for the Basin as a whole and assigning contributing volumes to parts of the Basin in this context of uncertainty is “folly” (Crase, 2012).

The State and Territory governments administer water licences that provide irrigators with a share of the water resource (also called entitlement), with the actual volume determined (share allocation) based on seasonal conditions. Water use and trade is governed through rules established in 36 regional scale Water Resource Plans, as developed by the State governments. These Water Resource Plans must align with the Sustainable Diversion Limits set by the Basin Plan and require accreditation by the Commonwealth. State and Commonwealth governments also hold water licences, as purchased from the market. This water is held by government in order to supply water to environmental assets such as wetlands and is referred to as environmental water. The use and trade of environmental water is governed by the States’ Water Resource Plans and State and Commonwealth level Annual Environmental Watering Plan and Long-term Environmental Watering Plans.

**Method**

The research was qualitative, using document analysis and interviews. Document analysis included legislation, planning documents, published reports, policy statements and published speeches. Documentation provided insight into government intentions for adaptive management, outlining commitments, processes and projects underway.

Interviews were conducted with Commonwealth and NSW policy makers and implementers to understand the reality of adaptive management, under the framework set by the Basin Plan and associated governance arrangements. The interviewees included past government employees involved in the development of the Basin Plan and those currently involved in its implementation. Regional stakeholders with roles within the governance arrangements for developing and implementing the Basin Plan and associated State planning instruments were also interviewed. In total, 30 interviews were conducted, with this sample covering different aspects of water reform within the Murray-Darling Basin. Saturation point, when no new themes were emerging, was reached. The interviews were semi-structured and explored views and experiences of adaptive management in water management. The interviews included questions on the definitions of adaptive management, example cases of adaptive management in practice and challenges to adaptive management. The interviews were transcribed before being thematically coded using Nvivo software. The research takes a constructivist view and applies an inductive logic, with examples used to infer broader principles, meaning the research is descriptive.
Results

**Intentions for adaptive management**

The intentions for adaptive management have been determined from government documents, including the Basin Plan, reports published by the Murray-Darling Basin Authority and public speeches by the Chair of the Murray-Darling Basin Authority.

With the passing of the Basin Plan, “adaptive management” became a defined term in legislation for the first time in Australia. In the Basin Plan, “adaptive management” is taken to include the following steps:

(a) setting clear objectives;
(b) linking knowledge (including local knowledge), management, evaluation and feedback over a period of time;
(c) identifying and testing uncertainties;
(d) using management as a tool to learn about the relevant system and change its management;
(e) improving knowledge;
(f) having regard to the social, economic and technical aspects of management.” (Section 1.07 Basin Plan 2012, Cth)

With respect to the differences between active and passive adaptive management, the Basin Plan definition is taken here as predominantly passive, due to the statement of ‘management as a learning tool’, the use of evaluation as feedback in a context of set objectives, identified uncertainties and acknowledged social, economic and technical ‘aspects’. The definition makes no reference to modelling or experimentation; it states ‘objectives’ rather than hypotheses and ‘evaluation’ rather than science or research and emphasises local knowledge. While it can be argued that in doing several of the steps a) to f) experimentation and other active adaptive management processes can be used, it is not required by the definition. While there is some ambiguity, the definition points towards passive forms of adaptive management. In looking at how the term is applied to confirm this interpretation as passive, adaptive management as a defined term is used nine times throughout the Basin Plan. It is found in:

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1 Other legislation, such as the NSW Water Management Act 2000 ambiguously refers to the “principles of adaptive management” (Section 5 Water Management Act 2000 No 92 Chapter 2 Water management planning Part 1 General Division 1 Water management principles), “objectives of adaptive management” (NSW Water Sharing Plans made under the Water Management Act 2000) or “an adaptive management framework” (Murray-Darling Basin Amendment Act 2002 – Schedule 1 http://www.austlii.edu.au/cgi-bin/sinodisp/au/legis/qld/bill_en/waolab2010362/waolab2010362.html?stem=0&synonyms=0&query=%22adaptive%20management%22)
• objectives for the Basin Plan\(^2\);
• purpose of Chapter 8 - Environmental Watering Plan\(^3\);
• objectives of environmental management framework\(^4\) with a note that “the application of adaptive management will enable various triggers to be responded to” (Section 8.11 Basin Plan 2012 Cth);
• principles of environmental watering, stating that “adaptive management should be applied in the planning, prioritisation and use of environmental water” (Section 8.40 Basin Plan 2012 Cth); and
• Chapter 13 – Programme for monitoring and evaluating the effectiveness of the Basin Plan with monitoring and evaluation to include adaptive management processes\(^5\);
• principles of monitoring and evaluating the effectiveness of the Basin Plan as “monitoring and evaluation findings, including in respect of progress towards meeting targets and trends in the condition and availability of the Basin water resources, should enable decision-makers to use adaptive management” (Section 13.04 Basin Plan 2012 Cth); and
• key evaluation question “to what extent has the programme for monitoring and evaluating the effectiveness of the Basin Plan contributed to adaptive management and improving the available scientific knowledge of the Murray-Darling Basin?” (Section 13.06 Basin Plan Cth)

Across these references, adaptive management is intended to contribute to decision making, evaluation is to contribute to adaptive management and adaptive management will be evaluated. Adaptive management is about responding to triggers and applying a management process, confirming the passive interpretation. The relationship between science and adaptive management is not apparent, instead, monitoring and evaluation of the Basin Plan is seen to contribute both to adaptive management and to improving scientific knowledge.

The Murray-Darling Basin Authority describes the Basin Plan as an adaptive plan that “is dynamic, and will be refined and updated with the knowledge gained from ongoing monitoring and evaluation framework” (A Guide to the Murray-Darling Basin Plan, 2016). In a speech to the United Nations, the Chair of the MDBA described the Basin plan and its implementation as “based on adaptive management” because “it’s meant to be a flexible plan because in nature, things change. As we discover better ways to do things, we need to respond. Equally, we need to be ready to adjust to things like seasonal and climate changes.” In this speech the Chair also stated “but, it’s not just a ‘science experiment’…the plan recognises the need to make judgements and decisions based on social and economic impacts” and “not everything happens in one day…communities need time to adjust to change and, for scientifically valid reasons, introducing a plan over time allows us to monitor, evaluate and adjust based on the

\(^2\) “to establish a sustainable and long term adaptive management framework for the Basin water resources” (Section 5.02 Basin Plan Cth)
\(^3\) “enabling adaptive management to be applied to the planning, prioritisation and use of environmental water” (Section 8.02 Basin Plan 2012 Cth)
\(^4\) to “enable adaptive management to be applied to the planning, prioritisation and use of environmental water” (Section 8.11 Basin Plan 2012 Cth)
\(^5\) “processes for reviewing and evaluating the Basin Plan, conducting audits, and assessing the condition of the Murray-Darling Basin, contributing to adaptive management” (Section 13.01 Basin Plan 2012 Cth)
new knowledge and evidence that confronts us as we move into the future.” (MDBA Chair Speech to UN, 2016). This managerial and passive interpretation is repeated in other public speeches and corporate documents, such as annual reports and provides insight into the organisation’s internal view of adaptive management. The organisation and leadership has provided a strong rhetoric of adaptive management as necessary and intended.

Despite adaptive management as a defined term in legislation and strong public leadership level support for adaptive management the Basin Plan itself can be viewed as limiting adaptive management. For example, the legislated process for adjusting the Sustainable Diversion Limits is widely viewed by policy makers and implementers as a great example of adaptive management provisions. The Basin Plan acknowledges that the figures used to determine the Sustainable Diversion Limits were based on river management infrastructure expected to be in place and “the level of scientific understanding of the Basin hydrology and ecology at that time.” As a result of these limitations, Chapter 7 of the Basin Plan outlines how the Sustainable Diversion Limits can be adjusted, with the process regarded as enabling adaptive management. However, for surface water the Basin Plan only permits adjustment on the basis of improved efficiency and supply of water. There are no provisions for new information on river systems, ecology or unpredicted negative impacts (social, economic or environmental). In addition, any experiential learning gained by river operators and Basin Plan implementers is not recognised as cause for change. The final limitation on adaptive management of the Sustainable Diversion Limits is that the net adjustment, Basin wide cannot be greater than 5%.6

Lastly, and possibly most significantly, the coupling of adaptive management and evaluation in the Basin Plan can be viewed as limiting to adaptive management. Chapter 13 describes adaptive management as making a change as a result of an evaluation, effectively limiting adaptive management to occurring at a set time of the five and ten year reviews or through a political process as raised by a State Minister. Changing the Basin Plan requires an amendment to the legislation, or as one interviewee bluntly stated “the bloody Act of course has to go through Parliament so it’s not a trivial manner to change the Basin Plan.”

**Reality of adaptive management**

In interviews with policy makers and implementers of the Basin Plan, adaptive management was widely espoused as necessary and important. The reasons included demonstrating the success of the plan, improving implementation and to provide accountability. Statements of importance and support included “It’s really important, it’s expensive to collect, but it would be just irresponsible not to do it” and “You obviously have to do it, and you have to do it as well as you possibly can. It’s part of the accountability”.

However, in interviewing those involved in developing and implementing the Basin Plan for their definitions, the interviews confirmed its lack of meaning in reality. Adaptive management was described as “more of a buzz word and an ideal rather than reality” and “It’s a bit of an overused term, and I don’t think we do it particularly well. I guess it’s so overused I’m a bit over it to be honest.” One interviewee even stated “the difficulty is though it’s very, very, very hard to define. Nearly everybody you talk to, and you will probably find this, has got a different

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6 See Basin Plan, Section 7.19 “Note: this section allows a supply contribution or an efficiency contribution of more than 5% of total surface water SDL to each be given full effect in an adjustment, provided that the net effect across the Basin is within the 5% limit”
idea of what it is." The definitions provided by interviewees commonly referred to learning by doing, checking progress to objectives, monitoring, review and management. One interviewee used the word hypothesis, but in a passive adaptive management way stating “adaptive management is about coming up with probably a hypothesis, and then putting things in place to review that and adapt accordingly from the management outcomes.” In this, there was no discussion on putting experiments in place to test any hypotheses. Some interviewees acknowledged the difficulties of implementing large scale, replicated experiments in a varied landscape noting "when you start talking about social-ecological systems, it becomes much more difficult, and you can’t avoid your approach to adaptive management being more passive." Evaluation language featured strongly, with some specifically noting efficiency and effectiveness with a typical definition provided by the interviewees being “continuing to review, monitor, evaluate and rethink about how things should go and then adapt according to how you monitor things.”

Adaptive management, despite its definition and prescription in legislation remains an enigma in reality. In both intent and reality there is a dominance of passive forms of adaptive management, a loss of experimentation to gain scientific knowledge and a dominance of monitoring and evaluation language. The prevailing understanding of adaptive management by those implementing the Basin Plan is that adaptive management is part of or follows from an evaluation. Adaptive management is about achieving the policy’s objectives, not changing or testing objectives; “adaptive management works on the basis of seeking to achieve the outcomes that were originally set, and having a robust and transparent process in place to make adjustments along the way, if needed, to achieve those outcomes.”

**Examples of adaptive management and implementation challenges**

To further understand adaptive management, the interviewees were asked for good examples of adaptive management. Several interviewees responded that they could not think of a good example of adaptive management and the same example was mentioned by a number of interviewees, confirming a shortage of adaptive management in practice. For those that could identify actual examples of adaptive management, in contrast to the prevailing passive view of adaptive management, the examples also included active adaptive management. These examples mentioned experimentation at a site scale, for example to understand fish spawning. The presence of active examples is incongruent with the passive definitions. Others gave examples of passive adaptive management with adjustment of policy instrument or methods used to achieve a set objective, for example adjustments through efficiency projects or a scenario planning approach looking at what happened last year and current conditions to make decisions for the coming year. Passive adaptive management experiments that involved applying single treatments at a time to test a single hypothesis, such as weir pool height manipulations, were also noted.

In seeking explanation for the limited availability of good examples of adaptive management, the challenges to adaptive management were questioned. The challenges identified by interviewees largely confirmed the literature. The ‘usual suspects’ of cost, unclear responsibilities, lack of information, organisational culture, time, data complexity, landscape differences and scale of implementation were identified (Carter & Ross, 2013). For example, landscape differences and scale were seen to limit replication and transferability, with statements such as “There are rivers where we are relaxing constraints, but we’re not setting up an experiment. Could you compare, say, the Lachlan to the Gwydir? I just don’t know if you
could do it effectively” and “The bigger the area, the more the people, the less active it can be and the more you move into a passive.”

In describing challenges, evaluation featured strongly in responses. For example, cost was identified on the basis that “in a tight fiscal environment, the monitoring and evaluation programmes are the ones that tend to get dropped off, unfortunately.” Similarly, challenges associated with data complexity and quality of information was described as “Having good data and information that’s feeding into that. You’ve got to have a good monitoring programme on the ground. You’ve got to be able to have an effective way of evaluating the outcomes from that.” In these cases evaluation is seen as adaptive management, in line with the noted merging of the concepts.

In addition to the usual suspects, or easy scape goats, conflict and politics were raised as challenges to adaptive management. These challenges surfaced as public support for decisions and cross jurisdiction politics and accountabilities. For example, public support for decisions were seen as changing over time, creating a time limit or lifespan on legitimacy; “even if you can accurately reflect community values and take them broadly into SDLs and you put it in, even if you could get that right, the following day you would be wrong, because community values are always changing.” and “if you think some of the information maybe comes from the scientists then you’ve got to translate that information into a way that can win the public and bring the public along. We shouldn’t underestimate the role of that, I don’t think, in adaptive management in the long term being successful because ultimately you don’t do anything unless you get the social licence to do it.”

When the Basin Plan was in development, it was argued that centralised governance of water resources would prevent local management and flexible responses (Crase et al., 2011). Interviews with those working to implement environmental watering have confirmed that this is now a reality. To overcome the time lags and other difficulties with gaining departmental and ministerial approval for environmental watering, the Annual Watering Plans are drafted as options papers, outlining a number of possible environmental scenarios ranging from dry to wet. This enables some flexibility to be retained by environmental water managers.

The interviewees also commented on how conflict over water use restricts adaptive management, particularly when a very specific detail, such as a volume for Sustainable Diversion Limits is negotiated and then legislated. For example, “I think it’s also at odds with our political process and also what the community expect when they want finite outcomes to be clearly defined and delivered.” In this context, adaptive management becomes limited and any change to policy is a point of conflict; “anytime those policies, particularly the ones that are legislated, that they need to be changed there’s always going to be conflict. In the sense that you may wish to change policy because of learnings that have occurred over the past 3 or 4 or 5 years or a decade, then yeah I reckon conflict is inevitable and it will make it a bit more difficult to get it through” and “There are too many people, too many vested interests who don’t want to change things and they always take longer, hugely longer than you expect.”

Conflict and politics were also identified as impacting on cross jurisdiction politics and accountabilities. Recent government changes to responsibility for conducting external review and audit of Basin Plan implementation were described as reducing the imperative for the States to respond and change, “There needs to be a reporting process that both the States and the Commonwealth are committed to. The National Water Commission was a product of a COAG decision, the Productivity Commission isn’t. The State’s don’t necessarily have buy-in to the Productivity Commission. … there’s nothing to oblige the States to actually make
changes as a consequence of the Productivity Commission’s reporting.” Here, a weakening of political will to change, through a loss of accountability, is seen as curtailing adaptive management.

Discussion
The definition of adaptive management provided by the Basin Plan connects adaptive management to evaluation. The prevalence of adaptive management as passive, initially in the legislated definition and most certainly in interpretation and implementation of adaptive management, lends the concept to redefining as evaluation. This connection or redefining was echoed by the interviews. It could be regarded that linking to evaluation is a broadening of adaptive management, in line with that implied by the more recent references to adaptive management as structured decision making.

Adaptive management and evaluation in the Basin Plan
Adaptive management, perceived as evaluation in a performance improvement cycle, has some compatibility with the Basin Plan’s definition. In both passive adaptive management and evaluation the results of the policy are monitored and results used to inform a management response. In the Basin Plan, adaptive management is the change that occurs following an evaluation of progress towards the policy objectives. This is problematic on two fronts, firstly the loss of knowledge discovery and secondly value judgements.

Adaptive management, as a decision that follows an evaluation, reinforces the passive approach of monitor and respond as the reaction to monitoring data. The policy or programme itself becomes the single hypothesis that is being tested, limiting adaptive management to resolving unpredictability. The adaptive management ideals of scientific discovery to address uncertainties of incomplete and imperfect knowledge remain incongruent with evaluation. The role of knowledge discovery in adaptive management and evaluation differs significantly. Evaluation is not regarded as generating new scientific knowledge on ecosystems or natural resources. Instead evaluation seeks to confirm or refute the results of policy or programme, with respect to the effectiveness, efficiency or appropriateness of its intended objectives. In evaluation, science may be used to confirm an assumption underlying a causal link from action to outcome or outcome to objective, whereas in adaptive management knowledge on system functioning is explicitly sought.

The role of value judgements differs significantly between adaptive management and evaluation. Adaptive management, taken as a process for improving policy and implementation through increasing knowledge of system behaviour, does not involve passing judgement or assessing merit. In stark contrast (and as noted by Scriven as a key distinction between research and evaluation), value judgements are central to evaluation that assesses the merit or worth of a policy or programme. Particularly within the Australian culture of natural resource evaluation, evaluation focuses performance assessment and is managerial. In the dominant approach of programme logic or programme theory, the only role for new discovery is in the testing and confirmation of assumptions with monitoring used to confirm and gauge expected policy results. One interviewee noted this difference in evaluation and the scientific discovery of adaptive management, stating “Data can kind of provide some of the script for the thinking about those choices, but the choices are so inherently a value choice. To suggest that its adaptive management gives it a scientism which I think isn’t there.” Adaptive management, interpreted as following from evaluation, dramatically changes the role of science in the policy making process.
Implications to the role of science in policy

Both adaptive management and evaluation seek to learn, with the ultimate purpose being to gain improved policy outcomes. Adaptive management takes a view of scientific hypothesis testing to discover new knowledge while evaluation focuses on the experience gained in policy implementation to identify recommendations. In evaluation, and it could be argued also in passive forms of adaptive management, monitoring seeks to confirm existing beliefs of system operation. Monitoring does not aim to explore alternatives. Instead, it is structured to a confirmation and validation bias. The misinterpretation or reinterpretation of adaptive management to evaluation, redirects adaptive management to a performance management concept, as a managerial tool. It also means a weakening of scientific inquiry, with incremental improvement of policy towards its objectives. The reinterpretation of adaptive management to evaluation may merely be reflective of the most recent adaptive management pseudonym of ‘strategic decision making’. However, in effect, the result is a marginalisation of science from the policy making process.

Whether or not this marginalisation is intentional, accidental or through ignorance remains somewhat debatable. It could be argued that the logistical challenges associated with adaptive management have steered adaptive management towards evaluation. It could also be argued that the conflict and political challenges have made evaluation a much more attractive prospect. The risk associated with science providing proof of poor or incorrect decision making by government may be too great. A few interviewees specifically spoke about the role of science, stating “we’ve got to get the science out of it” and explaining the passive approach to adaptive management in the Basin Plan as “the talk here about experiment and science, it wasn’t unacceptable.” To these interviewees politics and science were not compatible and as a result only certain forms or applications of adaptive management were palatable.

A fuller approach to adaptive management that systematically seeks to address more than just unpredictability through monitoring of outcomes is needed, or policy development will be limited to incrementalism and first loop learning. The scientific testing associated with adaptive management, that seeks to experiment to discover new knowledge and deliberative processes to engage multiple perspectives in decision making, pushes towards questioning objectives and values. In the absence of science, exploration and innovation of alternative solutions is limited.

Recommendations

A refinement to both adaptive management and evaluation practices is required to reinforce their respective contributions to policy planning and implementation. This solution recognises that scientific problem solving and performance improvement are both essential to governance of natural resources. For this adaptive management must remain as a distinct concept to evaluation, as both can generate significant knowledge and learning, with the findings ultimately used to improve policy. The common step of changing policy or making decisions based on findings is not an adequate reason to merge these concepts. That management may change, or in other words adapt, on the basis of findings, merely draws attention to the poor and ambiguous naming of the concept of adaptive management.
To overcome this, a clear statement of uncertainties at the outset of policy design is required, as originally intended in the Basin Plan’s definition of adaptive management. The most appropriate form of investigation can then be used to address each uncertainty. Imperfect knowledge is most likely to require some form of experimentation, incomplete knowledge to require some form of social inquiry and learning, while an unpredictable response to policy may be best addressed through evaluation to test if expected causal impacts occurred, and indeed contributed to, achievement of objectives.

However, the politics remain most challenging to the practice of adaptive management and inclusion of science in policy. The political risks associated with ‘being wrong’, particularly in a high conflict context such as water, are significant. There remains a strong political need to remain accountable to highly negotiated and specific outcomes, such as a volume of Sustainable Diversion Limit, making change unlikely. In addition, the bipartisan support for the Basin Plan, passing through parliament with 95 for and only 5 opposing (along with the review and amendment processes required to adjust the legislation), makes any significant change unlikely. In this political environment the science involved in adaptive management represents risk. To overcome this significant challenge to adaptive management requires a change in governance structures and practices, particularly to maintain accountability alongside adaptive management.

Conclusion

Adaptive management and evaluation are two distinct concepts and practices. Despite the differences there has been a coupling or merging of the two, both in intent and reality. The dominance of evaluation and its paradigm of performance improvement designed to test the achievement of set objectives, acts to confirm policy choices and contributes to decision accretion and ‘muddling through’. It fails to test alternative hypotheses and overlooks questioning the underlying values that contributed to initial decision making. Over time it leads to a narrowing of choices with incremental muddling through.

There are a number of logistical challenges that may have contributed to the merging of adaptive management and evaluation, but the underlying causes are conflict and politics. In the conflict context of the case study, adaptive management poses a political risk, with science having the potential to question the wisdom of past decisions. Prescription of adaptive management in legislation may provide adequate impetus for organisations to overcome the logistical challenges to adaptive management, but fails to address the underlying conflict and politics of the policy in focus. An evaluation focus on validating objectives remains preferable, confirming policy choices and providing accountability. As a result science is being marginalised from policy, with significant implications to discovery and innovation.
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Developing a monitoring, evaluation and learning system for the Food Systems Innovation initiative: an experience of ‘three steps forward, two-steps back’

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Abstract: Most monitoring and evaluation approaches and tools available to practitioners and organisations have been designed either to monitor tangible outputs and evaluate performance, or to capture unquantifiable processes and dynamics of change. While numerous are excellent, they are limited in their capacity to meet the multiple accountability, learning, and adaptive management needs and rhythms of complex initiatives aimed at fostering system-level innovation. In this paper we share our experience developing and trialling, over a three and a half year period, a monitoring, evaluation and learning (MEL) system for the Food Systems Innovation (FSI) initiative in Australia. A partnership between three Australian government departments, FSI was highly ambitious and complex. Its main goal was to improve the impact of ODA-supported agriculture and food security programs in the Indo-Pacific region by fostering innovation via partnership-building; the exchange of knowledge and experiences; cross-sectoral, systems thinking; hands-on-experimentation with novel approaches; and an embedded MEL system. The challenge the FSI team encountered was not difficulty in finding ‘best practices’ in MEL. Rather, it was identifying a suite of approaches and tools, whilst also attending to other dimensions of the MEL system, that were a ‘best fit’ with the complex nature of the agriculture and food security issues FSI was trying to tackle, and with the complexity of FSI itself. In this paper, we discuss the challenges, failures, and promising leads encountered while designing and implementing a flexible and multi-purpose MEL system that tried to balance, on the one hand, a rigorous theoretical foundation drawing on complex systems and innovation thinking with, on the other hand, the production of non-cumbersome and easy to implement and communicate MEL tools.

Keywords: Monitoring, evaluation, learning, MEL system, complexity, innovation, fit-for-purpose

Introduction

Over the past decade, the aid and development sectors have come under increasing pressure to acknowledge and address the failures of dominant models of aid investments and interventions predicated on linear understandings of change, technological solutions, and accountability applied in a world that is complex, highly dynamic and unpredictable (Boulton et al., 2015; Burns & Worsley, 2015; Ramalingam, 2013). This largely intellectual debate has begun to influence the way we think about and design aid practices, most notable in recent efforts in monitoring and evaluation (M&E) to develop approaches and tools that are ‘complex-aware’ (Douthwaite et al. 2003; Guijt, 2011, 2010a, 2007; Patton, 2011; Ramalingam et al., 2014; USAID, 2013) and aimed at catalysing learning and innovation (Hall et al., 2003; Kusters et al., 2015; USAID, 2016).
While this shift in M&E to move beyond simply measuring efficiency and effectiveness is significant, there are numerous challenges. The first revolves around the identification of ‘best practice’ monitoring and evaluation frameworks and tools that are well-matched for helping donors, practitioners, and partners navigate complexity and for catalysing collective learning and building system-level innovation. The fact that there exist so many M&E approaches and tools in many ways makes this task harder. Discerning among the vast ‘toolkits’ and ‘guides’ which ones are the right fit, or have the potential to be adapted to be suitable, is a slow process. The majority of M&E frameworks and methods are designed to either monitor and assess tangible outputs and evaluate performance for primarily planning and accountability purposes (mainly through quantitative methods and linear, or stepwise, perspectives of change) or to capture less tangible (i.e. less quantifiable) processes and dynamics of change (primarily qualitative or narrative-based approaches) (for succinct overviews and constructive critics of M&E see Guijt, 2008, 2010a; Hughes et al., 2013). Moreover, most M&E frameworks and tools are designed to be implemented at the level of discrete units or scales, most commonly at a project or organisational level, or for a specific sector; less so across different components, dimensions, and scales of a system (Lynam, 2012; Odame et al., 2012). Also, whilst there is a rapidly expanding body of tools and processes focused on learning (e.g. social learning approaches, appreciative inquiry) many of these are being developed and practised in other arenas (e.g. facilitation, knowledge management and brokering, adaptive co-management) although, in recent years, there has been a push to more explicitly link M&E and learning (Guijt, 2010a, 2007; Oswald & Taylor, 2010; Woodhill, 2007). However, many learning-focused methods remain time- and data-intensive, expensive, highly context-dependent, and their value-add a challenge to communicate and embed within M&E systems.

While progress is being made in identifying a set of best practice ‘complexity and innovation aware’ M&E and Learning (MEL) tools, this is not sufficient. For MEL approaches and tools to be effective in navigating complexity and enabling innovation they need to be, by design, flexible and adaptable (Ramalingam, 2011). As such there are no fixed ‘best practices’ but rather a set of ‘best-known practices’ (or promising practices) that need to be continuously assessed, probed, and revised to ensure relevance and effectiveness. Thus, the second challenge, which remains underexplored, is the systematic collation of lessons learned that emerge from the application of these MEL tools in complex systems and innovation systems - i.e., which approaches and methods are effective (or not) in catalysing greater capacity to navigate unknowns and uncertainties, to foster collective and cross-scale learning and to lead to fundamental changes and system-level innovation? Capturing patterns of how and why certain MEL approaches work, while others do not, across different contexts and points in time in policy/programme/project cycles is fundamental to enhancing understanding and practices of MEL as vehicles for building and measuring system capacity to learn and innovate.

Last but not least, for MEL to be effective in enhancing system capacity to innovate it needs to extend beyond simply discrete approaches and tools and, rather, embrace a wider assemblage of interlinked components or elements, i.e. the whole-of-MEL-system. While the term ‘M&E systems’ is widely used, it is not uncommon that the predominant focus remains on tools - for planning M&E, identifying indicators, collecting information, and so on. Over the past decade, more attention is being paid to other elements seen as critical for M&E to function effectively, including the need for sufficient human capacity and diversity of skillsets; partnerships for planning, coordinating and managing M&E; organisational structures for embedding and sustaining M&E; and dimensions associated with communication, advocacy.
and culture (see, for example, UNAIDS, 2009). Scholars and practitioners engaging explicitly with innovation systems thinking have also highlighted the need to move beyond approaches and tools that focus on individual organisations, or the relations between two organisations, to ‘systemic instruments’ that operate at and support system-level functions and change (see van Mierlo et al., 2010b). In practice, working across all of these dimensions of an MEL system is incredibly challenging.

We bring the points raised above to the fore by sharing, in the remainder of this paper, our experience in designing and implementing a MEL system for the Food Systems Innovation (FSI) initiative, a project which aimed to improve the impact of Australian-supported aid investments in agriculture and food systems. Our greatest challenge was trying to transform M&E from being a ‘tick-the-box’ exercise to a set of M&E and Learning tools and processes that could effectively support our team and partners not only to plan short- to medium-term activities and demonstrate accountability, but also to engage in co-learning, be responsive to emergent issues and opportunities, and ultimately help bring about significant and lasting changes. We largely failed but learned a lot along the way.

**Background**

**FSI’s story**

The Food Systems Innovation (FSI) initiative was a three and a half year research for development (R4D) project with the aim of enhancing the impact of Australian-supported international aid investments in agriculture and food (FSI, 2016a). It was founded on a partnership between three Australian government agencies/organisations: AusAID/Department of Foreign Affairs and Trade (DFAT), the Australian Centre for International Agricultural Research (ACIAR), and the Commonwealth Scientific and Industrial Research Organisation (CSIRO). DFAT funded FSI; ACIAR was a partnering organisation; and CSIRO was the project lead responsible for co-designing (with DFAT and ACIAR), managing and implementing the initiative.

FSI was launched in 2012 as a 1-year ‘inception project’ and was initially called FSIFS (Food Security through Food Systems Innovation). FSIFS emerged from an existing partnership between CSIRO and AusAID (which, in 2013, was integrated into DFAT). It had a focus on improving the design and implementation of food security R4D interventions. This Inception Phase ended in mid-2013 and Phase 2 was launched, with FSIFS being renamed FSI. In this second phase of the initiative, greater emphasis was placed on innovation and, accordingly, FSI aimed to contribute to an enabling environment to support continuous innovation within the Australian agriculture and food aid programme.

FSI in its second year had three components: ‘analysis and field application’ (primarily R4D activities); ‘knowledge management and communications’; and ‘capacity building’. A mid-term external review and a change in leadership at the end of the second year resulted in a reorganisation of FSI into three ‘focal areas’. The first was ‘Markets and Partnerships’ which centred on market-driven approaches to agricultural development that are inclusive and leverage private sector investment for maximum impact. The second, ‘Agricultural Linkages’, focused on strengthening the linkages between agriculture and other development priorities such as nutrition-sensitive agriculture. And the third focal area was ‘Managing for Impact’ with an aim of supporting agriculture projects to have sound Theories of Change, good management and robust monitoring and evaluation. These three focal areas broadly guided
the direction and objectives of the initiative’s key activities and products which were: learning events (which ranged from training courses to reflection workshops), knowledge products (conventional research-based reports to learning-oriented ‘Practice Notes’ and blogs), expertise and practice networking activities (among Australian and international experts and development practitioners), in-country engagement (primarily in Southeast Asia but also in Africa), and outreach and external visibility activities (from ‘Brown-Bag’ seminars and conference presentations to the FSI website) (see FSI, 2016a for more details).

Across the three focal areas, activities and products were designed and implemented with the objective of creating conditions for supporting innovation. Thus a key focus was on maximising collaborations and alliances; enabling the exchange of knowledge and experiences, analysis, reflection and learning; and fostering cross-sectoral, systems thinking. In addition, within the FSI project team emphasis was placed on working with uncertainty and emergent opportunities, and brokering of ideas, knowledge, networks and differences in perspectives, including regarding how to best achieve FSI’s goals. Engaging in ‘boundary work’ was seen as critical, i.e. building and managing the interfaces among FSI partners to effectively mobilise knowledge and networks into actions. Accordingly, FSI team members took on multiple roles, including those of boundary workers/brokers/spanners, managers, communicators and researchers. The FSI project team also endeavoured to embed (where possible) its activities and products within the broader Australian and international agriculture development environment.

With CSIRO responsible for the operationalisation and implementation of the initiative, the FSI project team (leader and implementation staff) was comprised predominantly of CSIRO staff, the majority of whom were scientists. Key partners - DFAT and ACIAR - contributed to FSI through their role as members of the FSI Steering Committee and Management Committee, and through engagement with and active involvement in focal area activities and contributions to MEL. Over the course of the three and a half years, the number and composition of people involved changed (particularly between the Inception Phase and Phase 2). Nonetheless, there remained a core of approximately 10 individuals, from across the different organisations, engaged in the last two and a half years of FSI. In line with FSI’s aim to build an enabling environment for innovation, there was a progressive effort to bring in external experts (i.e. not affiliated with CSIRO, DFAT, or ACIAR) to fill in gaps in expertise, knowledge and networks seen as critical for fostering innovation within the Australian agriculture and food aid programme.

The Monitoring, Evaluation and Learning (MEL) team and system
M&E was not explicitly discussed during the Inception Phase. Rather, in the first year of the initiative there was a strong focus on inter-organisational learning and capacity-building. Three team members, all of whom were CSIRO staff, were tasked to develop and implement a series of ‘learning activities’ (e.g. workshops, training courses, and presentations) with the aim of fostering the exchange of knowledge and skillsets among DFAT, ACIAR and CSIRO.

M&E was formally introduced in the second year of the initiative. DFAT and ACIAR feedback on the Inception Phase and a change in leadership led to the decision to bring in a formal MEL system. The view was that it would serve as a mechanism to more explicitly track progress as well as support the learning agenda that had been initiated during the Inception Phase. This resulted in the creation of a MEL team, headed by one of the CSIRO staff previously involved
in the ‘learning activities’ in the Inception Phase. While formally incorporated into FSI and loosely linked to the ‘Managing for Impact’ focal area, the MEL team and activities remained throughout FSI slightly in the margins as the majority of the FSI team and budget was allotted towards the above-mentioned three focal areas. The MEL ‘team’ consisted of one individual exclusively allocated to the M&E and learning activities, with other FSI team members and a DFAT staff member contributing to MEL strategic discussions and/or information gathering and reflection processes. While these individuals did not have any of their time formally allocated to MEL, most actively and frequently engaged with MEL. Nonetheless, their official roles necessitated them focusing on delivering to the initiative’s focal areas (FSI team members) or other priorities (in the case of the DFAT collaborator). This meant that the MEL ‘team’ was essentially comprised of one individual, a scientist with limited experience in the practice of M&E and learning.

The primary task of the MEL team was to design and implement a MEL system that could effectively support FSI progress its purpose and goals. This system, as envisioned by the MEL team, comprised a conceptual framework that delineated the assumed pathways to system-level innovation and, thus, key areas of focus for MEL (e.g. a programme logic or Theory of Change; indicators or domains of change); approaches and tools, along with guidelines and plans, for information gathering, processing, and reporting, and for collective sense-making, learning, and feedback into FSI management; key people (i.e., team members with roles in planning, coordination, and management of the MEL system; ‘producers’ and ‘users’ of information and participants/catalysers of learning processes); aligned structures (i.e., project and organisational structures in which to embed/link MEL); and supportive social dynamics and culture (i.e., relationship building processes and conducive environment for M&E, reflection, learning, experimentation and change). Another critical element was a budget for MEL which in the case of FSI was within the range of what the partners typically invest in M&E (i.e. less than 10% of the overall project budget).

What this MEL system needed to serve and how it was going achieve that - in terms of specificities regarding the various bits and parts comprising the system - for such a complex and ambitious initiative was not immediately apparent. It took almost two years, and a number of trials and errors, for the MEL team to come to realise that the MEL system for FSI had to be multi-layered and flexible enough to: support the initiative’s agree-upon short, medium and long term objectives, whilst also help nurture innovative ways of thinking and practice; meet the different needs and emergent information, learning and governance requirements and rhythms of partner organisations, and those of the initiative’s management and implementing teams; and be responsive to the continuous changes in the broader Australian ODA context (and hence to changes in FSI’s enabling environment and impact pathways). Designing and implementing a MEL system that could effectively support these different objectives, uses and decision-making expectations and needs proved to be a significant challenge. In the remainder of the paper, we share what we did, what worked and did not work, and why. We focus primarily on our MEL approaches and tools, as we found that the majority of our efforts and time was consumed by those elements of the MEL system.
Our journey from ‘best practice’ to ‘fit-for-purpose’ MEL system

A start with ‘best-practices’

In the first two years (Inception Phase and Phase 2; July 2012 – May 2014), the FSI team drew on ‘best practice’ approaches and tools in the field. Given that FSI was a partnership initiative between AusAID/DFAT, ACIAR and CSIRO, and a key initial objective was enhancing inter-organisational collaboration and learning, the team chose to focus on social learning approaches, drawing on single-, double-, and triple-loop learning theory (Argyris & Schön, 1996; Fabricius & Cundill, 2014; Flood et al., 2002; Guijt, 2010a; Romm, 1996). The rationale was that providing mechanisms for these three diverse organisations to share experiences, perspectives, and interests would lay the foundation for a stronger partnership, support the development of a shared vision for FSI, assist in institutionalising learning and adaptive management, and elicit cross-organisation relevant avenues for ‘thinking and doing out of the box’.

While the formation of the FSI partnership could be seen as a form of social learning in itself (i.e. the recognition of the need - if greater international development impacts are to be achieved - for a closer synergetic relationship between the three main Australian government agencies delivering agriculture and food aid investments, and the subsequent formation of an inter-organisational partnership) (see Guijt, 2007), embedding explicit iterative processes of critical reflection and learning in the partnership proved to be too challenging to implement at the time. There are many reasons for the difficulties we encountered, some of which are discussed later in the paper. Among these was our struggle to design tools and processes that were non-cumbersome, relatively easy to implement and, perhaps most significantly, that were perceived as cogent and pragmatic in the eyes of our partners.

This led, in year 2 of FSI, to the MEL team deciding to establish closer linkages with the M&E frameworks and tools that were either being used by, or were familiar to, our DFAT and ACIAR partners. We invited M&E specialists from our partnering organisations to contribute to our efforts. This resulted in the development of a programme logic-oriented, indicator-based M&E framework (Figure 1). We inevitably encountered problems with this form of conventional ‘best practice’ M&E. As highlighted by others (e.g. Woodhill, 2007) these types of approaches were too narrow and rigid to adequately capture the dynamic nature and complexity of initiatives such as FSI. And mechanisms to support learning and capacity to innovate were virtually absent.
Towards the end of year 2 (mid-2014), we decided that we needed to take stock of where we were at, particularly why we were struggling with our MEL system. Around the same time, a small group of FSI team members met to jointly reflect on the achievements and challenges encountered over the previous year. Using a loosely-facilitated discussion format, and aided by a visual flow-chart methodology, we spent two days trying to make sense of what felt like a ‘messy, incoherent and busy’ year. The experience of sitting together and jointly reflecting led to the team pinpointing some of the key activities, outputs, and processes that had led to positive outcomes for FSI. Most importantly, it enabled them to ‘connect the dots’ between what appeared to have been disparate activities/outputs/processes and to identify why some had been successful and others not. The reflections and lessons learned in those two days culminated in the development of what we called a ‘Learning Trajectory’, a diagram that visually captured accomplishments (and bottle-necks) and the underpinning processes that led to key outcomes (Figure 2). The Learning Trajectories helped FSI team members succinctly capture, understand, and communicate achievements (and failures) and were subsequently found to be helpful in informing the work plan for the third year of FSI.

**Experimentation with a ‘home-grown’ emergent approach**

Figure 1. FSI’s second attempt at an MEL framework (year 2): a programme logic, indicator-based framework
Figure 2. FSI’s Learning Trajectory (end of year 2 of FSI): an example for the Agricultural Linkages focal area
Moving to a ‘fit-for-purpose’ approach

While developing the Learning Trajectories proved to be a valuable critical reflection and learning experience for the FSI team, it was a time-consuming exercise. It also was not easy to replicate as it was logistically too difficult and too expensive to bring partners together to engage in regular face-to-face interactions. Nonetheless, our experience trialling three very different MEL approaches - from social learning, to indicators, and then the Learning Trajectories - shed light on where we had gone wrong and what was needed, in terms of MEL approaches and tools. It highlighted for us that the MEL system needed M&E tool(s) capable of capturing the non-quantifiable, process-level aspects of FSI that had come to light in the Learning Trajectory exercise; it also needed to be able to incorporate, in a concise way, differences in perspectives and opinions regarding FSI’s achievements, including those of our key partners as well as of others (e.g. people who participated in FSI activities). It also had to be easy to update on a regular basis, as well as be succinctly communicated to FSI’s team and governance committees. Finally, and arguably most importantly, we desired a tool that was better able to monitor and evaluate innovation, both its more tangible elements (i.e. implemented activities, products, networks, etc.) and embedded dynamic processes and emergent outcomes so that we articulate consistent, yet varied and nuanced, stories about how system-level innovation can be effectively enabled and supported in the long-term. In line with this last criteria, the tool thus also needed to have the potential to be used as a platform for reflection and learning.

At this juncture, we decided that we needed to seek external expertise and approached, with the above criteria in mind, an MEL practitioner with experience working in complex projects/programmes (Irene Guijt). That engagement led the FSI team to consider a M&E approach called Rubrics, a qualitative descriptive assessment tool which involves articulating and clarifying ‘the things that matter’ in a project or initiative (King et al., 2013; Oakden, 2013a, 2013b; Oakden & Weenink, 2015). Some members of the FSI team had been exploring this approach with partners overseas, which provided some, albeit limited, internal experience and validation of the potential of this M&E tool for FSI. With the guidance of external M&E experts (Irene Guijt and Judy Oakden), we experimented with the Rubrics for FSI. We started with the initiative’s programme logic and for each set of core activities, we revisited the outcomes and identified the key qualities or changes that would tell us that FSI was achieving its purposes and progressing towards its goals (Figure 3).

While the Rubrics approach met the criteria we had identified as crucial for the FSI MEL system, we found that we had to significantly adapt the approach. In the end it took us several attempts and modifications to design a Rubrics that was ‘fit-for-purpose’ for FSI (for more details and reflections on our experience see Stone-Jovicich, 2015). At around the same time (3rd year of FSI), we found that a regular e-mail update called ‘FSI This Past Month’ - prepared by the FSI Management Committee for members of the Steering Committee and other key individuals in DFAT and ACIAR, and comprising a detailed listing of the activities and outputs that had been completed and were underway - was a very effective monitoring tool. This also overlapped with the development of a knowledge product called ‘FSI Practice Notes’, compilations of succinct written reflections drawing on experience and aimed at facilitating shared learning and innovation to improve practice amongst research and development practitioners (see FSI, 2016b). These three approaches ended up forming the cornerstone of the approaches and tools of FSI’s MEL system in the final year of the initiative (Table 1).
**FSI OUTCOME:** Learning events are relevant, timely, appropriately designed; involve Australian and/or in-country partners and their networks; are perceived as worthwhile; and are effective in progressing FSI’s primary outcome (enhanced knowledge-exchange, learning, and networking among FSI partners and other stakeholders in Australia and overseas, thereby strengthening capacity to progress food systems innovation)

# 1. INDIVIDUAL RUBRICS FOR EACH EVENT

<table>
<thead>
<tr>
<th>EVALUATION CRITERIA</th>
<th>RATING</th>
<th>EVIDENCE</th>
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<tbody>
<tr>
<td>Relevant</td>
<td></td>
<td>Feedback from participants who filled post-event evaluation form (N=13)</td>
</tr>
<tr>
<td>Timely</td>
<td></td>
<td>• Aligned with my current work requirements or needs (85%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Knowledge I gained can be used to improve my work (77%)</td>
</tr>
<tr>
<td>Appropriately designed</td>
<td></td>
<td>• Structured in a way that supported my learning style (100%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Benefits of attending the seminar outweighed time away from office (85%)</td>
</tr>
<tr>
<td>Involve Australian and/or in-country partners and networks</td>
<td></td>
<td>• Will share the information I learnt at the seminar with colleagues (77%)</td>
</tr>
<tr>
<td>Worthwhile</td>
<td></td>
<td>• I met people who have the potential to be valuable in my work (100%)</td>
</tr>
<tr>
<td>Enhance knowledge-exchange</td>
<td></td>
<td>Selection of additional comments from participants:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• “I learn some new things in this presentation. I will use some of the things learned to my work”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• “The information presented was very useful for me as a practitioner and researcher. The example gave me a clear idea on how important it is to consider these issues”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• “I gained great benefit from the workshop program and specifically from the role-playing exercise”</td>
</tr>
<tr>
<td>Other evidence of success</td>
<td></td>
<td>• Since the training, participant X and Y have re-designed their program to incorporate the ideas and practices shared in the event</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Participant Z wrote the following, unsolicited e-mail: “I learned a lot from the event and was wondering if FSI will be offering a follow-on training course”</td>
</tr>
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</table>

# 2. SUMMARY RUBRICS OF ALL EVENTS

<table>
<thead>
<tr>
<th>LEARNING EVENTS</th>
<th>EVALUATION CRITERIA &amp; RATINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workshop 1</td>
<td>Relevant: Good, Appropriately designed: Good, Involve partners: Good, Worthwhile: Good, Enhance knowledge: Good, Enhance learning: Good, Enhance networking: Good</td>
</tr>
<tr>
<td>Lunch seminar</td>
<td>Relevant: Good, Appropriately designed: Good, Involve partners: Good, Worthwhile: Good, Enhance knowledge: Good, Enhance learning: Good, Enhance networking: Good</td>
</tr>
<tr>
<td>Reflection event</td>
<td>Relevant: Good, Appropriately designed: Good, Involve partners: Good, Worthwhile: Good, Enhance knowledge: Good, Enhance learning: Good, Enhance networking: Good</td>
</tr>
<tr>
<td>Workshop 2</td>
<td>Relevant: Good, Appropriately designed: Good, Involve partners: Good, Worthwhile: Good, Enhance knowledge: Good, Enhance learning: Good, Enhance networking: Good</td>
</tr>
<tr>
<td>Training event 1</td>
<td>Relevant: Good, Appropriately designed: Good, Involve partners: Good, Worthwhile: Good, Enhance knowledge: Good, Enhance learning: Good, Enhance networking: Good</td>
</tr>
<tr>
<td>Training event 2</td>
<td>Relevant: Good, Appropriately designed: Good, Involve partners: Good, Worthwhile: Good, Enhance knowledge: Good, Enhance learning: Good, Enhance networking: Good</td>
</tr>
<tr>
<td>Presentation</td>
<td>Relevant: Good, Appropriately designed: Good, Involve partners: Good, Worthwhile: Good, Enhance knowledge: Good, Enhance learning: Good, Enhance networking: Good</td>
</tr>
</tbody>
</table>

**OVERALL RATING – GOOD**

A series of training events on private-public partnerships and Theories of Change have been delivered and well received. There is a growing demand from in-country programs for similar events and 3 are being planned in the next quarter.
Table 1. The final suite of MEL tools for FSI (end of year 3 of FSI)

<table>
<thead>
<tr>
<th>MEL APPROACH/ TOOL</th>
<th>M, E, or L*?</th>
<th>M, E, or L OF WHAT?</th>
<th>FREQUENCY &amp; FORMAT</th>
<th>PRIMARY PURPOSE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FSI This Past Month</strong></td>
<td>Monitoring</td>
<td>FSI short-term to medium-term activities and outputs, planned and emergent</td>
<td>Approx. every month; Succinct e-mail message</td>
<td>Evidence-base for FSI Steering Committee &amp; funders; Accountability; Sharing where everyone is at; Day-to-day management</td>
</tr>
<tr>
<td><strong>FSI Rubrics Reports</strong></td>
<td>Evaluation Learning (potentially)</td>
<td>Evaluation of completed FSI activities and outputs; Reflections of processes, and progress towards short and medium term outcomes ; Deviations from plan; wins &amp; challenges; Lessons learned</td>
<td>Attended to be approx. every 3-4 months: FSI Steering Committee meetings; Succinct report comprised of rubrics tables &amp; narratives</td>
<td>Evidence-base for FSI Steering Committee &amp; funders; Accountability; Critical decisions and directions (management)</td>
</tr>
<tr>
<td><strong>FSI Practice Notes</strong></td>
<td>Learning</td>
<td>Practice-based experiences and lessons learned</td>
<td>As ‘critical mass’ of practices and associated lessons learned gathered; Succinct, reader friendly ‘notes’</td>
<td>Synthesis and sharing of key lessons learned and insights from practice</td>
</tr>
</tbody>
</table>

* Our definition of learning drew on single-, double-, and triple-loop learning theory (Argyris & Schön, 1996; Fabricius & Cundill, 2014; Flood et al., 2002; Guijt, 2010a; Romm, 1996). We viewed learning as comprising both a process (i.e. involves and emerges from an individual and/or from a group of people interacting together over a sustained period of time and engaged in on-going deliberation and the sharing of knowledge in a trusting environment) and an outcome [i.e. changes in the way we think (cognition), see (framing), value (affect/emotions), and act] (Cundill & Rodela 2012; Cundill et al. 2014; Wals & Rodela, 2014). These learnings can serve multiple purposes, ranging from accountability to supporting institutional transformation (see Guijt, 2007).

FSI officially ended before we could adequately test these MEL approaches and tools (for example, we never had an opportunity to experiment with Rubric’s potential as a catalyst for collective learning and for enhancing system capacity to innovate). Nonetheless, this mix of MEL tools and associated reporting mechanisms and formats appeared promising in terms of
their capacity to support FSI’s multiple needs, aims, and demands. As to whether they would have been effective for catalysing learning that transcended individuals and organisations and enhanced system-level innovation capacity, it is hard to say.

**Critical reflections and lessons learned from our experience**

1. **Don’t lose sight of the forest for the trees**

One of the biggest lessons for the MEL team was that it is very easy to focus on approaches and tools and lose sight of the broader MEL system. While we intuitively knew that an effective MEL system for supporting innovation needed to be greater than the sum of its information-gathering and sense-making tools, we struggled to give sufficient attention to other critical elements. These included putting more time/effort/resources into: a collectively articulated whole-of-FSI Theory of Change (or other similar approaches); adequate human capacity for MEL; clearly identified organisational alignments for embedding or linking MEL (e.g. M&E structures and teams within our partner organisations); and the strengthening of a culture of and practices for inter- and intra-organisational (and institutionalised) critical reflection, risk-taking, learning and system-level change and innovation. Attempts were made but an insufficiently experienced MEL team leader, a small MEL budget, and a FSI team that was stretched-to-capacity were some of the major constraints encountered.

2. **Start small and modest**

Starting with social learning as the underpinning conceptual framework for developing M&E and Learning tools and processes for FSI was too ‘big’, i.e. too ambitious and unrealistic. A certain level of trust is needed for people to engage in critical reflection and sharing of opinions and perspectives (Pahl-Wostl & Hare, 2004; Pretty, 1995). When FSI started, the partnership among the three organisations was in its formative stage. It was thus unrealistic to assume that the conditions were in place to encourage the team and partners to partake in co-learning processes. Moreover, while the MEL team envisioned social learning workshops as mechanisms to inductively generate a set of indicators that could then be used for M&E purposes and for supporting learning, they were time consuming exercises which were difficult to fit into the time-constrained environments in which everyone operated. In hindsight, we should have started ‘small’ - e.g. informal, ‘rapid’ ice-breaking conversations; ‘back-of-the envelope’ M&E frameworks used as boundary object to select, with partners, tools that were perceived by team members and partners as not too time-consuming and cumbersome to engage with.

3. **Don’t overthink**

The MEL team spent too much time on developing and trying to communicate the conceptual thinking behind the choice of M&E and Learning tools, and too little time on implementation. It was important to offer a solid rationale for why the team was selecting the types of tools it was - i.e., explaining the fit with complexity and innovation thinking - and thus build greater awareness around why conventional M&E approaches were not sufficient. However, in hindsight, we may have achieved this (and more effectively) by putting the tools into practice. Then, through processes of iterative feedback and refinement, we most likely could have demonstrated the value-add of these tools in terms of enhancing understanding of change in
complex projects and innovation pathways, and as mechanisms for capturing and communicating these storylines and impact.

4. Don’t fall into the data collection trap

In similar vein to the first lesson learned discussed above, it is easy to get too focused on the need to collect data and, in the process, miss the bigger purpose of MEL. The Learning Trajectory exercise, carried out mid-project at a point where FSI felt a bit chaotic, brought this to the fore for us. At that stage we had been very focused on defining indicators and data collection methods. The Learning Trajectory exercise, which brought together a range of team members, forced the MEL team to rethink what was really critical for supporting FSI to progress. It was not having an exhaustive list of indicators, along with a suite of robust data collection methods. These could not adequately keep up with the pace of FSI management needs and changes in partner priorities, nor meet FSI’s broader aim of fostering innovation capacity.

5. The MEL approaches and tools need to be ‘fit-for-purpose’

Whilst FSI was complex and had a focus on building an enabling context for fostering innovation, the MEL tools had to meet multiple accountability, learning, and adaptive management needs and rhythms. That meant that we could not just focus on tools that were suited for fostering learning and enhancing capacity to innovate; we also had to consider tools that were best for measuring progress on delivery of agreed-upon outputs and for activity planning purposes. In other words, we needed to put together a mix of MEL approaches and tools that were ‘fit-for-purpose’ (Ramalingam, 2011; Ramalingam et al., 2014). Most of the struggles we encountered were because we either focused at one end of the spectrum (learning-focused approaches) or the other (conventional, accountability oriented methods), or tried to build a tool that could do it all.

We also had to be willing to let go of tools, even if they had worked well. This was our experience with the Learning Trajectory exercise. It ended up being one of the most useful MEL tools at a particular point and time in FSI as it helped capture a snapshot of how FSI was progressing overall at the time and helped guide the subsequent phase of FSI, both its overarching direction and the planning of activities. FSI subsequently gained greater focus (for a range of reasons, beyond the contribution of the Learning Trajectory exercise) and the Learning Trajectory was no longer the most suitable tool.

It took a while to develop a fit-for-purpose MEL system. However, by the end of the project, we seemed to have identified a reasonable mix of M&E and learning methods that were a right fit with the multiple objectives and needs of the initiative. The ‘FSI This Past Month’ updates proved to be very effective in supporting the FSI team report on progress of activities and agreed-upon deliverables. The ‘FSI Rubrics’ were promising as a mechanism for assessing and demonstrating progress towards outcomes as well as for making visible and communicating how the sum of, and interactions and dynamics among, the individual activities and outputs (both defined in the project workplan and emergent) was key to some of FSI’s achievements and impacts. Also, in the ‘FSI Practice Notes’, we seemed to have finally found a learning tool that was seen as useful and not overly demanding.
6. Engaging those who will make use of the MEL information and lessons learned, along with MEL experts, is critical

After having failed several times, we realised that involving the people/groups who will make use of the information and lessons learned from the MEL approaches tools is critical to making the MEL system useful, appropriate, and effective (see Guijt, 2010b; Ramalingam, 2011). We should have engaged more closely, from the very beginning, with FSI team members, the Steering Committee and staff from partner organisations. We also would have benefited from linking earlier on with MEL experts who had experience working in complex projects. This would have led to a more balanced team, one made of team members who brought with them the diversity of knowledge, skills and experience needed. In this way, we would have most likely avoided what we did - i.e., ‘hop’ from one tool to another in search of the ‘best practice’ approach and tools - and arrived much earlier at a set of M&E and learning approaches and tools that were a ‘best fit’. Having said this, it is not guaranteed to work. We attempted various co-designing approaches at various stages of FSI and were challenged by the divergent perspectives groups and individuals had about the purpose of FSI and how it would achieve what it was set out to do. We also found that our partners had many other competing demands that made it difficult for them to engage with the MEL team.

7. A flexible and adaptable MEL system is paramount but within bounds

While the FSI team was fortunate to have been given the time to experiment, it ultimately resulted in considerable delays and we ran out of time to demonstrate a functioning and running MEL system for FSI. This detrimentally impacted the FSI team’s capacity to demonstrate and communicate progress. More critically, we did not have an opportunity to assess the extent to which our MEL approaches and tools could have contributed to FSI’s innovation capacity and to that of the Australian ODA agriculture and food system.

This highlighted for us the need to have some MEL processes and tools up and running early on, whilst also having space and time to be experimental, flexible and innovative with our approaches (see Guijt, 2007). The latter is critical. As our experience showed (as have others who have been engaged in similar spaces), we found that as we implemented different tools we encountered problems and disjunctures but also new insights. Moreover, as FSI evolved, the activities and needs of the FSI team and partners also changed. Thus the MEL system needed to be flexible enough to respond to all of these changes in order to ensure that it remained ‘fit-for-purpose’. However, this process consumed most of our time and energy and, in the end, the initiative ended before we could fully implement the suite of ‘most promising’ MEL tools.

Summary: key take-home messages

Monitoring and evaluation, with an emphasis on critical reflection and learning, is an essential enabler of innovation. However, for M&E to effectively support reflexivity, learning, and capacity to innovate it too necessitates an enabling environment (Ramalingam, 2011; van Mierlo et al., 2010a). The conditions required for M&E to be mobilised in ways that can catalyse and support learning-oriented processes and outcomes are many of the enabling factors needed for innovation. These include the right individual and institutional capabilities, appropriate resources and incentives, and policy frameworks and institutional arrangements that support genuine collaboration, non-linear perspectives of change, and experimentation with emergent, novel, and innovative approaches (Hall et al., 2007, 2010; Hawkins et al., 2009;
This flags the importance of not only unpacking which enabling conditions are critical for MEL in programmes/projects underpinned by innovation systems thinking and which are realistically achievable, but also considering whether some need to be prioritised or even sequenced.

Our experience with MEL in FSI also reinforced what many others have underlined: that the paradigms that govern aid and development investments, interventions and other practices (e.g. M&E) are ‘slow-moving’ institutions (Roland, 2004). In practical terms, this means that “small incremental changes to existing systems might be more feasible and workable than radical and abrupt changes that seek to impose blueprints from outside” (Holvoet et al., 2012, p. 751). This highlights that our ‘failures’ with MEL should not come as a surprise. It also points to some practical considerations, including that for M&E with learning to be institutionalised, i.e. embedded and sustained as part of the fabric of routine practice, the M&E framework and tools should at the very least not conflict with (and, at best, be complimentary or supportive of) other required (usually conventional) M&E systems. The M&E tools and associated processes also need to be ‘simple’, i.e. non-cumbersome to engage with, implement, and sustain as institutionalised practice. This does not imply that they should be simplistic, i.e. tools that dumb down the complex reality of the issues at hand and of innovation processes. As noted by Ang (2011, p. 779), “the development of sophisticated and sustainable responses to the world’s complex problems requires the recognition of complexity…[along with] simplification to combat the paralyzing effects of complexity…” The challenge is how to simplify MEL tools and processes in ways that support individuals and organisations to effectively navigate complexity and support innovation, without rendering them simplistic. Finally, also critical is having ‘champions’ who are embedded in the institutions and who can, over the long term, support and adapt M&E approaches and tools gradually towards greater reflection, learning and innovation.

A final take-home message that emerged from our experience in FSI is that ‘perfect is the enemy of good’. We spent much of our time and resources on developing a comprehensive and robust MEL system. We should have been more willing to go with an imperfect plan and less-than-perfect tools and approach MEL as an “evolving practice” (Gujit, 2007) where we learn and innovate along the way. This “learn(ing) in ‘real time’” (Ramalingam et al., 2014) is critical if we are to better understand, build, and implement M&E tools and systems that can support learning and innovation. In other words, what is needed is not simply best practice guidelines but ‘living repositories’ of systematically-collated and shareable reflections, lessons learned and practical advice garnered from experiences of applying M&E and Learning in complex and innovation contexts.

Acknowledgements
We thank Irene Gujit and Judy Oakden for their constructive insights and suggestions that helped us design a ‘fit-for-purpose’ MEL. Colleagues at DFAT – Jim Woodhill, Kris Hendrickx, Scott Bayley, and Elaine Ward, and at ACIAR – Andrew Alford and John Dixon, are also gratefully acknowledged for their feedback on specific MEL approaches and tools trialled. We would also like to thank the FSI team for their constant support, tremendous patience and invaluable insights throughout the process. Thanks are also due to Michaela Cosijn and Barbara van Mierlo for helpful comments on earlier drafts of this paper.
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Taking farmers on a journey: experiences evaluating learning in Farmer Field Labs in UK

Reed, M.1, Ingram, J.1, Mills, J.1 and MacMillan, T.2

1 The Countryside and Community Research Institute, The University of Gloucestershire, UK
2 The Soil Association, Bristol, UK

Abstract: This paper presents results from an evaluation of the Soil Association’s Duchy Originals Future Farming programme which supported regular farmer group meetings (Field Labs) and problem based field experiments. Drawing on the theoretical ideas of the three learning loops (Argyris & Schön, 1996), the paper examines the nature and extent of farmer learning that can be attributed to participation in the initiative. Using data from a survey, detailed interviews and a discussion forum, the evaluation found that farmer understanding of Field Lab topics, practices and skills, and research methods has been enhanced to different extents as a result of participating in Field Labs. However, overall farmer learning is as much about being given the tools and the confidence to go away and try things, as it is about acquiring specific knowledge, skills and practices. The paper concludes by reflecting on methodologies employed for evaluation of learning approaches and arguing for a more embedded and reflective approach.

Keywords: Field labs, farmer learning, participatory approaches, learning loops, evaluation

Introduction
A shift towards participatory and demand driven extension (Leeuwis et al., 2004) together with an increasing policy interest in peer to peer learning to foster innovation has led to the emergence of a range of participatory initiatives (operational groups, farmer field labs) in Europe. These are modelled on more established approaches such as Farmer Field Schools (FFS) and Stable Schools. A central element of these strategies is a learner-centred process that relies on discovery-based and experiential learning and critical reflection in groups. A common assumption is that these approaches lead to improved skills and knowledge, problem-solving and critical thinking, and enhanced empowerment and capacity building amongst participating farmers, as well as increased adoption and diffusion of sustainable and innovative practices. Verifying such claims and evaluating such approaches can be challenging methodologically (Douthwaite et al., 2003; Waddington & White, 2014).

This paper presents results from an evaluation of such an initiative, the Duchy Future Farming Programme (subsequently called Innovative Farmers). The programme1 supports ‘Field Labs’, which are regular farmer (organic and conventional) group meetings, and problem based field experiments guided by a facilitator with research expertise (MacMillan & Benton, 2014). Drawing on the theoretical ideas of the three learning loops (Argyris & Schön, 1996), this paper examines the nature and extent of farmer learning that can be attributed to participation in the initiative. The paper highlights the challenges of attributing learning to such interventions

1 This Programme was initiated by the Soil Association in partnership with the Organic Research Centre and UK retailer Waitrose, with funding from the Prince of Wales’s Charitable Foundation.
particularly in a retrospective evaluation and argues for an ongoing and reflective evaluation for the successor programme.

Understanding the nature and extent of learning or improving knowledge associated with interventions has been the subject of much scholarship (Coudel et al., 2011). This scholarship reveals that multiple elements are contributing to the process of learning and acquiring knowledge (Baars, 2011) which any evaluation of farmer-centred learning initiatives should consider. In FFS evaluations, learning tends to be seen as enhanced knowledge of farming technology such as Integrated Pest Management practices and pest identification. Often these studies provide evidence via adoption, or, taking a broader view, of improved analytical skills, critical thinking, ability to make better decisions and familiarity with practices, which lead to better decisions regarding inputs, yields and costs (Waddington & White, 2014). At a deeper level, empowerment and enhanced capacity to learn are also indicative of improved and more transformative learning (Duveskog et al., 2011). The methodology in this evaluation sought to examine and understand these different dimensions of learning.

The SA define field labs as farmer-led meetings, open to all (both organic and non-organic), where producers examine innovative approaches, share existing best practice, learn how to run effective producer-led trials and identify real gaps where academic research would make a crucial difference. Field Labs are designed to empower farmers as innovators, increasing the impact of their informal research and enabling them to influence the formal research conducted in their name. They aim to build knowledge of specific topics, an understanding of the research process and associated skills, and develop critical thinking amongst individual farmers. Typically, Field Lab groups meet 3-4 times to address these elements. The FL were evaluated against these aims. Specifically, the aims of the evaluation reported here were to assess the effect of participation on: (i) farmer learning in farming techniques/best practice; and (ii) farmer learning in research/innovation skills/critical thinking and other learning outcomes.

**Literature Review**

This review of the literature builds on insights that focus on understanding the context in which farm business operates, the way in which the literature on farm learning has tended to not be attentive to the significance of the context, and in this point to the novel elements of the subject of the study.

The focus on innovation and learning has recently become a policy prescription on the basis that through Schumpeterian effort meaningful economic growth can be resumed after the crisis of 2008. This implies in part that agricultural businesses and farmers were previously deficient in innovation and knowledge. In a British context this can be seen in the focus on export based agricultural technologies as well as food commodities in the Taylor Report (Herbert & Lord Taylor of Holbeach, 2010). Rather, as we argue, this paper illustrates the agricultural industry in the UK through self-organisation is attempting to realise important sustainability goals that it has set for itself. The wider British agricultural industry has already made clear its preference for farmer-led participatory approaches which are divergent from government policy and provision (Defra, 2013; Gibbs, 2013; OECD, 2015; Sutherland et al., 2013). This may have wider implications as others emulate the process or learn from it, but also speaks to the scholarship around farmer learning and innovation.
Much of the literature on innovation and participatory learning has its roots in learning with large organisations and the process of transformation that lead to organisational innovation, suggesting that this is not simply a question of agency but also of enabling structures (Coudel et al., 2011). In order to transport some of the insights about such learning scholars concerned with agriculture and farming have had to adapt to what Coudel and colleagues identify as more “loosely structured environments” (Coudel et al., 2011, p.121). This reflects a broader totalising tendency in much of the literature to assume that all agricultural contexts are sufficiently similar that comparisons and analogies can be made between projects and enterprises (Waddington & White, 2014).

The project which is the focus of this study typifies much of the context of British agriculture but differs in significant elements. Firstly, the food supply chains in the UK are retailer led with their influence not only influencing commodity prices but also on-farm practices, especially those related to food safety (Marsden et al., 1999). Farm level autonomy is circumscribed by such relationships as is the flow of information through and within the farm business. Secondly, the state has a significant role within the agricultural sector through agri-environmental interventions both in terms of legislation, but also through payment schemes to ensure environmental improvement (Mills et al., 2011). Again this represents considerable flows of not just money but information between and within farms (Mills et al., 2016). Many farms remain multi-generational, family owned and operated enterprises, that have high levels of capitalisation and technology, which is reflected in the developmental trajectories they have adopted (Ingram et al., 2013). Innovation at the farm level in this context is modulated by a complex, but not necessarily sophisticated, interaction between major private sector corporations, the implementation of EU schemes by various state agencies and devolved government bodies and familial requirements.

To leave the account of the context at this point would also reduce the complexity of the context. The project is led by an organic farming organisation, and most, but not all, of the participating farmers were also organic. Organic farming has been noted throughout the literature as having particular epistemic practices that differentiate it both practically and philosophically from much of the wider agricultural sector (Morgan & Murdoch, 2000). The practices of certification and market creation for the organic sector have been reflected in a particular organisational form as well as a distinct market profile, with a much greater uptake of schemes as well as a greater tendency towards use of some short supply chains (Lobley et al., 2009). Further scholars have argued that organic farming is part of a wider social movement that has wider civic and political goals that challenge both how agriculture is practised and its status within broader society (Reed, 2010). In recent years this has seen organic farmers allied with other groups in protests about GM crops and debates about the future role of agriculture (Reed, 2008). This suggests that agricultural sustainability innovation may have a wider social and civic impact that often recognised.

Recently social movement scholars have come to focus on the productive, epistemic actions that result from the collective action that is undertaken by movements as participants work on what they want to replace the present (Crossley, Melucci). Rao, writing from business studies notes how the rise of organic food was related to the role of activists, and from technology studies Hess argues that organic agriculture is the product of a social movement (Rao, Hess). This is significant as it indicates other social influences, in terms of flows of information and values, that are not often accounted for the in the farmer learning/innovation literature but also
another type of organisation, the social movement, which has a very high capacity to foster learning and innovation. Castells (2012) points to the innovations introduced through the ‘Occupy’ protests and the importance of internet augmented deliberations in a relentless process of interaction. It may be that through a movement many people have experienced profound changes in values or societal understanding that require pragmatic changes. The innovation literature can help in the analysis of how these changes occur.

Significantly, in their study of organisational innovation with regards to gay and lesbian advocacy, Foldy and Creed (1999) note the importance of wider social movement activism in fostering these changes. Through their detailed account of the activism within and without the businesses in questions they observe that “a closer look reveals an intertwining of single-, double-, and triple-loop approaches, a maze that resists simplification” (p.214). They do not abandon the schema but refine it to be able to analyse the particular, suggesting that whilst it is necessary for the first loop to succeed before second and third loops can, this sequence is neither linear nor easily observed to be serial, “They happen concurrently, sometimes cross-fertilising and sometimes at cross-purposes, but ultimately, it is that continuous interaction out of which change efforts grow” (p.224). This suggests that we need to be attentive to the dynamic ways in which analytical frameworks are heuristic guides, not to be mistaken for the reality they interpret.

Methods

Given the theoretical understandings of learning and the evaluation context (ex post), client requirements and aims, the methodology focused on evidence of learning in individuals as an indication of the FLs’ impact (but on the understanding that any individual learning was most likely connected to wider group learning), and aimed to establish whether different levels of learning could be distinguished.

The evaluation took place towards the end of the three-year programme and the method was somewhat prescribed by the programme requirements. Three main methods were used in the following order: detailed interviews with farmers/growers; a facilitators’ discussion forum; and a telephone survey by the research team of farmers/growers. Results from detailed interviews were used to inform and steer questions in the facilitators’ discussion forum, likewise results from detailed interviews and the facilitators’ discussion forum were used to develop the survey questionnaire. Also, the authors attended Field Labs towards the beginning of the evaluation and a facilitator/research workshop towards the end of the evaluation.

Purposeful sampling from a list of participants from 22 Field Labs was used to select 12 interviewees. These interviews were semi structured. Random sampling was used to select 30 telephone survey respondents from a sample of 221 farmers/growers and advisors (representing 14%). Interviewees and respondents were asked: to what extent they had gained new knowledge and information; learned new farming practices and skills; come to understand some of the underlying principles beneath these practices; come to understand and acquire research skills; and reflected on their learning overall. Survey respondents ranked statements using a Likert-like scale.

Drawing on qualitative and quantitative methods allows patterns as well as processes to be explored; the telephone survey reveals patterns in responses whilst the detailed interviews and discussion forum provide some explanation for these patterns and insight into processes
involved. In this respect, detailed interviews allow some in-depth analysis of the nature of learning while the survey can be used to extend this analysis and obtain some idea of the extent of farmer learning. This mixed methods approach also allows some triangulation, for example, farmer self-reported learning or practice change could be validated by facilitators (Moran-Ellis et al., 2006).

Results
Good correspondence between the three data sources confirms that topic knowledge, practices and understanding, and research understanding has been enhanced to different extents. It is apparent that significant learning has occurred as a result of attending Field Labs. Selected survey results are presented in Figure 1. The differences in the nature of the learning can be described in terms of the concept of learning loops, originally developed by Argyris and Schön (1996)\textsuperscript{2} to explain the types of learning that take place in organisations. The concept has been applied to natural resource management, adaptation and farming contexts (Duveskog et al., 2011; Eshuis & Stuiver, 2005). The intention here is to distinguish and frame the results using a simple interpretation of learning loops and not to provide a thorough analysis and critique of learning loops theory.

Single loop learning –improved learning about the Field Lab topics and practices
Single loop learning is understood here as changing the way of working within a set frame of thought through incremental learning. The focus is on techniques and practical and locally applicable answers to questions rather than questioning underlying principles. It is akin to the ‘know-what’ and the ‘know-how’ described by Lundvall and Johnson (1994).

The majority of survey respondents agreed that the Field Lab gave them a clearer understanding of the topic they were investigating; those who did not agree already possessed high levels of knowledge about the topic. Although the majority (80%) were satisfied with the level of learning in the Field Lab, only 37% agreed that the Field Lab they attended gave them a chance to learn new skills and practices such as how to grow cover crops effectively. The gap between these figures is accounted for by those who had not attended long enough to engage in learning or develop new skills.

Acquiring new knowledge from others at the Field Lab was mentioned by most of the interviewees who agreed that they had learned new facts about the Field Lab topic by sharing information with co-participants. According to the detailed interviews this learning depended on the nature of the topic, and on the baseline knowledge of the participant. Participants agreed that the format of the Field Lab in most cases allowed a good combination of technical, practical and financial information to be discussed. For some the Field Lab format, compared to other similar formats, was thought to provide a good context for learning about facts and figures. As one farmer remarked “They are more focused than a farm demonstration or walks and as trials are undertaken in a semi-controlled environment they should produce better facts and figures”.

Larger groups with a “good healthy breadth of views and experiences,” including some experts were considered to lead to most learning of this type compared to Field Labs described as not particularly participatory or with only a few participants. For more informed participants the

\textsuperscript{2} Double and single learning loops are part of a broader concept of organisational learning theory developed by Argyris and Schon in the 1970s, and later expanded by several other organisational thinkers (to include for example triple learning loops) (Foldy & Creed, 1999)
extent of this learning was not that pronounced. For some it was described as more about “joining the dots” rather than picking up specific information about the topic.

**Double loop learning – learning about underlying principles**

Double loop learning refers to learning that alters underlying values, rules and assumptions. This evaluation found evidence of learning about the principles underlying the topics and practices in Field Labs and learning about how to apply experimental and research protocols on-farm. This is akin to the acquiring the ‘know-why’ dimension of knowledge described by Lundvall and Johnson (1994).

Four of the interviewees agreed that the Field Lab had enhanced their understanding of the basic principles underlying the new techniques and measures. For example, for the Foam Weeding Field Lab, one interviewee said “Yes we did learn more about the underlying science behind the technology, particularly the role of the foam as a wetting agent, and the role that played”.

In some cases Field Lab participants felt they had been given the tools, and the confidence, to go away and try things for themselves, as this comment demonstrates: “It was more theoretical, we walked and talked and had a look at things, although we did handle compost, and the final mix etc. We got the basic recipe to go away and experiment with. We would have been confident to try it out.” (Wood chip compost).

![Figure 1. Responses to survey questions](image-url)

This theme of taking control of details and feeling enabled was picked up by an interviewee participating in a weed control Field Lab: “I was trained as a conventional farmer and we spent a lot of time looking at detail for organic farmers. The temptation is to think that you can’t do anything other than sow your crop and hope for the best. This brought us back to the details which I think have been missing in many organic situations. What happens is that you think things are so huge, subject to so many vagaries, and out of your control, but this helped remind us there are things you can control.”
With respect to learning how to conduct research, survey respondents were less likely to agree that they had learned research skills and results suggested that learning about research methods was not something they had considered as relevant. However, some 40% agreed they wanted to get more involved in research as a result of attending a Field Lab. Also notably a number of respondents and interviewees were already well versed in research skills and understanding. The interviews provided more depth on this subject, revealing how some farmers valued, and learned from, carrying out trials. For some participants the practical hands-on measuring was a distinctive element of the Field Lab. As one interviewee who had attended the ‘Compost Teas’ Field Lab remarked: “Basically we were physically doing the trial ourselves, actually doing it, not a researcher doing it and reporting back.”

**Triple loop learning – learning how to learn**

Triple loop learning here refers to learning how to learn. It allows participants to reflect on and learn how to evaluate and appreciate their own experiences and viewpoints, as well as those of others. This is aligned to transformative learning impacts which entails a deep seated shift in perspective (Duveskog et al., 2011; Percy, 2005).

The nature and extent of this deeper learning is hard to gauge from the survey, with responses to statements about the nature of learning inconclusive. The results from the interviews, facilitators’ discussion forum and participant observations, however, show that learning in Field Labs is as much about changing perspectives as learning new facts or practical skills. Interviewees explained that the Field Labs made them question things and as one participant explained “it introduced a different way of thinking about the problem”.

Another element of this learning is building confidence in decision making. For example, in a Field Lab experimenting with mastitis control in cattle some farmers felt empowered to manage mastitis more effectively by either using herbal treatments or being ‘brave enough’ to make decisive management changes. The openness and sharing ethos of working in a group were highlighted as important in instilling confidence and a sense of empowerment. As with first and second learning loops this was enhanced when groups were of a sufficient number (generally >10), had a good mix of participants and provided a good breadth of views and experiences. The opportunity for Field Labs to develop this learning over time relies on sufficient continuity within groups with participants committing and returning to events and reflecting together on outcomes. The commitment, enthusiasm, honesty and expertise of host farmers were also seen to generate effective group learning and inspire confidence.

Facilitators suggest that the whole Field Lab process is one of deeper learning. In the early stages, for example, farmers learn how to formulate and agree on ideas to test. As one facilitator remarked, this learning involves “knowing to ask the right questions”. With respect to setting up research in the Field Labs, facilitators focused on leading the farmers through the research process. They described how some farmers are inclined to just test “with and without” rather than setting up randomised trials, or to be over ambitious with their research questions, one facilitator explains: “it’s taking them through this process, and the how do you measure it? What are the parameters you are measuring? It’s saying to growers how are we going to do it then? It demonstrates to them that doing research isn’t like falling off a log”.

According to facilitators this realisation is part of the Field Lab learning process that farmers should go through, although the extent to which different farmers do so is unclear and hard to gauge or measure directly. Overall, rather than point to specific learning achievements,
facilitators said that Field Labs were more about “taking them [farmers] on a journey to understand how to look at their farms”. This again highlights the importance of building up continuity within groups, which facilitators noted was absent in many Field Labs.

Although facilitators have these aspirations for farmer learning, they voiced concerns that farmers did not always understand what a Field Lab entails. Several had clear examples of farmers not understanding what they were participating in: “Is it what they thought it was when they signed up? It is clear in the information, but still people turn up and they don’t understand the concept of the Field Lab – and why should they? It’s the topic that’s drawing them in, not the process.”

The management of expectations had two facets; as above those of the farmers, but also those of the researchers: “There is a perception that farmers expect to get spoon-fed by researchers and once they understand it is not like that then they are much more likely to get involved ….” In the more successful and longer term Field Labs there was a sense that those perceptions are changing, that dialogue and reflection between farmers and researchers is leading to more open-minded and appreciative learning.

Discussion
These results suggest that the Field Labs are supporting and building farmer innovation capacity. They do this by: facilitating collaboration for sharing and processing information and knowledge; enabling farmers to identify and prioritise problems and opportunities through experimentation; fostering confidence in practical and research skills; and nurturing new perspectives and outlooks.

The results highlight the difficulties in assessing changes in learning ascribed to Field Labs, especially in regard to evaluating improvements in farmers’ analytical skills, critical thinking and ability to make better decisions; as well as changes at a deeper more transformative level. A recent meta-analysis of FFS programme evaluations noted the difficulty in ascribing changes specifically to the intervention. It concluded that the evaluations are broadly not sufficiently rigorous and there are dangers of ‘systematic overestimation of impact’ particularly with respect to diffusion and scaling up (Waddington & White, 2014). This review and others challenge the notion of a causal chain or linear outcomes in complex situations and identifies an ‘attribution gap’ (Douthwaite et al., 2003). The review of FFS also highlighted the challenge in evaluating softer outcomes such as empowerment and capacity development compared to other impacts where studies have shown improved farmer knowledge and adoption of beneficial practices with participants feeling more confident with problem solving and decision making (Duveskog et al., 2011; Van den Berg & Jiggins, 2007; Waddington & White, 2014).

The nature of the Field Labs programme and activities further challenged the evaluation, particularly in attributing farmer learning to participation in the Field Labs. This was because the labs were at different stages, a number having not yet developed sufficiently to result in measurable change in learning; and the diversity of contexts, activities, topics and goals made comparison difficult. Further, the majority of respondents had only attended one meeting and as such their perspectives about, and opportunities for learning were limited. The different levels of participation and engagement in groups clearly has an impact on learning, as has been widely noted in other studies showing how learning is embedded in social and cultural contexts, and that people learn through their ongoing participation in these contexts (Sewell et al., 2014). Participants also started from different levels of understanding. Significantly a
number were innovative farmers already experienced in (formal and informal) on-farm experiments, accustomed to finding solutions, and each with their own experiential knowledge to impart. Given these conditions, any evaluation has to recognise the situated and contingent environment within which farmers learn (Eshuis & Stuiver, 2005) and the contributions that farmers can make as co-learners (Baars, 2011).

The results of this study suggest the need for evaluation to be embedded within the initiative as a form of action research with in built M&E so that it can evolve, adapt and learn as it develops, allowing ongoing reflection to foster learning and innovation. In turn creating a virtuous loop of credible critical learning that will enable farmers to guide their farms to their ends within a context in which they are the experts.

Conclusion
The evaluation found farmer learning as a result of participating in Field Labs is as much about being given the tools and the confidence to go away and try things as it is about acquiring specific knowledge, skills and practices. The learning process within Field Labs is about “joining the dots” and learning how to formulate ideas and “to ask the right questions” rather than specific skills or techniques. Although single loop learning is occurring, double loop is more apparent. Field Labs also aim to enhance farmers’ critical thinking and help them ‘learn how to learn’, yet, whilst there is some evidence for this, there is an indication that not all farmers understand the concept and ambition. Overall Field Labs were described as ‘taking farmers on a journey’ rather than achieving defined outcomes. This approach presents particular challenges for evaluation unless the evaluators are part of that journey in a continuous process of M&E and critical reflection. The successor programme (Innovative Farmers) has made provision for this by incorporating M&E from the outset through an action research approach. It has also brought in changes in response to this evaluation including a stronger emphasis on group continuity whereby farmers become member of groups that meets on an ongoing basis, running successive Field Labs.
References


Workshop 1.3: Using a co-innovation approach to improve innovation and learning
Convenors: Neels Botha, James Turner, Bruce Small, Kelly Rijswijk, Denise Bewsell, Tracy Williams and MS Srinivasan

New ways of supporting learning and innovation have become more acceptable over the last decade to better fit the new context within which research and development (R&D) for sustainable outcomes is practised. Co-innovation is a process-driven approach that aims to stimulate innovation and learning for sustainable outcomes. Co-innovation has been trialled as an approach to stimulating innovation and learning in New Zealand and other countries for several years in a variety of socio-cultural, economic and institutional contexts. Some of these experiments have been idealistic and theory driven, while others were pragmatic and inserted co-innovation principles through action research into more traditional models of learning and innovation, such as technology transfer. Our international team of social and biophysical scientists organises and ran a workshop on co-innovation during IFSA 2016 that explores co-innovation at the practical level through a range of presented papers, highlighting how theory was translated into practice. Generally a range of concepts like co-creation (Kukkuru, 2011); strategies for development of the co-innovation approach (Bossink, 2002), co-production (Klerkx and Nettle, 2013) and co-evolution (Kilelu, Klerkx and Leeuwis, 2013), are associated with co-innovation. In this workshop two concepts that were specifically explored were reflexivity (van Mierlo et al., 2010) and knowledge and innovation brokering (Bielak et al., 2013) because in New Zealand they have been found to be central to co-innovation. The workshop consisted of a series of papers on co-innovation that are grounded in theory but focus on knowledge gained from application in ex-post and action research case studies. We had a core of five papers from New Zealand and sought, through the open call for papers, additional papers on co-innovation that highlight the application of this approach, as well as the use of reflexive practice and brokering. The core of papers focused on:

- Developing a community of practice for understanding and using co-innovation, and the outcomes from this group at the agricultural innovation system level;
- Cost benefit analysis of co-innovation;
- A cross case analysis of the contribution of co-innovation to enhanced innovation and learning in the pastoral, horticultural and forestry sectors;
- Reflexive monitoring practice for implementing co-innovation;
- A Māori (indigenous people of New Zealand) perspective of co-innovation;
- Monitoring and evaluation for supporting co-innovation

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A co-innovation approach in family-farming livestock systems in Rocha - Uruguay: a three-year learning process

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Abstract: There are opportunities to improve livestock family farms’ (LFF) sustainability in Uruguay by changing management practices and incorporating technologies using the co-innovation approach. To harness these opportunities, between 2012 and 2015 a research project was implemented in Eastern Uruguay, where three simultaneous processes occurred at three levels: farm, region and research team. At farm level, the work was carried out in seven LFF as case studies. Through monthly visits to the farms by a field agronomist the process followed three phases using the Evaluation of Natural Resource Management Systems Incorporating Sustainability Indicators (MESMIS) framework: (i) characterisation and diagnosis; (ii) re-design and (iii) implementation, monitoring and evaluation. As a result farmer farm management knowledge and skills improved and the farms increased their meat production and net income (by on average 23% and 56% respectively) while preserving natural resources. At regional level, a participatory approach to planning, monitoring and evaluating the project’s progress with regional stakeholders was adapted from a Participatory Analysis of Impact Pathways (PIPA) method. An interinstitutional network was consolidated, which developed a common vision and expected project outcomes and designed a communication plan to disseminate the results. At team level a Participatory Action Research (PAR) approach was carried out. A transdisciplinary team was consolidated through cyclic processes of research, reflection and action. Consensus on the objectives and methods allowed combining knowledge to solve practice-oriented problems. The three-year process demonstrated effectiveness in improving LFF sustainability, opening a learning space with stakeholders and contributing a novel model of rural development: co-innovation.

Keywords: Methodology, MESMIS, PAR, PIPA, systemic approach, monitoring and evaluation, co-innovation

Introduction
Twenty-one percent of the farms in Uruguay disappeared between 2000 and 2011 (Cortelezzi & Mondelli, 2014). Nowadays, there are more than 26,000 livestock farms covering more than 11.7 million hectares, most of which (60%) are family farms (Tommasino et al., 2014). In our work, and according to the definition of family-farming provided by the Uruguayan Ministry of Livestock and Agriculture, “family-farming” satisfies the following criteria: labour is mainly provided by the family while hired labour is limited, the family is directly responsible for the production and management of agricultural activities, the family lives on the farm or within a 50 kilometre radius, and the production is intended for self-consumption and marketing (Tommasino et al., 2014).
The traditional model of agricultural technology transfer has led to low adoption of improved agricultural technologies (Moschitz et al., 2015; Okali et al., 1994). On the other hand, the active participation of the farmers in the process of problem identification and development of alternatives may maximise the impact of the generated proposals (Leeuwis & Van der Ban, 2004). Accordingly, some advances have been observed in Uruguay by the National Agricultural Research Institute (INIA) while working together with organic farmers (Albicette, 2011), and by the Faculty of Agronomy of the University of the Republic with livestock and horticultural farmers (Dogliotti et al., 2012; 2014). This presupposes a research process paradigm shift, where the human factor is an integral part of the innovation process.

Most of the livestock family farms (LFF) in Uruguay apply low technology levels and consequently they present low production efficiency with substantial fluctuations between years (Pereira, 2003). At farm level, some opportunities can be identified to improve family-farm production efficiency and sustainability through an adequate selection and orientation of production activities and the use of appropriate technology and farming management skills. In line with this, technical information for natural grassland management (Soca et al., 2013; Altesor et al., 2011) and cattle and sheep management (Nabinger et al., 2011; Quintans & Scarsi, 2013) is available and known by end users. Farm sustainability cannot be solved by mere adjustments or modifications in isolated components of the system, which generally responds to disciplinary advances. To improve LFF sustainability, a systemic approach of LFF is needed, therefore implying changes in the quality and availability of production resources, along with changes in farm management. The latter includes certain changes in knowledge, skills, attitudes and abilities -KASA- (Rockwell & Bennett, 2004) of the family (Dogliotti et al., 2012; 2014). A Rapid Rural Appraisal (RRA) (Schönhuth & Kievelitz, 1994) was conducted during 2009 and 2010 in Rocha, Eastern Uruguay by INIA in collaboration with local farmer organisations (Sociedad de Fomento Rural-Ruta 109 - SFR-R109, Sociedad de Fomento Rural-Castillos - SFR-C), the national farmer union (Comisión Nacional de Fomento Rural - CNFR) and local government (Intendencia Municipal de Rocha - IMR). Through this RRA we confirmed a reduction of the number of family farms and an increase of average farmer’s age. We also identified knowledge gaps and misuse of the available technological alternatives related to low income. As a consequence, the strategy of the farmers was to intensify their production (i.e. use of external sources of feed, substituting natural grasslands by sowed pastures, increases in animal stocking rate), usually associated with inadequate technologies and practices. This posed a risk to natural resource preservation while affecting the present productivity and compromising sustainability for future generations (Capra et al., 2009).

The project “co-innovating for the sustainable development of family-farming systems in Rocha-Uruguay” aimed to contribute from the scientific research and the technological development standpoint to the improvement of family-farming systems sustainability, the development of this rural area and the improvement of farmer wellbeing using a co-innovation process. As defined by Coutts et al. (2014), co-innovation is a participative and interactive approach to fostering effective innovation across sectors and stakeholders. Within this project we proposed a methodological framework to design, implement and monitor and evaluate (M&E) an intervention strategy for improving LFF sustainability.
Materials and Methods

We implemented a co-innovation approach that combines complex systems theory, social learning and dynamic project M&E (Rossing et al., 2010) at three interconnected and simultaneous levels: farm, region and research team (Figure 1). The process occurred over three years (2012-2015) and involved two rural areas of Rocha - Uruguay: Castillos and the hilly areas delimited by roads 109 and 15 (Figure 2).

Figure 1. Project methodological approach. The co-innovation approach was implemented at three simultaneous and interconnected levels: farm, region and research team. At each level specific methods/methodologies were used and supported the diagnosis, re-design and implementation, monitoring and evaluation of the introduced changes in the farming systems.

Farm level

To improve LFF sustainability, we implemented a multiple case study (Yin, 2014) within the MESMIS framework (Spanish acronym for Evaluation of Natural Resource Management Systems Incorporating Sustainability Indicators [Masera et al., 2000]). Seven family farms were selected jointly by INIA researchers, extension agents of two grassroots local farmer organisations (SFR-R109 and SFR-C) and agronomists of the national farmer union (CNFR). The main activity of the selected LFF is livestock production (raising cattle and sheep) based on native grasslands.

Three phases were followed according to Dogliotti et al. (2014): (i) characterisation and diagnosis; (ii) re-design of the farming system and (iii) implementation and M&E of the proposed changes in the farming system. The field agronomist was responsible for supporting the farmer and the family to implement the proposed changes as well as monitoring the whole process. In order to carry this out the field agronomist visited each farm on a monthly basis. He also facilitated the connection between the farmers and the research team members responsible for collecting on-farm information regarding grassland and animal management, environmental indicators and social processes.

The characterisation and diagnosis at each LFF was undertaken by the farmer and his family along with the field agronomist and the research team. The status and operation of the production systems were described and the main problems of these systems were identified taking into account the family’s conception of sustainability. Finally, based on the MESMIS framework (Masera et al., 2000) the critical points were organised according to four groups of sustainable attributes (productivity, stability, reliability-adaptability-resilience and self-reliance) and the indicators to monitor them were determined (Table 1). During the re-design phase (strategic planning) of the LFF, different productive alternatives were proposed based on the

Figure 2. Localisation of the rural areas where the project was implemented: Castillos and Rocha hilly area, Rocha, Uruguay.
resources available on the farm. After that, the proposals were evaluated by quantifying the expected physical and economic results, as well as the potential impact on farm management and on natural resources. After a learning process where the producer’s practical knowledge and the scientific knowledge provided by the research team merged, one proposal was constructed by the family and the field agronomist in order to overcome the critical points. The last phase of the process was the implementation (tactical planning) and M&E of the proposal. The impact of the re-designed system was monitored and quantified with the selected indicators. Some unexpected difficulties arose as the process evolved so the original proposal was adjusted through continuous cycles of re-design and implementation.

**Region level**

The Participatory Analysis of Impact Pathways (PIPA) was designed to help the people involved in a project to explicitly present their expectations towards the project and to plan, implement and monitor activities together in order to fulfil those expectations (Alvarez et al., 2010). In our case, we used PIPA to support and disseminate the processes which took place at farm level, therefore we engaged regional stakeholders in a participatory learning process during interinstitutional workshops carried out twice a year. During these workshops participatory methods were selected from a toolkit (Knowledge Sharing Toolkit, 2009; UNICEF Bangladesh, 1993) and a facilitator guided the discussions and the reflection process. To keep continuity throughout the process, workshops activities were documented and systematised in minutes, which were sent to each participant to be used as memory refreshers and starting points for the succeeding meetings. As the project advanced and changes occurred, lessons learned were incorporated in real time. In the last workshop a written survey was conducted to evaluate the project performance and outcomes, both qualitatively and quantitatively. This survey was composed of 17 questions regarding global assessment, goals achievement, project performance, other topics and future impact of results, rated on a Likert scale ranging from 1 = very bad to 5 = excellent.

**Team level**

A multidisciplinary team (research team) was set up to elaborate and implement the project, to conduct M&E of the processes at farm and region levels and to answer specific research questions. The research team followed a Participatory Action Research (PAR) process. PAR presupposes a cyclic process of research, reflection and action where the researchers are both participants and learners (MacDonald, 2012). The research team had a varied range of backgrounds and expertise, e.g. farm management, pasture and grassland management, livestock production, soil sciences, environmental impact assessment and social sciences.

Two one-day workshops per year were organised aiming to achieve a common vision of the objective and methodology of the project, plan activities, reflect on the process and discuss partial results and how to communicate them. In these workshops participatory methods were implemented as previously described in the **Region level** section.

Finally, to evaluate the process within the team we implemented a quantitative survey designed to evaluate transdisciplinary research (Small et al., 2015). The survey consisted of 38 questions/statements accounting for the key process factors in transdisciplinarity, to be
scored on a 1 to 7 scale (1 = very poor to 7 = very good) and included the possibility of adding comments regarding the addressed issue. In addition, researchers were asked to provide up to three lessons learned from the project. The survey was delivered by e-mail to the researchers and was answered anonymously.

**Results**

*Farm level*

During the first year (2012) each farm was characterised and the main weaknesses and strengths were organised into sustainability attributes and critical points according to MESMIS (Table 1). Among the weaknesses the following were identified: (i) low productivity associated with low family income and labour organisation; (ii) low use of improved technologies for animal, grassland and farm management and (iii) degraded natural resources, mainly native pastures and soil. On the other hand, the strengths were: (i) high degree of satisfaction with their livelihood and availability of family labour, and (ii) high biodiversity.

Considering the previous analysis, the second phase - re-design of the farming system - took place over the course of two years (2013-2014). Several proposals were elaborated for each farm and those which did not imply any incremental costs and used the on-farm resources were selected. After reaching an agreement on the production objectives the proposals focused on: (i) adjustments to the system’s stocking rate (total stocking rate and bovine/ovine ratio); (ii) use and application of technologies for cow-calf systems and (iii) grazing management using different paddocks according to pasture height and animal age.

The implementation of the proposals for the re-design of LFFs started in 2013. Over a period of two years, the impacts of the introduced changes were monitored by using a set of indicators accounting for the three dimensions of sustainability (Table 1). As for the economic dimension, the seven farms increased average equivalent meat production from 99 to 123 kg ha\(^{-1}\) year\(^{-1}\) and their net income from 58 to 98 US$ ha\(^{-1}\) year\(^{-1}\). Regarding the environmental dimension, the amount of standing spring biomass of natural grasslands increased from 1183 to 1868 kg DM ha\(^{-1}\), while the diversity of birds as well as the labile organic carbon fraction of soils (760 mg C. kg soil\(^{-1}\)) were maintained in this environment. Finally, significant changes in the social dimension were observed: a 25% reduction in workload on animals and pasture management; an increase in use of the 11 proposed technologies from 39 to 97 %, and farmers shifted from ‘not planning’ to starting ‘mid-term planning’. All of these advances were a result of changes in farmers’ knowledge and skills around how to understand and manage their LFFs, as expressed by themselves: “we now know how to manage pastures and cattle”, “with less we can do things in a better way”, “now we have more clear production objectives, we know when to do things”.
Table 1. Main critical points and indicators used to assess livestock family farms (LFF) performance, organised in four groups of sustainability attributes and sustainability dimensions, according to MESMIS.

<table>
<thead>
<tr>
<th>Sustainability attribute</th>
<th>Critical point</th>
<th>Indicator (unit/scale)</th>
<th>Sustainability dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Productivity</td>
<td>Low productivity</td>
<td>Equivalent meat production $^1$ (kg ha$^{-1}$ year$^{-1}$)</td>
<td>Economic</td>
</tr>
<tr>
<td></td>
<td>Low family income</td>
<td>Net income (US$ ha$^{-1}$ year$^{-1}$)</td>
<td>Economic</td>
</tr>
<tr>
<td>Stability</td>
<td>High level of satisfaction with family livelihood</td>
<td>Subjective life quality $^2$</td>
<td>Social</td>
</tr>
<tr>
<td></td>
<td>Low labour organisation</td>
<td>Workload on animals and pasture management (h year$^{-1}$)</td>
<td>Social</td>
</tr>
<tr>
<td></td>
<td>Low use of improved technologies</td>
<td>Implemented improved technology (%) $^3$</td>
<td>Social</td>
</tr>
<tr>
<td></td>
<td>High biodiversity</td>
<td>Birds Richness $^4$ and Birds diversity (Shannon Index=$H$) $^5$</td>
<td>Environmental</td>
</tr>
<tr>
<td></td>
<td>Degraded natural grasslands</td>
<td>Spring biomass of native grassland (kg DM ha$^{-1}$)</td>
<td>Environmental</td>
</tr>
<tr>
<td>Reliability/Adaptability/Resilience</td>
<td>Degraded soils</td>
<td>Labile organic carbon (mg C. kg soil$^{-1}$)</td>
<td>Environmental</td>
</tr>
<tr>
<td></td>
<td>Availability of family labour</td>
<td>Proportion of workload provided by the family on animals and pasture management (%)</td>
<td>Social</td>
</tr>
<tr>
<td>Self-reliance</td>
<td>Low farm management skills</td>
<td>Mid and long term planning $^6$</td>
<td>Social</td>
</tr>
</tbody>
</table>

$^1$ Equivalent meat production ha$^{-1}$ = (kg meat + 2.48*kg wool)/grazing area; $^2$ According to family perception, from 5 = very satisfied to 1 = not satisfied; $^3$ Proposed production technologies: 100% means common 11 technologies proposed to all farmers for the re-design of the LFF (e.g. adjustment in stocking rate, animal allocation according to pasture biomass, pregnancy diagnosis); $^4$ Number of species; $^5$ Shannon Index $H= -\Sigma p_i \ln p_i$, where $p_i$ = the proportion of species, $r$ = total of species, and $i$ varies from 1 to $r$; $^6$ Scale from 5 = value and apply long-term planning to 1 = not valued and do not apply planning.

Region level
An interinstitutional network of several actors in relation to rural development was generated. The actors were the seven above mentioned families, the research team and representatives...
of the farmer organisations and union (SFR-C, SFR-R109 and CNFR), the University, local/national government and local extension services (Albicette et al., 2016).

During the first interinstitutional workshop participants developed a shared view of what their expectations were at the end of the project (the vision) regarding: (i) contribution to enhancing sustainability of the farms in the region; (ii) improvement of interactions among farmers; (iii) promotion of knowledge acquisition and development of abilities for farm management; (iv) increasing networking towards LFF development and (v) dissemination of the acquired knowledge through field days and mass media. The participants discussed the impact of several pathways and proposed strategies, outputs and outcomes to achieve that vision. A communication plan (CP) for the project was elaborated considering its strategy. During the following PIPA workshops the research team members shared the implemented project’s activities and obtained results so that anyone could follow the process. Participants reflected upon results and progress achieved so far, considering the elaborated strategy and using participatory methods and suggested changes for better impacts. This was seen as the M&E process of the PIPA. Activities and workshop results were documented in minutes which were used for linking the workshops together. The CP aimed to effectively disseminate project results and promote learning considering different groups’ objectives: farmers; professionals involved in rural development and organisations. As an example, we present the strategy plan for farmers (Figure 3) and for professionals involved in rural development (Figure 4). Specific activities were defined annually during PIPA workshops.

![Figure 3. Communication strategy for farmers](image-url)
During 2014 and 2016 several activities according to the designed plan took place. Five field days were organised and supported by the interinstitutional network, involving more than 600 participants. In December 2015 almost 200 people participated in the final field day where the research team, farmers and members of the interinstitutional network exchanged results and lessons learned with the participants. The evaluation of the activity was completed by 98 people with 65% being farmers. The field day was scored as ‘very good’ or ‘excellent’ by 93% of the respondents and 83% considered that the technological proposals were useful for the farm on which each worked. At the end of the field day a session with members of national organisations reflected on the project’s results and exchanged ideas for the future of Uruguayan LFF1. The Rural Development Director of Ministry of Livestock stated that the results of this project had shown that in LFFs it is possible to undertake an intensification process along with increasing sustainability and adapting to climate change. He also stated that: “This is not a minor result: with this rigorous scientific data the country’s productivity and the competitiveness of livestock family production could be improved”. Similarly, the representative of CNFR said: “We valued this way of working and we are looking forward to reaching out to more farmers. Fifteen days ago, we presented a project based on this methodology, which will allow us to obtain funding to reach other regions and farmers”.

1 For more information about the 2015’s field day: http://www.inia.uy/estaciones-experimentales/direcciones-regionales/inia-treinta-y-tres/hacia-una-ganader%C3%ADa-familiar-sustentable-jornada-final-del-proyecto-co-innovando-en-rocha-2012-%E2%80%93-2015
The final evaluation of the three-year process, in which all were asked to score certain project related issues, was answered by 18 stakeholders (excluding INIA participants). The global project was valued as ‘very good’ with a mean value of 4.22 out of 5. The relevance of the changes that occurred on the seven farms was valued at 4.28. Two main topics were highly valued, the methodology used to work with farmers (4.44) and the incorporation of suggestion during the project (4.17). The less valued topics were related to the information available in the region on the project results (3.61) and the impact of these results on the near future (3.4).

**Team level**
We consolidated a research team with 25 members including 17 researchers and 8 assistants. A PAR methodology advanced our understanding of the progresses in different areas (economic-productive, environmental and social), guided from the beginning by different disciplinary researchers. It took six workshops of the whole research team to understand the research problem, as well as the methodological approach, and several interdisciplinary meetings for discussions guiding the research process. As the process advanced the workshops focused on analysing the strengths and weaknesses of the project’s implementation, which allowed for the incorporation of lessons learned during the project.

Transdisciplinarity emerged as a new property of the project team integrated by researchers, farmers and local actors. Transdisciplinarity was validated through a survey implemented according to Small et al. (2015), where process success factors were valued as positive with an average score of 5.40 out of a maximum of 7.00. The survey was answered anonymously by 21 members of the research team in 2015.

**Discussion and final considerations**
To develop sustainable agricultural practices researchers need to collaborate with end-users of technology (Akpo et al., 2015; Dogliotti et al., 2012). Consequently, joint definitions of problems and opportunities among the seven farmers and the research team, and considering family’s needs and resources, were key elements in the development of the ongoing re-design of proposals. The results at farm level showed that all the farms improved sustainability when evaluated through a combination of several indicators (Table 1), with the MESMIS method including social quantitative indicators (as pointed out by Astier et al. 2011). Learning occurred based on the data obtained from the indicators that were measured and analysed. Some economic and environmental indicators were reaffirmed in importance, and new social indicators were designed and used to better understand changes and learning processes in family farming systems (Astier et al., 2011).

Changes on farms took place thanks to the co-working between farmers and the research team, especially the field agronomist, mixing their knowledge of farming systems and learning together. A strong relationship between them generated confidence and trust (Rossi, 2011) as well as contributing to the rapid response of farmers to understanding the use of technology, improving their knowledge, abilities and skills (Rockwell & Bennett, 2004) and innovating on their farms (Klerkx et al., 2012). Furthermore, they all have new aspirations to deepen the process of improving farm sustainability. As mentioned by Drechsel et al. (2001)
changes in KASA are a prerequisite for the adoption of an innovation if other conditions are favorable.

Local actors were involved in a three-year project process, considering the seven farms and generating an interinstitutional network that was capable of designing a common vision of what was expected from the project, as well as the planning to make changes happen (Alvarez et al., 2010). The communication plan elaborated by the network defined activities that helped to disseminate the experience and contributed to local development. The vision, the project’s strategies and the activities had been changed during the process to some extent, based on the M&E process and on what had been learned (Douthwaite et al., 2003). The participatory process continued as an experiential learning cycle that can be compared with that described by Douthwaite et al. (2002). The most remarkable results considering the regional level were: (i) government and policy makers now know about the project strategy and results and consider it as an inspiring approach towards implementation of LFF policies and (ii) key organisations related to rural development such as CNFR are now using this methodology in their development projects with farmers. Considering all that, the project directly contributed to enhancing LFF sustainability and rural development.

The PAR methodology (Moschitz & Home, 2014) used by the research team resulted in a novel way of addressing agricultural complex problems by INIA. Furthermore, transdisciplinarity can be seen as a new avenue for generating knowledge along with farmers, representing an institutional innovation (Klerkx et al., 2012; Moschitz & Home, 2014). This approach challenges the research institutions to face practice oriented problems, demanding further development and adaptation according to the needs of other research teams.

Finally, the process of changing towards more sustainable LFF systems in Rocha-Uruguay was achieved by applying a co-innovation approach (Rossing et al., 2010). A three-year learning process jointly implemented by farmers, researchers and interinstitutional network members was based on: (i) working with a systemic view aimed at solving real problems felt by farmers; (ii) combining three levels of action - farm, region and team; (iii) considering an adequate period of time to allow changes and their assessment; (iv) M&E of the process encouraging a learning process among stakeholders and (v) and allowing flexibility to incorporate lessons learned and to make adjustments during the project. The results presented in this work demonstrate that the approach used to address complex systemic challenges and to solve practice-oriented problems by using/applying participatory approaches/methods was effective at enhancing LFF sustainability and contributing to rural development, albeit on a small scale. However, this is an ongoing learning process that needs to continue and improve.

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The authors are grateful to the families who allowed us to work in their farms and shared their experiences with us as well as the local actors who participated in the PIPA’s workshops and in the elaboration of the Communication Plan. The authors thank Fiorella Cazzulli for her support with language editing and the National Agricultural Research Institute of Uruguay (INIA) for its financial support.
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Evaluating a space for co-innovation: the practical application of nine principles for co-innovation in five innovation projects

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Abstract: Primary Innovation is a five year collaborative initiative demonstrating and evaluating co-innovation, a systemic approach to innovation addressing complex problems, in five ‘innovation projects’ (active case studies) in different agricultural industries. In defining the elements of co-innovation, Primary Innovation has emphasised nine principles (based on those from Nederlof et al., 2011) which guide activity in the innovation projects. To understand how useful the nine principles were in guiding practice, and their influence on co-innovation, innovation project participants assessed and reflected on: how the principles were applied in practice; issues that arose; how each influenced the project; and how important each principle was perceived as being in influencing project outcomes. Data were captured and summarised in an on-line survey. While each principle added an important element to each innovation project, different contexts and barriers to implementation required them to be applied in different ways and to different degrees. The nine principles should be understood in each individual project’s context because their appropriateness and usefulness were affected by the type of problem being addressed and the stage of the project. It was also evident that they need to be built into the process from the start.

Keywords: Co-innovation, principles, practice, innovation projects, barriers

Introduction

The need to innovate and how co-innovation fits the requirement

Agriculture is of importance to New Zealand’s economy and one of the six key drivers needed to achieve the government’s ambitious goal of doubling the value of New Zealand’s exports is increasing business innovation (Ministry of Business Innovation and Employment, 2014). It was this driver that helped make the case for a new approach to innovation in the New Zealand agricultural sector. As a result the New Zealand government is now investing significantly in strengthening the innovation system through a programme called Co-learning and Co-innovation to Achieve Impact in New Zealand’s Biological Industries, which is referred to as Primary Innovation (Botha et al., 2015).

Primary Innovation

The technology transfer approach, which encourages the adoption of agricultural research findings, has failed to address increasingly complex problems (Botha et al., 2014). Earlier attempts in New Zealand to encourage adoption of more systemic approaches such as farming systems and Agricultural Knowledge and Information Systems (Klerkx et al., 2012; Reid et al., 1993) were of variable success (Reid & Brazendale, 2014; Turner et al., 2016).
Primary Innovation was therefore designed to demonstrate an alternative approach in New Zealand’s primary sector that could successfully address complex challenges in modern agriculture. The intention is that problems are addressed through a co-evolution of technologies, practices, policies and market changes undertaken in processes of collaboration and negotiation involving multiple stakeholders in the problems. This is also referred to as ‘co-innovation’ (Dogliotti et al., 2014; Hall et al., 2001; Klerkx et al., 2012). Co-innovation is considered to be the result of a process of networking and interactive learning among a heterogeneous set of actors, such as farmers, input industries, processors, traders and researchers. There is an emphasis on organisational change (Kilelu et al., 2013), where: innovation is ‘co-produced’ by many stakeholders; researchers become part of a broader network of actors; and innovation is an emergent property of their interaction.

Primary Innovation has five innovation projects that are embedded in different primary industries, dealing with issues of differing complexity. The projects, in order of estimated complexity from least to most complex, are (Coutts et al., 2014): (i) Heifer Rearing Project (HR) - focused on improving the rearing of dairy heifers by third-party graziers; (ii) Tomato Potato Psyllid (TPP) – which is a vector of the bacterium Candidatus Liberibacter solanacearum (CLso) - with the aim to develop economically and environmentally sustainable control solutions for the TPP/CLso complex; (iii) Timber Segregation Project (TS) - working along the forestry value chain to better match forests to markets; (iv) Irrigation Water Use Efficiency (WUE) Project focused on provision of climate and soil moisture data to farmers to support water use decisions; and (vi) Nutrient Management Project (NM) – focused on increasing the implementation of farm nutrient management plans.

Each of the innovation projects sought to operationalise co-innovation to test the extent to which it enabled progress to developing successful solutions to each of the five problems being addressed (Coutts et al., 2014). The practice of co-innovation has been informed by social research (Hall, 2005; Klerkx et al., 2012; Nettle et al., 2013), systems research (Adner, 2006; Adner & Kapoor, 2010; Rohrbeck et al., 2009) and business management research (Hueske et al., 2015; Rufat-Latre et al., 2010; Smart et al., 2007; Traitler et al., 2011) on how to tackle complex problems. This research has sought to understand the factors associated with successful (and unsuccessful) attempts to address complex problems in agriculture and natural resource management.

However, implementing co-innovation in practice does have challenges (Botha et al., 2014). Firstly, there is still not agreement in the literature on the specific characteristics of co-innovation, for example when operationalised as innovation platforms (Nederlof et al., 2011). Secondly, much of the literature on co-innovation is retrospective case study analysis (e.g. Amankwah et al., 2012; Batterink et al., 2010; Botha et al., 2014; Dogliotti et al., 2014; Klerkx & Nettle, 2013), i.e., diagnosing what co-innovation looked like in specific circumstances. These insights from specific cases (e.g. improving family farm profitability in Uruguay (Dogliotti et al., 2014)) need to be translated into practices for use in each new context (Thiele et al., 2007), such as the innovation projects described above, for the lessons to be operationalised. Thirdly, challenges to implementing co-innovation have been considered as simply barriers to progress instead of a major focus of research (Beratan, 2014). As a consequence there is limited insight into co-innovation practice in the face of barriers, such as insufficient resources, time or capabilities.
Co-innovation is therefore best described in terms of principles, as its practice is still being defined. Co-innovation is context-specific and adaptive, i.e., how co-innovation is implemented must be tailored to the particular situation, which will also change over time (centre of Figure 1) (Hall, 2005; Klerkx et al., 2010; Schut et al., 2014). In Primary Innovation, key principles for co-innovation were identified from the main principles identified by Nederlof et al. (2011) for agricultural innovation platforms. These were adapted for the context of innovation in the New Zealand primary sector based on the project team’s previous experience of co-innovation in the New Zealand context. We used these nine principles to conceptualise the space within which actors can negotiate how co-innovation is implemented in practice over time in specific cases (Figure 1). The nine principles are listed and described briefly below.

Figure 1. A space for innovation project participants to co-innovate, defined by the practical implementation of nine principles

1. Take time to understand the problem from many different views
2. Be inclusive - is everybody present who needs to be there in order to understand the problem, its causes and to develop workable solutions
3. Engage with and value all sources of knowledge - seek new insights and take the time to listen to all the different perspectives everyone brings something to the table
4. Strive to learn from each other by actively listening and understanding - be open to new ideas by being willing to let your understanding and perspectives evolve
5. Keep sight of the shared vision, ambition or change
6. Be honest, open and constructive in your interactions with other participants.
7. Be aware of the wider context of the problem and any actual or potential changes which may occur
8. Be flexible and adaptable
9. Stick with the co-innovation process despite its frustrations

Take time to understand the problem from many different views

By taking the time to fully understand the nature of the problem, and building a shared vision (or ambition for change) solutions will be more likely to succeed. If you begin by assuming you understand the problem and already have a preconceived solution you may not get the changes you desire. Be prepared to consider a variety of solutions.
Be inclusive – ensure everybody is present who needs to be there in order to understand the problem, its causes and to develop workable solutions.

Ensure everyone is there who can help to understand the nature of the problem and its causes and influence the implementation of any potential solutions. Include those who take ideas to the market or create the rules, as well as those who may potentially block solutions. It is easier to develop a solution together than to try and sell a solution after it is formed.

Engage with and value all sources of knowledge – seek new insights and take the time to listen to all the different perspectives – everyone brings something to the table.

Be respectful of other views, experiences and ideas, while at the same time challenging ways of thinking in a constructive manner. Sources of knowledge could be local and tangible or scientific but are not limited to these sources.

Strive to learn from each other by actively listening and understanding - be open to new ideas by being willing to let your own understanding and perspectives evolve.

How we work together and the roles we have may change over time. Active listening is a way of listening and responding to another person that improves mutual understanding. Over time, learning goes to a deeper level, where mutual understanding can impact on attitudes and values and views on what is important.

Keep sight of the shared vision or ‘ambition for change’.

Agree on the nature of the problem, its causes and the desired outcome of the project, and regularly review this outcome and progress toward achieving it.

Be honest, open and constructive in your interactions with other participants.
Remember we are all in this together and no one group can solve this problem on their own.

Be aware of the wider context of the problem and any actual or potential changes which may occur.

We may need to change our solutions and goals as a result of external influences (natural disaster, legislative changes, world markets, unexpected setbacks).

Be flexible and adaptable.
How we work together and the roles we have may change over time.

Stick with the co-innovation process despite its frustrations.
Be prepared to be uncomfortable and for setbacks to occur – we may have to work through historical tensions, current tensions and although this is not fun it is a necessary part of negotiating shared and workable solutions. Things will take time, but this investment will pay off.

Figure 1 illustrates how these principles together create a ‘space for co-innovation’ in innovation projects. The concept of ‘learning spaces’ and ‘collaboration spaces’ have been used elsewhere to describe either characteristics of physical environments that encourage social learning (Kolb & Kolb, 2005; Matthews et al., 2011; Temple, 2008) or online platforms for collaborative activities, such as software development (Geyer et al., 2001; McComb et al., 2010; Morán et al., 2004). Here we conceptualise a ‘co-innovation space’ as being characterised by the extent to which combinations of the nine principles are present. We hypothesis that when more of these principles are perceived by actors in an innovation project as present and strong, co-innovation is more likely to occur, leading to successful innovation.
Aim of the paper
With Primary Innovation in its final stages, research was undertaken on how well the nine principles were perceived as being applied in practice in the five innovation projects, how these principles were adapted to each project’s context, and the extent to which the project teams believed the principles influenced innovation and impact. This paper presents the results of this inquiry and provides grounded experiences in the use and usefulness of these nine principles and also raises questions for on-going theory development around the practice of co-innovation.

Methodology
This paper is based on the results from a survey of the five Innovation Project teams’ use of the nine principles. Each of the project teams was made up of three to five individuals, including the project leader, a Reflexive Monitor, researchers and extension agents, who together implemented co-innovation principles in the project. Each of the project teams were facilitated as a group by the second author in a structured discussion of the questions on the use of the 'nine principles' and a group consensus of responses recorded. During the group process responses were directly inputted into a web-based survey format to reduce double handling of the data and to enable quick access for analysis. Sessions were audio recorded to enable the research team to return to the conversations for any points of clarification. The questions asked in relation to each principle were:

1. How have you applied this principle?
2. What difficulties/issues have you encountered in trying to apply this?
3. How did you address these difficulties?
4. How do you feel that this principle has benefited/added to/changed the project?
5. From your perspective, to what extent have you applied this principle in relation to what you think would be ideal for your project? [rating 0-10]
6. From what you have found to date, how important would you rate this principle in terms of its contribution to a successful project outcome [rating 0-10]
7. General comments about the principle

Data were collated and the authors analysed the data in a group workshop with the purpose of developing a succinct summary of the feedback around each principle. The rating data was also analysed to provide a context around the qualitative feedback. Synthesised lessons from application of principles were also drawn across the five cases.

Results
The results are organised by each of the nine principles, with each described in terms of: (i) was the principle perceived as important to the outcomes of the innovation project and what were the benefits of applying the principles; (ii) to what extent was the principle applied in each innovation project; (iii) how was the principle applied in practice in the innovation projects; and (iv) what were the barriers to putting the principles into practice and how were these barriers overcome?

Understand the problem from different views
Perceived importance and benefits
This principle was rated as highly important to outcomes by all projects, however there was some variation in extent to which projects were able to implement the principle in practice. The
TPP project for example found it more difficult to implement this principle as it has a strong science focus and the project was contracted and planned before co-innovation was considered. The NM project reported that, by seeking these wider views, “It has got people on board and given them an opportunity to have more conversations.” It was also noted that they employed a more controversial way to include different views: “Ignored nay-sayers and organised meetings anyway – they now are supporters”. They also acted to bring newcomers ‘up to speed’ noting that ongoing nurturing was needed.

**Application, challenges and responses**

The projects focused on farmer practice – WUE and HR – on the other hand deliberately brought in farmers’ views early in the project. The WUE project posed the question ‘how could we manage irrigation better’ rather than ‘irrigation is not well managed’. This resulted in expanding the project focus from soil moisture and irrigation to include a soil water drainage element. In the HR project results from farmer focus groups were combined with advice from a technical reference group and input from the funder. This resulted in a broader scope looking at regional differences and non-traditional solutions – moving from weight-gain contracts as the only solution to HR to a broader emphasis on relationships between dairy farmers and graziers.

Although the HR project tried to incorporate different views it did not mean that the stakeholders were always willing to understand each other’s views: “Initially the technical advisory group sort of made their own solutions, they were not really interested in what we were doing and in how we were arriving at solutions.” And to find out which views to include sometimes took a while as the HR project did not have graziers involved from the start. The TS project experienced similar difficulties with getting people on board and understanding each other’s views, taking the project a year to consult with stakeholders and set up ‘clusters’ for stakeholder input. The clusters consist of a mix of growers, academics, processors and suppliers and were described as providing an opportunity for taking time to listen to others’ views – and to put a focus on the timber customers rather than just the grower (seen as a ‘game changer’). It was noted that “this is the first time that some of the growers and processors have sat in the same room together to have these conversations”.

**Be inclusive**

**Perceived importance and benefits**

Inclusiveness was rated as very important by the HR project (10) and less important by the others (range from 7-10) with the NM and TS projects rated the lowest (7). This engagement with stakeholders helped researchers to understand operational challenges and provided a greater legitimacy to the innovation project. Role modelling inclusiveness, as well as persistence of the project team, helped to capture the interest of researchers and science managers and convinced them that being inclusive could be beneficial to them and the project later on.

**Application, challenges and responses**

Science based research projects found it particularly difficult to achieve (score 6) because scientists preferred to work in the traditional mode and there were difficulties with getting everyone together and increased contestability associated with increasing the number of stakeholders. In contrast, in the project with a small number of participants (WUE) it was easy to include all participants through face-to-face interactions. In two projects, TS and HR, value
chain analysis and stakeholder analysis were used to help ensure all stakeholders were identified and included. Commercial interests in the dairy industry made it hard to include some stakeholders, while in TPP many scientists did not believe an inclusive process was beneficial or necessary to achieve project goals.

In the NM project one-on-one conversations were used to deal with commercial sensitivities and being respectful helped to get and keep stakeholders on board, while in the TS project a strong mix of one-on-one and group interactions helped to address the difficulty of getting all stakeholders in the same room. The HR project experienced challenges around the practicality of including everyone and observed how participation changed over time due to disagreements.

Engage with and value all sources of knowledge

Perceived importance and benefits
This principle was rated as ‘central’ to the innovation projects, with an average score of 8.5/10 regarding importance. Most teams were able to invite a wide range of stakeholders into the project, because they valued the knowledge others would bring in terms of understanding the nature of the problem and co-developing solutions. The commitment to this principle was reported widely to result in different stakeholders effectively engaging with and listening to each other, broadening understanding of the issues.

Application, challenges and responses
In practice several challenges arose. First, how to navigate the relative value placed on science knowledge and experience based or industry knowledge, e.g. “Our scientists use experiments and others’ experience” (HR). Reconciling these views when working towards solutions has been difficult because of what different groups believe constitutes ‘data’ or ‘evidence’ or demonstrates cause and effect. In the TPP Project “…there are not too many people that are engaging with people outside of their science bodies” meaning dialogue with stakeholders was a new way to operate.

Second, creating bridges between different disciplines or practices to promote understanding also posed challenges: “We had difficulties understanding what each other were on about” (HR). The TS project mentioned that “you often trade away a bit of control as well as some budget and resource as the number of collaborators has increased.” The solution for all cases was “just do it anyway and let everyone be heard” (NM) largely through creating forums for dialogue.

Strive to learn from each other

Perceived importance
Providing platforms and processes for interaction, discussion and sharing experiences was seen as important to the learning process with resulting changes to planned actions. Teams in the innovation projects felt that they had been doing a lot of listening as part of their projects, and were then able to adapt future actions.

Application, challenges and response
However they identified that the link between listening and learning was tenuous if people involved already felt they knew what the problem was. In the HR project the team explained; “We listened at the focus groups, we took it away, developed a strategy and then went back
into the regions and said this is the strategy we'd come up with, is this what you meant, is this right? What the focus groups told us did not align with our ideas - we were willing to let our own understanding evolve. It ended up being wider than what we started with.” In comparison, the NM team commented; “People can be respectful but actually still not listening… which makes it hard to actually achieve … this is something that will be noticed over time.” The TS project continued in this theme; “This is one of the harder ones for the sector and academics to implement. They have to be willing to change their practices of the past and these can be quite entrenched.” Moreover organisational boundaries and people’s personal comfort zones could get in the way of learning too (TS).

**Keep sight of the shared vision or ‘ambition for change’**

*Perceived importance and benefits*

Innovation project teams agreed that having a shared vision or ambition for change was important. While a shared vision was important there were tensions about the means of achieving the vision.

*Application, challenges and response*

There were some tensions apparent in this principle as not all innovation projects had a shared vision. The innovation projects that had a shared vision had some mechanisms for helping the project teams keep it ‘top of mind’. For example, the NM team have a series of management group discussions informing the vision, and milestone and deliverables based on this vision to keep track of what is happening. The TS team commented “… the way change should occur was much more contested”. For the HR project, there was a process of getting to a shared vision, where the vision was refined until they “… ended up with one that is a win-win for everyone”.

**Be honest, open and constructive**

*Perceived importance and benefits*

Team members across the projects felt that this principle required on-going work. It started a process of building trust, with the long term aim of getting those within the project to a point where they could be honest, open and constructive.

*Application, challenges and responses*

Some teams did this by utilising the structures that had been put into place, for example in the TS project the team commented that “… having a levy that supports research has levelled the area – everyone gets equal value from science”. Most projects struggled initially to build trust, the TPP project for example were working on building trust “… by suggesting that more interactions would be good”, but at the same time they also noticed that “Sometimes there are honest comments but not always put across in a constructive way.” A particular challenge for a number of projects was the need for hidden agendas to be brought into the open so that real interactions could take place. In the NM project the team said, “You never really know what the hidden agendas in a group may be”. In the HR project the commercial competition between some stakeholders initially stood in the way of building trust, and this remains an ongoing issue.
**Be aware of the wider context of the problem**

**Perceived importance and benefits**
This principle allowed the projects to remain anchored in reality and provided a “…much wider perspective of what the findings meant and what it meant for different people - kept the system in perspective” (WUE).

**Application, challenges and responses**
An awareness of the wider context within which the project operates was obtained largely “…by involving all the stakeholders and valuing their points of view”, by doing this “you naturally end up looking at the wider context” (WUE). The principle was seen as important because it “…informs the project as it develops and we understand if priorities change. Need to be aware that things can change and that projects will need to adapt”.

The changing context affecting an innovation project is demonstrated both within the HR and the NM projects, both led by DairyNZ, a dairy farmers’ levy based organisation. Lower global prices for dairy products resulted in a reduced pay-out to farmers triggering an internal reprioritisation of DairyNZ resources towards efficient financial management campaigns. At the project level, this meant greater constraints on staff time and resourcing. Each project team recognised this and altered their plans to suit. For example, the HR project slowed the pace of the project and openly discussed the challenges with other stakeholders.

**Be adaptable**

**Perceived importance and benefits**
Flexibility and adaptability was rated as very important by all the projects with scores varying between seven (HR) and ten (NM). However, both projects indicated that they had applied the principle very well with scores of nine and ten respectively.

**Application, challenges and responses**
Projects overall described the application of the principle in a range of ways. For example, team adaptability and flexibility while being faced by inflexible research goals (TPP), changes to how the project was run (NM), changes in participants’ perspectives (WUE and TS), and project role and participation changes that had occurred over time (HR).

Research focused programmes experienced difficulties in being flexible and adaptable because of predetermined research contracts, goals, deliverables and budgets that lead to lock-in and disciplinary silos. Changing contracts have significant implications for researchers and cause hassles for science and contract managers which discourage flexibility and adaptability. In one project, difficult relationships contributed to inflexibility and reluctance to change. Continuously communicating openly with funders and participants was mentioned in research focused projects to promote flexibility. In the HR some participants left the project because they felt confronted by the requirement to change. The NM team reported that applying the principle created the “…ability to respond to new knowledge and changes in context.” Better utilisation of resources occurred because “…you don’t waste resource on things that don’t work, for example, we have introduced new tools that weren’t thought of at the start of the project” was an advantage to the TS project. The WUE team indicated that the principle “…has underpinned the project and the way it has evolved,” and it also created buy-in from farmers and engaged “other players” like the regional council.
Stick with the co-innovation process despite its frustrations

Perceived importance and benefits
Most projects reflected that this was an important principle that all were implementing because they “are still doing it”. However, it was not seen as necessarily easy with the nine principles all being closely connected and so the need for co-innovation to be “a mind-set not a recipe”. The HR project argued that context was critical rather than persevering with all principles once they have achieved their benefits.

Application, challenges and responses
The TPP project spent effort adapting the co-innovation approach to the context that worked for the different stakeholders – in terms of language and methods. The TS project reported that while they remained committed to active engagement through innovation clusters, they were aware of a need to be flexible, e.g. moving from six monthly to twelve monthly meetings to avoid ‘meeting fatigue’ and using distance communication tools. The NM project reported the need to deal with setbacks and “…working in spaces where we are out of our comfort zones and keeping the shared vision in front of us”. A number of projects referred to how application of the principles resulted in “…slowing down the process” and a loss of some control by researchers. However, TPP noted that the approach has “…put the team in a better place for other projects going forward (trust building)”, and “…it’s an investment in the future”.

Discussion
Relevance or importance of principles
All of the innovation projects rated all of the principles highly (on average 8.6/10, range across principles 8.2-9.4) in terms of their importance to achieving outcomes regardless of context. The highest rating of 9.4 was being honest, open and constructive (6).

A common theme on how these principles benefitted projects, was that they created buy-in by a wider group of stakeholders and improved problem understanding. The TS project’s reference to a mix of stakeholders in the room focusing on the timber customer was described as a ‘game changer’. Other projects reported that this facilitating conversations with different groups and seeing stakeholders effectively engage with one another resulted in a broader understanding of what was needed. There was consistent feedback about how this inclusion ‘got stakeholders on board’ with what the project was trying to achieve.

Improved problem understanding as a result of being inclusive, valuing multiple sources of knowledge and striving to learn from each other also reshaped solutions. For example: the HR project moved from a focus on ‘contracts’ to that of strengthening relationships between dairy farmers and contract ‘rearers’; the WUE project moved from a focus on water application only, to the inclusion of soil moisture monitoring that highlighted drainage issues; the TS project included new timber processing tools that weren’t thought of at the start of the project; and the NM project was able to stop some planned activities because they were wasting resources.

Some principles were rated much lower by individual projects. The HR project for example, rated sticking with the process (9) and engaging with and valuing all sources of knowledge (3) as only 5/10 each. In their case, the problem area was a lot more defined with the focus on the two groups with a stake in the problem. It seemed that from their perspective once the
issue had been teased out and an alternative approach identified, on-going and broad engagement was less needed.

Even though all principles were rated as very important by the projects, the average rating of the extent to which they had applied the principle was lower at 7.8/10 – with flexibility (8) having the lowest average rating (7/10). Comments around flexibility related to the context issues raised earlier – contracts already in place; timelines and milestones already set; and lack of resources. This was particularly the case with research focused programmes – and particularly where the attempt to implement co-innovation occurred after the project had commenced. Application of adaptability (8); wider context (7); and different views of the problem (1) were rated in one project as two, three and four out of ten. There was flexibility in the way different projects applied and adjusted implementation of the principles. For example, the NM project focused on individual farmer collaborators while the HR project used farmer focus groups to gain input and feedback.

**Challenges encountered**

A number of projects made reference to the process of applying the principles around engagement as having ‘slowed the process down’. The need to communicate, negotiate, organise meetings, follow-up and other logistical issues around engagement added cost in terms of time and resources. This was particularly an issue where contracts and timing and milestones were in place and there was little scope to act on what emerged from the extra engagement. One project that also reported this ‘slow down’ as well as some loss of control by the project team saw long term benefits of the process in positioning the research team ‘in a better place for projects going forward.’

There were also issues around mind-sets and agendas that some individuals/groups brought with them to the table – and skill was needed to develop a truly collaborative/cooperative approach in some instances. This impacted on gaining the ‘shared vision’ (5), but also on the way that the vision was enacted. This raises the question about the extent to which all stakeholders need to share the same specific vision.

**Conclusions**

The responses to the survey showed that the nine principles should be understood in the context of the individual projects. Teams provided examples of where they have applied these principles, where they have had problems applying them and how they view them in terms of influence on outcomes. Despite the apparent overlap, each principle added a different aspect around the underlying application of co-innovation. Although there is scope to review these principles and consolidate some, care needs to be taken not to lose each specific facet of the diamond.

The application of these principles within these innovation projects demonstrated that their appropriateness and usefulness were affected by the type of problem being addressed and the stage of the project. Clearly, it is difficult to meaningfully bring in broader perspectives, flexibility and extra engagement when contracts have already been written with explicit activities, outputs and tight deadlines. Also, where projects are directed at very specific management practices or boundaries, there are limits to the value of broader stakeholder involvement and slowing down a process for little gain. It is clear that they need to be built into the process from the start – with the appropriate room to move within the project time frame. Also, the application of these principles needs to be considered in the context of the
complexity of the problem or scope of the opportunity and recognise that not all projects require the same degree of application.

The principles have been shown in these examples to assist in implementing co-innovation in practice, and appear to have supported project teams in reflecting on, learning about and improving their own co-innovation practice. The principles in themselves though do not ensure that project teams have the skills or tools they need to be able to apply them. It was evident that when engaging a broader group of stakeholders’ skills such as facilitating learning, negotiation (with funders and stakeholders) and conflict management are needed. Tools are also needed to support teams in terms of selecting the stakeholders with whom to engage (for example, stakeholder analysis, social network analysis), in capturing complexity (for example, systems mapping), looking at alternatives and in evaluating progress. Extra time and resources are also needed to fully enact some of these principles.

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References


Hitting the bull’s-eye: the role of a reflexive monitor in New Zealand agricultural innovation systems

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Abstract: Reflexive monitors (RMs) are vital to the success of co-innovation approaches in Agricultural Innovation System (AIS) projects. While the practices utilised by RMs have been examined in various contexts, links between their roles and the theoretical frameworks they straddle is limited. This paper will address this gap in terms of explaining the case-specific behaviours that have been utilised in seven different New Zealand (NZ) AIS projects. More importantly, however, it will place the role of the RM in a framework that incorporates AIS, Actor-Network Theory (ANT) and broader Agricultural Transition Theory (ATT). Qualitative data from interviews with six RMs will be used to argue that RMs are a key component in the co-innovation process and are required to play diverse roles depending on project circumstances to enhance system innovation – for example devil’s advocate, project supporter, consensus seeker, conflict mediator, critical enquirer or encourager. The findings have implications for how RMs should be chosen, the characteristics that make a good RM, and how they report on the practice of monitoring a project reflexively.

Keywords: Reflexive monitoring, co-innovation, actor-network theory, agricultural innovation systems, agricultural transition, New Zealand

Introduction

The theoretical framework within which the Reflexive Monitor (RM) role sits in primary industries is the co-innovation approach utilised within the systems innovation and Agricultural Innovation System (AIS) literature. In a seminal resource on applying reflexive monitoring van Mierlo et al. (2010b, p. 11) provide the following definition regarding the position of a RM in a project:

[A RM] "encourages participants to keep reflecting on the relationships between the key items: the ambitions of the project, usual practices and the way they are embedded in the institutions, plus the developments in the system that offer opportunities for realising the ambitions of systems innovation".

While this task in itself may seem like a significant effort, Arkesteijn et al. (2015) report that there are various forms a RM position can take at certain points in time. These include observer, facilitator, or even criticiser that works to link ambitions, practices and subsequent
project developments (Arkesteijn et al., 2015). Importantly, in regard to the workload of a RM, it is also a requirement that they do not fulfil many other tasks within the project so they can maintain focus on broader systemic change (van Mierlo et al., 2010b). Figure 1 shows a continuum from ‘appreciative inquiry’ through to ‘critical analysis’ to highlight the extremes of where a RM can act depending on project circumstances, although it should be noted that RMs can sit anywhere along the continuum and their positions might be altered by changes over the project lifetime. Appreciative enquiry involves encouraging the project team to build momentum. On the other hand critical enquiry involves questioning the project team and the barriers to project outcomes. Both are examples of facilitation techniques (Kristiansen, 2014).

<table>
<thead>
<tr>
<th>Reflexive monitoring attitudes</th>
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<tr>
<td><strong>Appreciative inquiry</strong></td>
</tr>
<tr>
<td>Involved participant</td>
</tr>
<tr>
<td>Build on what is going well</td>
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<tr>
<td>Focus on searching for solutions</td>
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<tr>
<td>Creating safe environment for participants</td>
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<tr>
<td>Building enthusiasm within the project team</td>
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Figure 1. Spectrum of reflexive monitoring attitudes and differences according to approach (Adapted from: van Mierlo et al., (2010b)).

In the context of this paper, AIS is used to frame the institutional interactions of primary industry networks and the impacts of those interactions in addressing a key problem in each innovation project. We aim to build on the AIS literature, as well as to contribute to the broader literature concerning actor-network theory (ANT) (Latour 2005), and agricultural transition theory (ATT) (Wilson 2007). By analysing one actor of an AIS, the RM, we contribute to the application of the co-innovation approach, highlighting the actual roles taken on by RMs in New Zealand (NZ).

This paper examines the RM role in regard to six NZ innovation projects using a participatory action research approach (Chevalier & Buckles, 2013). Early within the initial analysis phase of the research programme that included these innovation projects a gap was identified between theory and practical applications of the RM role in NZ, particularly in the experience and tools being used by RMs and complexity in regard to the expectations of the RM role within each project (Rijswijk et al., 2015). In this context it was hypothesised that ANT and ATT could be useful frameworks to inform and situate the practice of reflexive monitoring due to the emphasis on reflection and participation in applied research and practice and the subsequent transitions that manifest. The role of RMs in NZ are analysed through the eyes of RM practitioners and develop two conceptual models; one to expose the factors that influence the RM’s ability to function within an innovation programme and a second to explore how the RM may operate in practice.

This paper thus aims to report on the practical application of RM roles in co-innovation.
approaches to innovation projects. Firstly, the broad theoretical framework the paper utilises is presented. The research method will then be described before the results are presented to answer the primary research question: what roles are RMs performing in the context of NZ primary sector co-innovation projects? Finally, links back to literature will be made in order to increase the relevance of the findings and encourage debate in broader AIS work.

Theoretical framework
Klerkx et al. (2012) examine the evolution of AIS in relation to understanding agricultural systems and key enablers for innovation. The concept of co-innovation became a mechanism to link collaboration and innovation in order to solve complex problems (Lee et al., 2012). The concept of co-innovation can be thought of as one end of the continuum from direct technology transfer at the other. Co-innovation involves understanding that each actor has a role in designing their future, as opposed to the technology transfer approach (Mylan et al., 2015). Reflexive monitoring in action (RMA) is already practised in the European context (van Mierlo et al., 2010b), usually across multiple industries, however, formal RM use within a NZ AIS context is only beginning to emerge (Rijswijk et al., 2015).

It is also important to define what is meant by ATT. Here the term is used to broadly encompass the work that has been done in mapping the transitions of agricultural regimes through various processes. For example, Robinson (2004) used the term ‘food regimes’ to discuss the evolution of agriculture, whilst other important work has encouraged transitions from agricultural bio-economies to eco-economies based on more agro-ecological principles (Marsden, 2012; Marsden, 2013a; Marsden, 2013b). Although it is generally recognised in this work that there is a need for productivist agricultural outputs, for a number of reasons it is increasingly important to value the multiple functions of agricultural land use (Wilson, 2007; Wilson, 2008). The underlying assumption of these varying, yet related, fields of scholarship is that, as a society, we should aspire to increase the diversity (biological/economic/social or people/profit/planet) of our agricultural systems. It could be argued that within the vast expanse of ATT work, a contribution from ANT may help decipher the trajectory of any future change. This is made possible by Latour (2005, pp. 64-65) asserting that ‘for ANT, we now understand the definition of the term is different: it doesn’t designate a domain of reality or some particular item, but rather is the name of a movement, a displacement, a transformation, a translation, an enrolment’. In many cases, broader ATT argues for change in the way society conducts agriculture, while ANT can provide an alternate view of this transformation, whereby the resources traditionally dissociated with the social (commodities, scientific research, agricultural policy, or genetic modification to name but a few) become ‘actors’ in the game, not just ‘hapless bearers of symbolic projection’ (Latour, 2005, p. 10). These principles are broadly shared with AIS, which points to AIS, ATT and ANT sharing an ambition for change that it could be possible to bring together to increase the strength of such a movement.

Method
In regard to this paper, primary data were gathered using semi-structured interviews with the five RMs in each of the six innovation projects in a NZ research programme called Primary Innovation (one interviewee acts as RM for two projects). The innovation projects included: a project examining heifer rearing in the dairy industry; an integrated forestry sector project; a nutrient management project involving the dairy industry; an irrigation scheme project; a project aiming to reduce a pest in tomato and potato crops; and a project looking at broader systemic change within NZ AISs. Interview questions were developed depending on the
project the RM was involved in. The questions asked were altered to suit the RM being interviewed allowing them to talk more specifically about significant issues relating to the relevance to each innovation project in a more reflexive manner (Beers & Bots, 2009; Lamprinopoulou et al., 2014).

The following seven steps provide a timeline for the events that have led to the composition of this paper. Of primary importance is the iterative process that has been utilised in order to enhance learning and increase the alignment of the project tasks with the meeting of project aims. Simultaneously, significant effort has gone into the utilisation of more developed theoretical understandings of the RM role in the Dutch context, utilising expertise from the Wageningen University and Research Centre (WUR) and subsequently applying that knowledge to the NZ AIS cases.

1. Research programme begins with six projects requiring RMs (October 2012): initial confusion, questioning of the RM role.
2. Regular monthly meeting of NZ RMs begins (April 2013).
3. Barbara van Mierlo visit to NZ (August 2013) providing a key question for RM practice: ‘what is the ambition for change for the project?’
4. RM trip to WUR (April 2014), including RM workshop with Barbara van Mierlo: highlights diversity in RM role and similar questions from others working in co-innovation space.
5. Projects renamed ‘innovation projects’ (July 2014): key shift in thinking for the whole of the research team, reflected in terminology.
6. NZ RM workshop (July 2014): bull’s-eye diagram developed and ‘RM guide’ started.

Results

**Applying RM principles to decision making**

RMs can analyse and reflect on co-innovation projects based on the steps of the action learning cycle (van Mierlo et al., 2010b) (Figure 2 inset). Reflection and action should be structured to assist the project team achieve their ambition for change by mitigating systemic failures (van Mierlo et al., 2010a; Nederlof et al., 2011; Wieczorek & Hekkert, 2012). The RM cycle in Figure 2 is also useful for deciding when a RM should intervene in a project to uphold co-innovation principles.
Figure 2. Action learning cycle that could be implemented by a RM.

At each stage of the RM cycle a process can be followed to determine how a RM might act.

1) **Observe**: the process of observation draws on multiple forms of evidence from body language, facial expressions, tone of voice, interpersonal communication, language used, content of the conversations, short interviews, conversations, structured participant reflections and secondary data sources (Dick, 1991; Forester, 1999; Kitchin & Tate, 2000). van Mierlo (2013, pers. comm.) found that successful RMs were typically experienced facilitators. As a consequence, they are familiar with structuring small group processes of dialogue and decision making.

2) **Analyse and evaluate**: all the data collected during the previous stage can undergo thematic analysis (Flick, 2009). The depth of analysis depends on the speed at which the cycle is moving; the faster the cycle the quicker the thematic analysis. The key questions during analysis are:

   - are these behaviours and actions consistent with the co-innovation principles? (i.e., will it assist the project to overcome/change any potential barriers to success within the system?)
   - what will the likely impact of the observed behaviours, actions or practice be on the ambition for change if no intervention occurs?
   - what is driving the observed behaviour, practices and action?

van Mierlo et al. (2010b) and Nederlof et al. (2011) provide insights into what behaviours and system characteristics are desirable and what may hinder systemic change. This literature and the RM’s previous facilitation experience provide a reference point against which to evaluate behaviours and activities within the project.
3) **Reflect:** once the data has been analysed, reflection can occur on how behaviours, practice or activities could be altered (or current practice strengthened) to enhance the change ambition or generate systemic change. Each option should be carefully evaluated based on the benefits and costs of its application. Who is involved in the reflection will depend on the speed at which the cycle is moving; the faster the cycle is moving the less people will be involved. If the cycle is occurring rapidly, the RM may be the sole reflector. Reflection should be structured to assist the project team achieve their ambition for change by mitigating systemic failures (van Mierlo et al., 2010a; Nederlof et al., 2011; Wieczorek & Hekkert, 2012).

4) **Act:** all actions and interventions should be undertaken by the most suitable person and will depend on the nature of the issue. For example, it may be the RM in a meeting setting or the project manager in consultation with other project members. How these actions occur will need to be negotiated with the project team at an early stage of the project. There is a wealth of literature and practice which may inform the choice of action and the benefits and trade-offs associated with each alternative (Dick, 1991; Chambers, 2002; Chevalier & Buckles, 2013).

**What does a RM in NZ do?**

This section addresses the primary research question in terms of the roles of RMs in the context of six NZ innovation projects. Based on the experiences of those operating as RMs in the seven cases it was clear that there is no one size fits all definition or approach to reflexive monitoring, as there were examples across the entire spectrum identified by van Mierlo et al. (2010b) (Figure 1). All of those interviewed agreed that the role is about supporting the project manager and team to achieve the project goals; “a supporting role but a critical supporting role” and is “a role that doesn’t get much recognition”. Other aspects of the role are identified in Table 1. As one RM noted: “you adapt your skills to the role, and RMs require certain personality traits and mind-sets rather than particular skills… [they must be] open to other viewpoints, [have a] strong team mentality and want to see collaboration and co-learning outcomes”.

Over the life of the research programme there have been shifts in thinking about the RM role. At the beginning of the project there was confusion and questioning as to whether the RM was essential and how it was different to a good facilitator. As the programme began and there was interaction across projects and with other RMs (notably workshops with Barbara van Mierlo from WUR) there was acceptance of the RM role, albeit with some confusion about how exactly it was to be undertaken in specific projects. van Mierlo (pers. comm. 2013) provided an initial question to help guide RMs; ‘what is the ambition for change?’
Table 1. Definition of a RM by current RMs.

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Description</th>
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| Supporting role (supporting project manager and wider project team) | - “Support work done by project team”  
- “Find ways to get the group to agree, not everyone will agree but everyone has to be able to live with it”  
- “There to help take temperature gauge, let the project leader know how the process is going”  
- “Picking up different things from what a project manager would pick up” |
| Get the project team where it needs to go   | - “It doesn’t have to be a straight line, it can be a bit wobbly, because it will be, constantly assessing against what you’ve said you want to achieve and how are we going towards it”  
- “Always asking why”  
- “Asking the question ‘is the project on track?’”  
- “If the direction is changing, do they realise?”  
- “Keeping them on track towards the goal” |
| Identifying conflict                       | - “Don’t get involved in the conflict between members…highlight conflict to project manager”  
- “Mediate conflict…if that’s what project manager wants from you” |
| Data collector / Evaluator                 | - “Making sure the project is tracking along”  
- “Figuring out what is causing blockages” |
| Facilitator                                | - “Facilitate project meetings” |
| Providing feedback                         | - “Two different parts, devil’s advocate and pushing hard and looking for positives and building support”  
- “Offer opinions, throw things back at them to think about” |
| Identifying the right stakeholders to be involved and valuing their knowledge | - “Making sure everyone’s knowledge is continually included”  
- “Making sure the right people are involved at the right time”  
- “Having everyone’s knowledge heard”  
- “If someone is missing ask why” |
**RM Influence and challenges**

During the most recent workshop involving NZ RMs (step 6 of the list in the method section) it was found that not all characteristics identified in Table 1 have the same level of influence to the RM role as others. A diagram was subsequently developed through discussion of the question: ‘what influences the way we work and our ability to have impact as reflexive monitors?’ Each RM contributed their personal list of items. The workshop was used to identify similar issues and highlight which of these were under the control of the RM. The resulting ‘bulls-eye’ diagram is presented in Figure 3. In the centre bull's-eye are the aspects that the RM has the most control over, as the circles expand the RM has decreasing influence on these aspects of the role and may find it can be unproductive to attempt to address these concerns (Figure 3). The central controllable aspects of a co-innovation project are of primary importance in regard to choosing individuals to take on a RM position. Follow up interviews (after the most recent workshop) revealed that RMs believed the most important requirements for the role were:

- personal skills
- a good relationship with project manager
- having a support network
- having a clear job description
- having freedom to experiment
- meeting expectations of the project team

![Figure 3. The bull's-eye highlighting things a RM can control with decreasing influence.](image)

**Figure 3.** The bull's-eye highlighting things a RM can control with decreasing influence.
Similarly, although the RM has less of an influence over the outer rings (Figure 3) these aspects of the project can still present concerns. For example, the challenges a RM will face in the role will be influenced strongly by the:

- **Project they are involved with:**
  - the project might go against the RM’s own principles (e.g. personal concerns about genetically modified organisms)

- **Project leader and their expectations of the role:**
  - how the project leader defines the role
  - what the project leader expects of the RM (e.g. interventionist role, sit back and observe or somewhere in between?)

- **RMs personality:**
  - may not be comfortable taking on an interventionist role or being passive/reserved

- **RM having another role in the project (e.g. they also provide technical expertise or are conducting social research):**
  - this may cause tension between how the RM is seen by the project manager, the project team and how the RM sees the role

- **RM working in the same organisation as the project leader:**
  - may make it harder to be objective or critical

- **RM working in a different organisation to the project leader:**
  - may not be aware of the political climate the project leader is operating in
  - may not understand how the project leader’s organisation works
  - may be working with different company structures and hierarchies

- **Physical proximity to the project team:**
  - it may be expensive and time consuming to attend all meetings
  - it may take longer to build up trust
  - there can be a lack of opportunities for informal interaction

Although some of these challenges may be out of the control of the RM, those that cannot be controlled need to be managed in a way which assists the project team and its partners to achieve their ambition for change. It is extremely important as an RM to reflect on all these factors in order to inform practice and identify potential future risks to the project. The primary focus of the RM should be on what they can do to encourage and support the application of co-innovation principles within their projects (van Mierlo et al., 2010b). These principles were built from previous work and are based on taking time to understand, being inclusive, valuing various sources of knowledge, being open and honest, sharing a vision, sticking with the process, being flexible and being aware of the wider context (van Mierlo et al., 2010b; Nederlof et al., 2011).

The literature and results suggest that RMs collect data, provide feedback, support the project and are critical when required. The 13 lessons learnt in Table 2 also make this point quite clear. At all times RMs are required to foster relationships with various actors using components of a broad toolkit which can now be found online (AgResearch Limited, 2016). It is also important to consider the role of a RM and the findings from this work, in relation to a discussion of the theoretical concepts introduced earlier.
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| **Build a relationship with project manager** | - “Need honest conversations around expectations”  
- “Regular communication”  
- “Need their buy-in”  
- “Help facilitate you into the group”  
- “Establish a relationship of trust and rapport with the project leader, tough and very direct discussions will come up”  
- “It's a hard road to get the project leader to realise things need to be done differently – there is a fine line between being seen as helpful and being seen to be interfering” |
| **Define the role**                         | - “Work with project manager to define the role and what their expectations were”  
- “Important to ask this as there to help them”  
- “Don’t go in and say what you think, project manager has to have buy-in”  
- “Need a clear definition of the role at the start”  
- “You must remain disconnected from the project – it is not your project, you need to remain apart from it in order to see it clearly”  
- “Must have the skills to ‘speak the truth kindly’ and remain dispassionate when those who are personally involved get defensive when you touch a nerve” |
| **Use accessible terminology**             | - “Jargon doesn’t work…is a barrier…use laymen terms”                                                                                                                                                  |
| **Be flexible in your approach**           | - “Activities you try”  
- “Be willing to try any approach – think creatively about methodologies”  
- “Takes a lot of time – more than you think”                                                                                                                                                       |
| **Have open communication channels**       | - “Always be willing to see another point of view, and encourage others to see other points of view also”  
- “Things won’t happen the first time you bring it up – keep telling the same consistent message until they are heard”  
- “Give consistent messages”                                                                                                                                                                         |
| **Have a support network**                 | - “To talk to and off-load”  
- “Don’t necessarily need solutions from them”                                                                                                                                                      |
| **Monitor and evaluate**                   | - “Part of your role”  
- “Helps you understand/track what is going on”                                                                                                                                                      |
| **Provide feedback**                       | - “Two different parts, devil’s advocate and pushing hard and looking for positives and building support”  
- “Can only identify change, you cannot make change happen”  
- “You point out the behaviours needing change and actions that must be taken, but cannot make them change, only support them to change”  
- “If change isn’t occurring, or they disagree, then you need to be able to self-evaluate and accept that you might be wrong on this one” |
| **Specific training is required** | “Facilitation training”  
| | “Conflict resolution”  
| **Build trust** | “With the project manager”  
| | “With project team members”  
| **Use different strategies according to participants** | “Interview team members individually, as this allows them to get across the real institutions and attitudes that are driving the team culture, as well as highlighting what they believe the key problem or ambition for change is”  
| **No right way to do the role** | “Best advice I got was from another RM – just make a start, just do something…it is very difficult to know what to do as an RM, so it is literally taking a step out and hoping a stepping stone presents itself so you can go forward”  
| | “Context specific – approach role differently based on a number of factors”  
| **Have a buddy** | “Someone to learn from”  
| | “Talk things through with…doesn’t mean giving you answers”  

What do the lessons learnt mean for AIS, ANT and broader ATT?

Firstly, it is important to understand that RMs fit within AISs that can be conceptualised in numerous ways. For example, an AIS could form part of a socio-ecological system (SES) approach to a problem, where resources are separated from individual actors and the relationships between these groups form the SES (Lebel et al., 2006; Ostrom, 2009; Weible et al., 2010; Bardsley & Bardsley, 2014). Although this might be a useful framework to address some issues – particularly regarding the resilience of systems and their adaptive capacity (Walker & Salt, 2006; Olsson et al., 2014), in this context it is argued that the AIS literature, and particularly the RM role, sit more readily within conceptualisations of ATT and ANT.

As discussed earlier in the theoretical framework section, AIS projects are based on the recognition that all stakeholders need to be receptive to constant change in the current climate (supporting the ANT thesis of transformation). As found in the results, the RMs role in an AIS project is to be a guiding voice in regard to following the principles of co-innovation by reflecting on where the project is going. Latour (2005, pp. 11-12) calls on social scientists to no longer “limit the range of acceptable entities, to teach actors what they are, or to add some reflexivity to their blind practice. Using a slogan from ANT, you have ‘to follow the actors themselves’ that is to try to catch up with their often wild innovations in order to learn from them what the collective existence has become in their hands.” This highlights an important social science role that RMs must play.

The practical lessons learnt from RMs in the innovation projects in NZ provide evidence of the changing nature of approaches to tackle complex problems by reflectively considering the actions of those involved throughout an innovation project (Table 2). There is ‘no right way’ to be a RM, you need to be flexible, strategic, work on relationships and have support in place. Theoretically the RM role within the framework of RMA could be seen as central to the AIS project, an actor itself in ANT, and contributing to broader ATT by altering the direction of agricultural regimes from inside these networks (Figure 4 shows a simplified diagram of this).
There are also broader implications for trans-disciplinary research in general, particularly in regard to linking threads of theories that share similar traits. Although we do not have scope to discuss those in this paper future work will aim to tighten these gaps in knowledge and merge theoretical understanding.

The RM in each project allowed for the actors involved to create space where they could enact their own collective transitions toward project outcomes (Audet, 2014). This work highlights the important role of a RM in regard to encouraging innovation and shifting the mind-sets of project stakeholders. As Cohen and Illevea (2015, p. 201) explain, the “complexity and uncertainty of a transition make it difficult, if not impossible, to deliberately engineer”. Conceptually this work built on important literature to provide both practical suggestions for future RMs and began to thread the ‘actors’ that are these theories, in the encompassing ANT use of the term, into a larger theoretical meta-database (Latour, 2005; Wilson, 2007; Klerkx et al., 2010; van Mierlo et al., 2010b; Marsden, 2012).

![Diagram of RMA within existing socio-agricultural conceptualisations](image)

**Figure 4. How RMA fits within existing socio-agricultural conceptualisations**

**Conclusion**

This paper analysed the role of RMs in regard to six NZ innovation projects. In response to the research question it was found that a RM is required to be prepared for various situations, depending on the individual project, the stakeholders involved and the broader context in which the project sits, as they will influence the actions that can be taken. Simultaneously a RM should focus primarily on the aspects of a project they can influence (the middle of the bull’s-eye in Figure 3) as that will be most productive and hence most likely to alter the agricultural regime they are embedded in. This study strengthened the scholarship around the practical application of reflexive monitoring in AIS and also introduced relations with ATT and ANT. This study found these concepts have potential in regard to taking this work further, particularly as co-innovation through AISs is increasingly recognised as an appropriate approach to tackle problems with ever-increasing complexity.
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References


Multi-scale modelling as a tool for sharing the perspectives of researchers, practitioners and farmers on beneficial management practices to be adopted in an intensive agricultural watershed

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Abstract: Canadian agricultural production systems are facing issues related to maintaining high crop yields and profitability while adopting beneficial management practices (BMPs) that mitigate their impact on the health of the environment. Since 2014 Agriculture and Agri-Food Canada (AAFC) has been collaborating on the development of an open innovation platform, namely the “L’Acadie-Lab” living laboratory, initiated by an interactive community of farmers, practitioners and researchers to increase the adoption of BMPs in the L’Acadie River watershed, in southern Quebec Canada. So far, workshops have been held featuring farmers, practitioners, scientists and other stakeholders. These workshops have revealed a disconnect between farmers’ expectations and research organisations’ ability to provide a consistent array of practices and knowledge. To get new knowledge and technology adopted, consistent choices between various practices that interact on a range of spatial and temporal scales have to be proposed to the users and the economic and ecosystem benefits have to be demonstrated. In response to these issues, the authors propose the development and use of a participatory modelling approach as a tool for sharing the perspectives of researchers, practitioners and farmers on innovative practices to be adopted. The approach links the knowledge of researchers and certain modelling tools at the plot level or the farm level with ecosystem services simulation models at the landscape level to produce quantitative or semi-quantitative results. Farmers and advisors will play a special role in defining the scenarios to be simulated to ensure that their situations and concerns are reflected and to increase the commitment to innovation.

Keywords: Beneficial management practice, open innovation, knowledge and technology transfer, participatory modelling, intensive agricultural watershed.

Introduction

Issues for Canadian agriculture
The agricultural systems in eastern Canada and notably Quebec and Ontario are dominated by intensive crop production, mostly maize and soya, which use large quantities of inputs.
These systems have many environmental impacts such as water quality deterioration, loss of biodiversity, soil erosion, deforestation and greenhouse gas emissions.

Research and development agencies have developed and promoted beneficial management practices (BMP) for more than two decades. In particular, advances have been obtained in knowledge pertaining to BMPs related to fertilisation, soil conservation practices, hydrological infrastructures and integrated pest management (AAFC, 2015). However limited success has been seen in their implementation in farmers’ fields (Groulx-Tellier, 2012; Bibeau & Breune, 2005). In fact the implementation of the BMPs faces two significant issues in Quebec:

- the difficulty in getting a critical mass of farmers to participate, in particular for developments that have an impact on the landscape;
- these programmes often fall short in sustaining the adoption of the BMPs.

Current programmes of development of the BMPs have made it possible to favour the adoption of agro-environmental practices among those farmers who were already the most convinced of their importance (pro-environment attitude). A large proportion of farmers that have a less environmentally friendly attitude thus remain to be convinced and the extent of their participation in these programmes is therefore critical for the success of implementation of the BMPs. It is also often observed that once the financial support has come to an end, the mobilisation of the agricultural community starts to weaken. In other words, the developments that are done in the field are not all maintained or preserved once the project is over. This situation calls for a new way of thinking around the transfer of BMPs to the farming community. In fact, the most recent literature supports this need for a shift in thinking on the research-development-transfer continuum.

**New ways of seeing innovations**

Innovation theory generally distinguishes two categories of innovation processes (Leeuwis & Aarts, 2011): linear processes, most commonly given by the experts or by the technology to be promoted; and systemic processes. The theoretical conception of innovation that is most familiar to governments is the top-down approach, where innovation follows a linear path from the initial idea to adoption by the end user, who is a receiver of information (ENRD, 2013). Initially developed for the transfer of so-called ‘hard’ technologies and marketable products, this type of linear process is today considered inadequate for knowledge and technology that concern the introduction of beneficial management practices and sustainable production systems in the farming landscape (Dolinska & Aquino, 2016; ENRD, 2013; Anandajayasekeram, 2011). This inadequacy stems from the fact that agriculture is based on management decisions made in a complex context of biophysical, ecological and socioeconomic interactions, and that the knowledge and technology cannot be directly adopted; each farmer has to adapt them to his specific context (Martin et al., 2015; McIntyre et al., 2009). Moreover, the public research and development organisations tend to produce individual and partial sets of knowledge and technology (silos), which the farmer or even the agricultural advisor finds difficult to integrate (Anandajayasekeram, 2011). Finally, the success of linear innovation is very dependent on the capacity of research to design tangible results that are relevant for users (ENRD, 2013). In a system where local conditions are preponderant factors in the adoption of knowledge and technology, the innovation approach must sometimes incorporate the contribution of the users into the creation process, for which the linear model was not designed. Esparcia (2014) frames the importance to innovation of combining local and expert knowledge with a wider network of support from the public sector.
Systemic innovation models were proposed in the early 1990s to take into account the fact that in agriculture, innovation does not arise from a single source of knowledge, but from multiple sources (e.g. researchers, practitioners, users, NGOs, etc.) and that every generation of knowledge and technology occurs in a certain political, economic, agroclimatic and institutional context (Anandajayasekeram, 2011). Today, Canada's strategy "Seizing Canada's Moment: Moving Forward in Science, Technology and Innovation 2014" (Government of Canada, 2014) recognizes that "innovation is a complicated process that is neither defined by a simple formula or playbook, nor easily measured," and that sometimes, "innovation comes directly from advances in science and technology, but it can also stem from other sources." According to Berthet et al. (2015), innovation in such an agro-ecosystemic context will depend on changes in the nature of the knowledge, which will be both agricultural and ecosystemic, and on the social interactions inherent in the reduction of the knowledge by the various stakeholders, which suggests a need for a participatory approach.

Following these statements, the authors of this paper have initiated a new dynamic in a region situated in the South West of the Quebec province, in a river basin that concentrates the environmental issues related to agricultural systems impacts. This dynamic takes the form of a living laboratory that is presented in the next section.

The living lab approach

**Fundamentals of living labs**

Since 2014, the authors have been collaborating with agricultural and environmental organisations of the L'Acadie watershed on developing a knowledge and technology transfer platform (Umvelt, 2015; Gariépy et al., 2015). This living laboratory, called L'AcadieLab, requires the commitment of all actors, and seeks to address the issues of rehabilitating agroecosystems and creating attractive living environments within the territories with intensive farming.

The L'AcadieLab relies on an open innovation approach, inspired by living laboratories and involving a community of agricultural producers, practitioners and researchers. This approach:

- is based on the process of co-creation and experimentation of new agro-environmental practices with the end users (the farmers) in real conditions (a specific watershed);
- is carried forward by the users. It involves the farmer both as stakeholder in the processes of co-creation and as beneficiary of the positive outcomes of these processes;
- is based on a collaborative partnership that brings together the whole agro-environmental innovation chain from the research to the extension and professionals of farming.

Through this approach, the knowledge provided by the farmers is every bit as important as the knowledge coming from the other stakeholders (e.g. the actors in the agro-environmental innovation chain and the researchers). It is, above all, a way of being and doing in the project. For example, instead of proposing a priori a new integrated development model for watersheds, it offers an opportunity to establish a dialogue among existing models, and attempts to create synergies among them in order to ultimately arrive at a new or combined approach and at development tools integrated by the co-creation among the stakeholders.

**L'Acadie River watershed**

The L'Acadie River flows north over 82 kilometres in the Montérégie region, on the south shore of the St. Lawrence River, in Quebec, Canada. Its source is located near the municipality of
Hemmingford (45.038N/73.558W). It runs north through Napierville and L’Acadie to its mouth at Chambly Basin (45.476N/73.287W). It is the main tributary of the Richelieu River which is home to more than 50 species of fish, some of which (such as copper redhorse, river redhorse and lake sturgeon) are considered threatened or endangered.

The L’Acadie River flows through a number of small towns as well as agricultural and forest areas (Figure 1). Its drainage basin covers an area of 41,336 hectares (ha), including 30,884 ha (75%) under cultivation - mainly grain corn, soybean and vegetables. More than 10,000 ha are cropped under the supervision of local agri-environmental advisory clubs. An AAFC experimental farm also operates in the watershed. The area has major issues pertaining to surface and subsurface water quality as well as soil conservation and habitat rehabilitation.

Considering the type of land use and intensive anthropogenic activity within the watershed, as well as the commitment by farmers to agricultural beneficial management practices, the L’Acadie River watershed offers a suitable context for the implementation of a living lab aimed at improving the development and adoption of knowledge and technology.

![Figure 1. L’Acadie watershed land use and number of farms per category of production](image)

### Activities conducted and results achieved in the L’AcadieLab so far

In 2014 to 2015 a series of meetings were held to lay the foundations of collaboration and to identify BMPs to be implemented. Researchers, local partners, community stakeholders and 55 farmers have participated in this start-up and mobilisation phase. Ten BMPs with the potential to maximise the positive environmental benefits of the projects to rehabilitate agricultural systems have been listed and analysed collectively to identify the most promising. It is on this basis that the cycle of co-creation and exploration has been developed. The following paragraphs highlight the gap between the farmers and the researchers’ perceptions with regards to the gain and effort pertaining to specific BMPs.
Farmers' perception of the usefulness and credibility of the BMPs

Figure 2 illustrates the evaluation done by local agriculture stakeholders (mainly farmers and agricultural advisors) of the effectiveness of the proposed BMPs. In the opinion of the participants who were invited to evaluate the proposed BMPs, it seems that measures such as the riparian buffers, the two stage channel and the wet-retention ponds are perceived as unattractive measures. These measures require an effort on the part of agricultural producers that is considered to be excessive in relation to their perception of the environmental gain and of the satisfaction of their needs that such measures could produce. On the contrary, integrated pest management, direct seeding and controlled drainage seem to be of proven value in terms of gain. Moreover, SCAN (a tool for optimising fertilisation) and cover plants seem to be less difficult to adopt for the producers. Apart from the evaluation by the local agriculture stakeholders, what we observed was their high capacity to establish a consensus on their perceptions of the potential gains and required efforts associated with each practice.

Figure 2. Perceptions of local agriculture stakeholders of the effectiveness of the proposed BMPs. Each point represents the consensus obtained among farmers, agricultural advisors and stakeholders participating in the workshop.

Support of researchers for an open innovation approach: a challenge yet to be met

A similar exercise was carried out with the researchers from different research institutions that could be involved in the future of the L'AcadieLab. In Figure 3 each point represents the vision expressed by one or more researchers. Although the same exercise was proposed to the farmers and researchers, a consensus was not reached within the community of researchers concerning the potential gain and effort that the implementation of the BMPs would require in real conditions.

There is therefore a clear difference of perceptions between the farmers and local stakeholders, and the researchers. For example, the riparian buffer is seen by local participants as a BMP with a low potential gain while the researchers considered that the gains related to the adoption of this measure would be medium to high. To get new knowledge and technology adopted, consistent choices between various practices that interact on a range of
spatial and temporal scales have to be proposed to the users and the economic and ecosystem benefits have to be demonstrated. Further information about the BMPs, their usefulness, advantages and drawbacks, and contribution to the sustainability of the farming systems and of the region is needed.

Consequently, even in a collaborative approach are there major challenges that lie ahead if we want farmers to adopt innovative practices stemming from research, including: building the capacity of stakeholders to make consistent choices between various practices that interact on a range of spatial and temporal scales; and establishing methodologies for assessing the economic and ecosystem benefits for farmers and society in adopting new knowledge and technology. In response to these issues, the authors propose the development and use of a participatory modelling approach as a tool for generating the needed knowledge and for sharing the perspectives of researchers, practitioners and farmers on innovative practices to be adopted.

!![Image]

**Figure 3.** Perception of researchers questioned about the effort and the gain produced by the BMPs. As the researchers did not reach a consensus, their different visions are represented (each vision is represented by a point).

**Proposition of a framework for scenario development**

**Rational**

Through the development of participatory modelling, the project team is seeking to address three major scientific and management issues relating to the establishment of the L’AcadieLab and to the BMPs:

- the improvement of the capacity of the stakeholders to make a coherent choice among various scenarios for adopting the BMPs introduced at various spatial scales (parcel, farm, landscape or watershed) and temporal scales (e.g. impact of climate changes, changes in markets);
- the development of a methodology for evaluating the consequences of adopting these BMPs for the farmer and society, in particular through indicators of sustainability, which will
immediately be used to evaluate the sustainable nature of the systems and modes of production;

- the acquisition of a scientific understanding of how to optimise and quantify ecosystem services as a result of the possible introduction of new knowledge and technology into agricultural systems.

Many methodologies have been developed and implemented to bring together the actors in research and development projects (Bos et al., 2009; Neef & Neubert, 2010). Participatory approaches, in partnership, possibly with the creation of multi-actor platforms, have been imagined and tested for the diagnosis of existing and innovative systems and the co-construction and evaluation of scenarios (Giampietro, 2003; Kok et al., 2007; Etienne, 2011; Meynard et al., 2012; Bewsell, 2013). The farmers and local actors of the L'Acadie River watershed, AAFC researchers and partner institutions will also be closely associated with this work of evaluating innovative systems and formalising possible futures, for at least three reasons:

- the actors in a territory bring knowledge of the biophysical and socioeconomic characteristics of their environment, which are relevant for evaluating agricultural systems (Scoones & Thompson, 1994), and for co-creating innovative systems (Salembier et al., 2015);
- their knowledge can influence the choice of evaluation criteria, and even bring in new criteria and act on the definition of the level of detail necessary for quantifying indicators, so that they will put their trust in the indicators and be able to use them for negotiations or decisions (Delmotte et al., 2016);
- some actors in a territory (for example, agriculture advisors, farmer associations' representatives) have the capacity to make the changes required to improve the economic and environmental performance of the agricultural systems (Martin et al., 2015).

For these reasons, our plan is to use, together with the actors, a diversity of models to design and assist developments of agricultural systems. The simulation models will be used to evaluate the anticipated consequences of the transfer of knowledge and technology and of projected innovation in terms of the sustainability of the agricultural systems and of goods and services offered by the agricultural territory of the L'Acadie River watershed. However, so that the knowledge and technology can be jointly developed and shared with the local actors (e.g. farmers, agriculture advisors, farming and environmental associations), it is appropriate to mobilise them through a participatory approach.

**Methodological approach**

The project’s methodological approach consists of associating the knowledge of the scientists and cropping and farming modelling tools with one or more simulation models of ecosystem services on the territorial scale.

The implementation of the methodology will involve two phases: (i) an initial phase of diagnosis, making use of the farming system sustainability analysis method (the IDEA method – Vilain, 2008), in order to better understand and prioritise the issues that concern the agricultural systems in the region; and (ii) a second phase, more forward-looking, that will use the models to develop and assess scenarios.
Initial diagnosis

In recent decades, many conceptual frameworks have been developed for evaluating the sustainability of agricultural systems on the basis of multi-criteria evaluation (Munda et al., 1994; Lopez Ridaura et al., 2002; Parra-López et al., 2009; Koschke et al., 2012). However, in many cases, these frameworks have a primarily scientific perspective and have not been designed, in terms of field studies operationality, for and with the local actors in agricultural systems. However, some recent studies, in particular in Canada (Bélanger et al., 2012; Thivierge et al., 2014) and in Europe (Delmotte et al., 2016; Sadok et al., 2009; Barbier & Lopez-Ridaura, 2010; Zahm et al., 2015) have proposed methods and tools for adapting these frameworks to particular contexts.

In the first phase of the project it will therefore be appropriate to adapt the existing conceptual frameworks to the situation of the L'Acadie River watershed. To do this the above-mentioned works will be mobilised - in particular the potential of the IDEA method developed in France and of other similar approaches such as the DELTA method (Bélanger et al., 2012; Thivierge et al., 2014) will be analysed. IDEA is a method for diagnosing the sustainability of farming operations that is already operational. Its implementation also encourages thinking about the criteria and indicators of sustainability that must be adapted to the context of the farming operations and of the study region. This method has the advantage of very quickly providing a result for the participating farmer and, by carrying out some diagnosis, to establish a summary diagnosis of the current situation and major issues for the region.

It will therefore be adapted to:

- provide a diagnosis of the current situation, which will be used as a benchmark for comparison with the scenarios where the BMPs would be implemented. This step will also make it possible to complete the existing data on the farming operations, with a view to modelling them;
- reflect collectively on the major issues relating to the sustainability of the agricultural systems of the L'Acadie River watershed that it will be necessary to take into account in the various modelling tools available.

This implementation of a multi-criteria evaluation method will be part of the on-going work in the basin of the L'Acadie River using the participatory approach. This shared diagnosis will therefore be constructed collectively. This approach should help to define the indicators of sustainability to be quantified by models or, as the case may be, to be further developed in a more qualitative way.

Modelling and scenario assessment

In the second phase, the simulation of scenarios for the adoption of practices will provide food for thought for participants in the L'AcadieLab platform concerning the advantages and disadvantages of the various innovations in terms of the sustainability of the systems and the ecosystem services offered by the farming landscape. Workshops will be organised in order to co-construct, with the local actors, scenarios for developing the region's agricultural systems, and for thinking about BMPs and other innovations that could be implemented in the context of these scenarios and the farming operations of the region. The use of modelling will also make it possible to take into account the impact of climate change scenarios on the choice of practices and agricultural systems. Two models will be considered for agricultural systems analysis: STICS (multidisciplinary simulator for standard crops) and IFSM (Integrated Farm
Moreover a model of ecosystem services will be used at the regional level. The models are described in the next sections.

**Modelling agroecosystems at the level of the parcel and the farm**

Simulation models of agroecosystems are particularly useful tools for evaluating the impact of agricultural practices and climate changes on the operation and performance of agricultural systems, and thus for supporting decision-making at the farm level. These models operate on different spatial scales, from the individual agricultural field to the whole farm or watershed. The crop model STICS (Simulateur multiTidisciplinaire pour les Cultures Standard [multidisciplinary simulator for standard crops]) simulates the growth of plants and the carbon, nitrogen and water balances of a field (Brisson et al., 1998; 2008), taking into consideration the interactions among the different modes of crop management, the soils' properties and the climate. This model has recently been calibrated and validated to simulate growth of several field crops in Canada (spring wheat, corn and soybean in particular) and more particularly in the Montérégie (Jégo et al., 2010, 2011). STICS has also been coupled with a snow cover simulation model (Jégo et al., 2014) in order to improve prediction of water and nitrogen balances in fields under the climatic conditions of Eastern Canada (short growing season and long snow cover period).

On a larger spatial scale, the IFSM model (Integrated Farm System Model; Rotz et al., 2015) has also been recently adapted to simulate the growth of the main perennial and annual crops used in Eastern Canada (Jégo et al., 2015). This model allows simulation of the agronomic (productions), economic and environmental (water, nitrogen, carbon and phosphorus) balances of a farm. Several dairy farms representative of three regions of Canada (including two in Quebec) were defined in the model in a previous project. Although the IFSM was initially developed to simulate the operation of dairy farms, the most recent versions of the model also make it possible to simulate the farms involved only in producing field crops, which are present in the northern part of the L'Acadie watershed.

**Modelling ecosystem services**

Evaluating the consequences of developing innovations on the scale of a farming landscape or watershed makes it possible to take into account sustainability issues other than those evaluated at the level of the field and individual farm (Mitchell et al., 2015). Some aspects of the impact of agriculture on the environment can only be measured and quantified at these scales. The concepts of ecosystem services aim to evaluate the benefits derived from the operation of the ecosystems. Use of these concepts in connection with agricultural systems is recent and is now the subject of many pieces of research work, which aim in particular to produce the tools required to quantify these ecosystem services (Dupras et al., 2013). A model was developed to allow evaluation of ecological services at the level of the territory (Mitchell et al., 2015). This model makes it possible to evaluate, in addition to supply services (agricultural production, forest production), regulation services such as pollination, the natural regulations of the predators of crops, the quality of water or storage of carbon in forests, and also such sociocultural services as the aesthetic quality of the landscape or the region's farm tourism potential. This model has been developed for the territory of la Vallée du Richelieu (RCM), which is geographically a very close neighbour to the watershed of the L'Acadie River. This RCM has characteristics that are very similar in terms of land use to those observed in the L'Acadie River. It will thus be possible to use this model in connection with the project to support decision-making for the adoption of BMPs and production systems.
Conclusion
An open innovation platform, the “L'Acadie-Lab” living laboratory, was instigated in 2014 by an interactive community of agricultural producers, practitioners and researchers to increase the adoption of beneficial management practices (BMPs) in the L'Acadie River watershed, in southern Quebec, Canada. A gap has been observed between farmers’ expectations in terms of economic and ecosystem benefits of BMPs and research organisations’ ability to provide a consistent array of practices that interact on a range of spatial and temporal scales. In response to these issues, the authors propose the development and use of a participatory modelling approach as a tool for sharing the perspectives of researchers, practitioners and farmers on innovative practices to be adopted. The approach links the knowledge of researchers and certain modelling tools at the plot level or the farm level with ecosystem services simulation models at the landscape level to produce quantitative or semi-quantitative results. Simulation models will be used to evaluate the anticipated consequences of the transfer of knowledge and technology and of projected innovation in terms of the sustainability of the agricultural systems and of goods and services offered by the agricultural territory of the L'Acadie River watershed. Farmers and advisors will be mobilised through a participatory approach and will play a special role in defining the scenarios to be simulated to ensure that their situations and concerns are reflected and to increase their commitment to innovation.
References


Just-in-case to justified irrigation: applying co-innovation principles to irrigation water management

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Abstract: A pilot study using a co-innovation approach to identify the opportunities to improve irrigation management is underway in five farms in an irrigation scheme in New Zealand. Through a process of co-learning, a group of on-farm and off-farm stakeholders defined the problem of on-farm water use efficiency and developed solutions to enhance farmers' ability, desire and capacity to adopt improved irrigation practices. To enable informed decision-making, participants were supplied with current soil water demand (measured on farm) and 2 to 15 day rainfall forecasts as a daily email update. We conducted several one-on-one formal/informal meetings and annual workshops with stakeholders to evaluate the farmers' ability to integrate the updates into their current irrigation practices. Some of the key learnings are: (i) on-farm irrigation decisions are influenced by on-farm and off-farm hydrological, climatic, infrastructural and regulatory factors, thus we need to develop a wider view on irrigation management; (ii) for successful uptake, it is important to understand the external stimulants that, directly and indirectly, conflict or align with proposed practice changes; (iii) introduction of stakeholders with conflicting perspectives needs to be carefully managed; (iv) with co-learning, project objectives continuously evolve in response to ongoing monitoring, review and reflection on the processes, thus it is important to build flexibility into the implementation pathway; and (v) when scaling up from five farms to the wider irrigation scheme, opportunities such as collective learning and reflection at end-user focused workshops may become more challenging owing to stakeholder size, thus other co-learning opportunities need to be identified.

Keywords: Irrigation, co-innovation, co-learning, stakeholder management, agricultural innovation system, water use efficiency.

Introduction

The limitations of science-driven technology transfer approaches in which agricultural innovation is seen as a linear process of development, dissemination and adoption become apparent in the context of complex or 'wicked' problems (Botha et al., 2014; Klerkx et al., 2012; Leeuwis & Aarts, 2011; Smits, 2002; Rittel & Webber, 1973). This lack of success has been attributed to their insufficient attention to multi-actor processes and perspectives, lack of acknowledgement of non-scientific knowledge and not viewing innovation as a combination of technical, social, economic and institutional changes (Turner et al., 2016; Klerkx et al., 2012; Leeuwis & Aarts, 2011; Smits, 2002). Agricultural Innovation System (AIS) addresses these limitations by arguing for a holistic, transdisciplinary, multi-stakeholder approach that encourages participants to collectively identify and address problems and instigate technical, social and market changes (Botha et al., 2014; Klerkx et al., 2012).
Irrigation management in New Zealand (NZ) presents a case study for a complex problem in need of a systems approach such as AIS. On-farm irrigation management in NZ is influenced by several layers of technical, hydrological, climatic, societal, environmental, economic, regulatory and cultural factors, which individually and collectively impose controls and constraints on farmers’ ability and desire to adopt efficient irrigation practices. IrrigationNZ, an industry body for irrigators in NZ, forecasts that irrigation in this country will expand from the current 0.75 million hectares (ha) to 1 million ha by 2025, and urges the need for developing validated irrigation practices and tools that will enable farmers to become ‘water-wise’ (IrrigationNZ, 2016). They indicate that current irrigation efficiency can be improved by as much as 20% through improved irrigation practices. Historically, there has been limited success with technology transfer of irrigation management tools and practices. Uptake of technology such as soil moisture sensing to schedule irrigation has been stagnant over the last three decades (Davoren, 2015, HydroServices; personal communication), though the area under irrigation has been doubling every twelve years since 1970 (IrrigationNZ, 2016). Previous technology transfer approaches have tended to be farm specific, ignoring wider issues to water management such as water limits, multiple water users and community aspirations for improved water use efficiency (WUE). Here we define WUE as scheduling irrigations by taking account of current soil water demand and forecast rainfall.

Theory on learning through co-innovation
The AIS perspective promotes multi-actor processes to explore technological, social and structural needs and visions; to build trust, to agree on working procedures and to foster capacity building, learning and (intellectual) resource management (Klerkx et al., 2012; Leeuwis & Aarts, 2011; Botha et al., 2014). Stakeholder engagement has been associated with benefits such as increased knowledge, insights, experiences, networks, resources and creativity, improved ‘ownership’ of the innovation, empowerment and improved livelihoods, and a way of legitimising research and innovation projects (Leeuwis, 2004). However, it can also present challenges in terms of rules to be followed, resources required, power relations and political agendas (Leeuwis, 2004; Schut et al., 2014). Taking into consideration the context-specific nature of successful co-innovation (Neef & Neubert, 2011), the irrigation WUE case study is built on nine co-innovation principles, adapted from Nederlof et al. (2011), and described in detail in Coutts et al. (2016).

In this paper, our objective is to highlight the key learnings from applying a co-innovation approach to improving WUE on NZ farms. We have linked these learnings to the nine, adapted co-innovation principles. Through the use of co-learning we identified opportunities and barriers to improve the uptake of previously poorly used irrigation management tools and practices. Although existing literature provides relevant insights, "learning by doing remains essential in operationalising co-innovation" (Botha et al., 2014, p. 219). Accordingly, this paper provides insight into the implications of applying co-innovation principles in an irrigation case study in NZ. Considering the length of the paper, we have limited ourselves to the co-learning among the stakeholders and have not included any of the biophysical data collected during the study.

The project
The five-year duration WUE study was initiated in 2012 in the Waimakariri Irrigation Scheme (WIS), a run-of-the-river irrigation scheme located north of Christchurch, South Island, NZ. In this scheme irrigation practices are strongly influenced by the reliability of river flows which are currently at about 74% (Walton, 2015; WIS Executive Manager, personal communication).
Irrigators tend to use a ‘just-in-case’ approach where irrigations are applied whenever supply is available, even when demand is low. Very few farmers use the alternative practice, deficit irrigation, which is a ‘just-in-time’ approach where irrigation is scheduled based on water demand, rather than supply.

The project was based on the premise that a proactive irrigation management that matches current irrigation demands against forecasted (2-6 days) rainfall would lead to desirable economic and environmental outcomes for farmers and wider society. Accordingly, the project researchers aimed to support study farmers in their irrigation decisions by providing them with customised information on current demand (measured soil moisture) and forecast rainfall. This pilot study was focused on five farms (four dairy/one cropping) within WIS. They were selected because of their enthusiasm for the project and current (significant) water use. The farms are geographically scattered across the irrigation scheme (5-15 km apart from each other), and have varying soil types (varying soil water holding capacities to support crop growth), rainfall supplies and evaporative demands, and thus varying irrigation demands. Each farm was equipped with a soil moisture sensor that measured soil moisture (a proxy to irrigation demand) at 20 cm depth and a rain gauge that measured irrigation and rainfall. Data were recorded at 10 minute intervals and shared with participating farmers via a daily email. Farmers were also given 24/7 access to real-time soil moisture, rainfall and irrigation data via a secure, customised website. Additionally, farmers were provided with 2-, 6- and 15-day weather forecasts that included rainfall, air temperature, relative humidity and wind speed and direction, enabling them to schedule irrigations based on forecast rainfall. These data were included in the daily email update. To encourage a collective approach study farmers were provided with access to data from all pilot farms which enabled them to compare their conditions and practices against others as well as make useful observations of others’ practices.

Methodology

Data collection
Individual meetings with pilot study farmers took place periodically during the irrigation season (September – April) to explore current irrigation practices, to provide training on data interpretation and irrigation scheduling, and to gain feedback on the project and support provided by researchers. Several formal and informal one-on-one meetings, email communications and telephone conversations took place with other stakeholders (irrigation scheme manager, researchers, regional regulatory authority, local catchment committee and local and national government officials) to involve them in the project and to obtain more information on links between on-farm water management and wider water management policies, strategies and perceptions. At the end of each irrigation season a workshop was held to debrief on the season just finished and to plan ahead for the season ahead, with participation of pilot farmers, scheme managers, irrigation professionals, regional councils (local government bodies tasked with regulating environmental resources and outcomes) and researchers. Workshop discussions aimed to (i) develop a shared understanding of WUE and solutions, (ii) guide the development and uptake of irrigation management tools, practices and processes and (iii) discuss the benefits, risks, barriers and opportunities of using a weather-based irrigation management. Feedback from workshops was used to review and refocus the process and information being generated and sought. To date, three such workshops have been held: Workshop 1 in May 2013; Workshop 2 in May 2014; and Workshop 3 in May 2015. Each of these workshops have been held in the WIS; firstly at one of the pilot farms, then moving to a local hall as the size of the stakeholder group grew. Workshop 1 was attended by
pilot study farmers, irrigation scheme managers and researchers. In addition to workshop 1 attendees, workshop 2 was attended by the regional council and members of the local catchment management committee who advise the regional council on resource management. In addition to workshop 2 attendees, workshop 3 participants included farmers from WIS but not currently part of the project, managers from neighbouring irrigation schemes and the project funders.

There were a range of data collection points within the project. Each interaction, whether individually based or in a workshop setting, provided opportunities to obtain rich descriptive data, capturing individual and collective decision making, individual and collective reaction to information and the co-innovation processes being used. During the irrigation season, individual discussions with farmers and other stakeholders were recorded in the form of notes and narratives to determine management changes, training needs and the usefulness of the co-innovation approach. At the end of each workshop a feedback sheet was used to collect data on each participant’s response to the workshop. In February 2016 the project leader and the reflexive monitor reflected on the first 4 years (December 2012 – February 2016) of the project.

The biophysical data on rainfall, irrigation and soil moisture conditions present a record of the irrigation practices of each participant (i.e. when and how much irrigation was applied) during the season. These data were thus used at the workshops as a launching pad to initiate a discussion among stakeholders around examining the barriers and opportunities to changing irrigation practices.

Results
In this section we highlight three prominent learnings from the project that distinguish the co-innovation approach from the conventional technology transfer approach used to disseminate irrigation tools and practices in the past. These learnings were derived from a review of the biophysical data and reflection on processes and practices by stakeholders at the one-on-one meetings and annual workshops.

Lesson 1: broadening the context of the initial project into an innovation space
The primary aim of the study was to improve irrigation WUE in the pilot farms through the use of weather forecast based irrigation practices. As opposed to the ‘just-in-case’ and ‘just-in-time’ irrigation practices described earlier, we term this ‘justified irrigation’ as the irrigations are justified based on current soil water demand and forecast supplies (rainfall). To ensure the problem defined and solutions identified are consistent and fit with the perspectives of the wider stakeholder community that is relevant to water management, we involved both on-farm and off-farm stakeholders in the co-innovation process. In this way we conceptualised an irrigation landscape that extended far wider than the farm (see Figure 1). Through stakeholder interactions we mapped the controls, barriers, constraints and opportunities to irrigation management in NZ farms.
While an individual irrigation event may appear to be a stand-alone on-farm activity, the ability of farmers to implement it efficiently relies on several factors – from on-farm infrastructure to scheme and regional scale controls shown in Figure 1. These factors were identified at various stakeholder meetings and workshops. On the farm, the ability of a farmer to efficiently manage irrigation practices is primarily reliant on the availability of suitable irrigation infrastructure, access to a reliable water supply, accurate knowledge of soil properties, crop irrigation demands and access to a reliable weather forecast. Between farms, additional issues such as water trading and dynamic resource consenting rules (rules that control water abstraction and use) may influence irrigation decisions. At the irrigation scheme level the efficiency of on-farm irrigations can be influenced by environmental limits placed on nutrient losses and water use, and the ability of schemes to reliably reticate water to meet user demands.

At scheme, catchment and regional levels, water quantity and quality limits on resource use dictate irrigation practices. While catchment and regional-scale controls may not impact on-farm individual irrigation decisions, they can affect irrigation practice as a whole. With increasing intensity of irrigation the risk of contamination of groundwater or surface water also increases. In some areas of NZ deterioration of water quality is already apparent (Environment Canterbury, 2016a). Therefore nutrient management has also become the domain of national and regional government and regulatory frameworks are currently under development. In Canterbury, the location of this project, water take consents have a number of environmental conditions attached to them. These include (or are about to if not already), improved WUE and farm nutrient management plan requirements and self-audited management of water quality.

At regional and national levels, public perceptions about irrigation and the demands of competing users (including those expanding irrigation), influence irrigation practices. The clean-green image projected by the tourism industry often clashes with agricultural
intensification, as the latter is perceived as polluting the clean-green environment. A recent example of such a clash can be found at RNZ (2016).

At the national level, the science knowledge available to make informed decisions, linking cause and effect, becomes limited. For example, at farm scale, lysimeters that measure irrigation-drainage are used to link over-irrigation to the loss of water and nutrients below root zone. However, relating the impact of over-irrigation and the resulting drainage and nutrient loss at one farm, to wider catchment and regional scale water quantity and quality, is challenging. The contestability of science knowledge is very high at these large scales.

In essence, irrigation decisions and investments are made on-farm, but are informed and constrained by the wider system in which they fit. Hence, to be successful, on-farm irrigation solutions must encompass and represent the wider system, along with the constraints and opportunities it presents. Also, the solutions developed and the resulting effect of these solutions on WUE and irrigation practices should be demonstrable to both on-farm and off-farm stakeholders. This highlights the relevance of one of the nine co-innovation principles, “be aware of the wider context”.

The knowledge of the wider irrigation landscape has been very useful in including and responding to external stimulants to improve irrigation in NZ, e.g. IrrigationNZ has adopted an 80% beneficial use performance target for irrigation (IrrigationNZ, 2016). Similarly, the Sustainable Dairying Water Accord requires irrigation systems to be designed and operated to minimise the amount of water needed to meet production objectives (DairyNZ, 2016). The regional regulating authority in the pilot region, Environment Canterbury (a member of the stakeholder community), have designed a Matrix of Good Management, a set of recommendations to improve irrigation and nutrient management in the region (Environment Canterbury, 2016b), which is to be implemented in 2017 under the National Policy Statement on Freshwater described in Snelder et al. (2014).

**Lesson 2: learn from each other and be flexible and adaptive when implementing co-innovation**

Co-learning has been central to the study. All stakeholders - researchers, irrigation scheme managers and pilot study farmers - have been learning from interactions and through reflection on on-farm biophysical data and observations. Biophysical data provide a 'stake-in-the-ground' for discussion at the workshops and enable a means of understanding the decision making on-farm, as well as how the decision making at a scheme or region level has an impact on decisions on-farm.

**Researchers co-learning with farmers**

The project was originally aimed at assisting farmers in scheduling irrigations based on current irrigation demand and forecast weather. However, researchers have adapted the information provided throughout the project as they have learnt from other perspectives represented. For example, at the start of the project a soil moisture sensor was installed at 20 cm below surface (coinciding midway to 40 cm root zone) so that soil moisture conditions could be measured and irrigations could be scheduled accordingly. However, interactions at Workshop 1 indicated that drainage resulting from over-irrigation (applying more water than the top soils can hold) and poorly-timed irrigations (irrigating before a rainfall event or when soil moisture is high) was important, as the regional authority have been mandating farmers to store as much as 80% of applied irrigation in the soil and allow only 20% of irrigation as drainage. However, farmers
were given no specific procedure or tool to measure irrigation-drainage, nor were any practices recommended to prevent drainage. At Workshop 2 the discussion thus focused on drainage estimation to enable stakeholders to understand the process and ways of preventing irrigation "wasted" as drainage. At that workshop, farmers also expressed interest in knowing the monetary value of their drainage, which became the theme of Workshop 3. We chose, for every hectare of irrigated land, an arbitrary monetary value of $1.50 per mm of rainfall-drainage and $2 per mm of irrigation-drainage. At Workshop 3, we presented these numbers to the stakeholders and there was a general agreement that these numbers were reflective of actual numbers. Cumulated at farm scale, the monetary benefits proved substantial. At Workshop 3 researchers and stakeholders sought tools that could allow monitoring and managing irrigation and drainage together in real time. At Workshop 3, researchers introduced the use of a profile soil moisture sensor in place of a single point soil moisture sensor used at 20 cm depth. The profile soil moisture sensor measures soil moisture at eight depths along the soil profile (i.e. every 10 cm interval over the top 80 cm soil profile). This has enabled researchers to provide farmers with information on irrigation demand and drainage at the same time. Farmers could schedule their irrigations using the soil moisture at the top 20 cm and monitor the drainage by reviewing the soil moisture levels at 80 cm depth following the irrigation. Pilot study farmers were given real-time, 24/7 online access to these data and were individually trained in December 2015 and January 2016 to use the new data to schedule irrigation.

Irrigation scheme manager co-learning with farmers
The weather forecast that the farmers receive via daily email update provides 2-, 6- and 15-day weather forecast (rainfall, temperature, humidity and wind speed and direction). Because of the unique weather conditions of NZ, it is generally considered that any forecasts past 48 hours are less reliable and often changeable over a very short period of time (hours). Following the first year of this project, the irrigation scheme took notice of the accuracy of 2-day weather forecasts and reduced their irrigation water request lead time from 48 to 9 hours. This allowed the pilot study farmers to use the best weather forecast available when ordering their irrigation water from the irrigation scheme.

Farmers co-learning with other farmers and researchers
At Workshop 1, when farmers were queried on their use of weather forecasts, the general response was that forecasts were important at the start and end of the irrigation season ("shoulder season") and were less important during the peak season when irrigations are applied regularly and frequently with no regard to weather forecast or demand (a 'just-in-case' irrigation practice). At Workshop 3, after collecting data for over three years and observing farmers' behaviour, the researchers presented biophysical data that showed evidence for substantial irrigation-drainage during the peak season, most of which resulted from untimely irrigations (e.g., irrigation on previously wet soil, irrigation immediately preceding a rainfall event) and the complete absence of irrigation-drainage during the shoulder season. This information provided an opportunity for farmers to reflect on their irrigation decisions and decide whether it was appropriate to change their irrigation management during peak season. In December 2015, during a one-to-one meeting with a pilot study farmer, he indicated that based on the data supplied in the project he had skipped a few irrigations even when his neighbours continued to irrigate. This suggests that reflection on practices in this case actually influenced behaviour to some extent. This also reflects the co-innovation principle regarding flexibility. One of the key drivers of irrigation decisions during peak season is poor reliability of
supplies. This has not changed over the course of the project so farmers may not wish to change their irrigation practices, even though they have been shown that irrigation-drainage occurred during the peak season. However, with the new profile soil moisture probe they have an option to reconsider the amount of irrigation applied.

**Lesson 3: network development and increased engagement with co-innovation**

Over the course of the project a network of farmers and other stakeholders has been built within the irrigation scheme through the provision of the daily emails. At the beginning of the project in December 2012 the daily update was sent to the farm owners/managers of the five pilot study farms. The daily update is now being sent to 25 individuals every day and each recipient can see the irrigation practice occurring at every pilot study farm. All the recent additions to the list were made on the request of recipients. As the pilot study farmers share their experience with their neighbours and peers at informal gatherings, the daily updates have gained more recipients.

In addition, over the course of the three workshops more people have been added to the network, contributing knowledge and experience; for example, an exchange in workshop 2 where one pilot study farmer with 20 years of farming experience, shared with another his experience with managing soil drainage, saying “if you keep growing grass longer, drainage will decrease because increased organic matter leads to increased water retention/storage”. The workshops have helped to develop an understanding of the irrigation management issue and built trust amongst the project participants. The workshops have also been a forum for hearing, sharing and understanding multiple views on water management. The trust that has been built during the process has enabled additional stakeholders to be bought into the project, particularly representatives from the regional council.

**Discussion**

The co-innovation process has been leading to significant learning and observable irrigation practice changes among the stakeholders. Changes in irrigation scheduling from the start to date, as well as changes in the project focus and description, are evidence of these changes. Widening the stakeholder community to include both on-farm and off-farm stakeholders allowed us to understand the scope and complexity of on-farm irrigation decisions and to identify structures and external stimulants and controls that influence WUE at farm scale. These observations correspond to those reported in van Mierlo et al. (2013) on the application of an innovation system perspective in Dutch poultry subsectors, and reaffirms the importance of acknowledging the multi-level and multidisciplinary character of innovation highlighted by other researchers (e.g. Turner et al., 2016; Geels, 2002; Smits, 2002). The presence of regional council representatives (Environment Canterbury) at Workshops 2 and 3 provided legitimacy to the irrigation practice among the end-users, through recognition of the environmental benefits of their practices and was reinforced through further initiatives by councils to request presentations about the project to other regional water management groups. However, such inclusions had to be done very carefully; being mindful of contrasting and conflicting ideas is considered integral to stakeholder participation (Neef & Neubert, 2011; Cornwall, 2008; Leeuwis, 2004). We did not introduce the regulatory authority as a stakeholder at Workshop 1, because sufficient trust first needed to be established between researchers, the pilot study farmers and the wider irrigation scheme. Our experiences correspond to those reported by Schut et al. (2014) who emphasised the need for context-sensitive research strategies in competing claims situations. Hence, much attention was paid to decide on the right moment and time of involvement and potential side effects of research actions.
The co-innovation process also saw changes, mainly resulting from reflexivity, to the roles of the researchers and other stakeholders. Stakeholders continually reflected on the process and pathways towards system change, and this led to changes in roles. Researchers moved between being a fully independent science knowledge holder and supplier in a technology transfer approach to, with co-innovation, donning the roles of broker and facilitator. The relationship between researchers and other stakeholders moved beyond informative to co-learning and capacity building. Such transitions have been described by Schut et al. (2014) as changes in dynamics of boundary arrangements at the researcher-stakeholder interface. This mandated a reconceptualisation of researcher roles towards knowledge co-creation, network building, brokerage and entrepreneurial activities, roles that have been observed in other similar studies (Hermans et al., 2013; Klerkx et al., 2012; Wieczorek & Hekkert, 2012; Leeuwis & Aarts, 2011). Similarly the pilot farmers, by having conversations with other farmers in the scheme, enhanced the dissemination of the WUE message.

Use of co-innovation meant that the stakeholders needed to remain flexible in their practices as well as perception of problem and process. Project objectives were continuously revised in response to ongoing monitoring, evaluation and reflection on the processes in the workshops. This captures elements of reflexive monitoring, as outlined in van Mierlo et al. (2010). During the course of the project the definition of WUE expanded from water quantity management (irrigating the right amount at the right time) to water quantity and quality management (irrigating the right amount at the right time and minimising drainage and associated nutrient loss from root zone). This broadened the scope and focus of the project. Our findings support previous work from Leeuwis & Aarts (2011) and van Mierlo et al. (2010) who argued that project flexibility can foster collective identification and utilisation of “perceived windows of opportunity”, which increases the potential to reach what Röling (2009) refers to as “science-for-impact”.

As a part of the pilot study the recipients of daily email updates are allowed access to biophysical data from the participating farms. Discussions during the workshops indicated that farmers, in addition to the data from their own farm, frequently took notice and interest in irrigation activities occurring at other farms, which helped with co-learning among farmers. However, as we scale up from pilot farms to wider irrigation schemes and beyond, such a ‘shared-data’ approach may become less practical, potentially hampering the learning among the stakeholders. It would be interesting to explore how this potential co-learning and self-organisation can be sustained within the increased complexity associated with scaling up and out, as has been identified by Hermans et al. (2013) and others.

Conclusions
The co-innovation process reinforces that decisions, controls and drivers for on-farm water use and management intersects with the values and perspectives of off-farm stakeholders, particularly those linked to environment, economy and regulations. The co-innovation process has helped researchers to develop a wider view of the complex problem of WUE, which is a significant shift from the technology transfer approach. This wider view of the system has allowed researchers to effectively respond to the impacts of external stimulants that influence water use on farms. Because of the on-going learning that occurs during the co-innovation process, stakeholders have to be flexible enough to adapt to the information provided and respond accordingly. Within the irrigation scheme, farmers and the scheme managers are responding to the daily updates provided by changing their irrigation behaviour and practice, both on-farm and at the scheme levels. Stakeholders involved in the project recognised the
need to manage water better and are engaged in learning about WUE. Some of the learnings could not be immediately put into practice however owing to external factors (e.g. farmers inability to reduce irrigation frequency and the resulting irrigation drainage during peak irrigation season owing to poor supply reliability). Such learning highlights the importance of capacity building as part of innovation and the innovation process.

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Triggering system innovation in agricultural innovation systems: initial insights from a Community for Change in New Zealand

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Abstract: The ability of actors to co-innovate is influenced by how Agricultural Innovation Systems (AIS) are structured, with systemic problems related to the absence or weakness of structural elements. To create structural change, the causes of interconnected systemic problems need to be dealt with by addressing underpinning institutional logics; so called system innovation. This requires active engagement with potential change agents, with potentially conflicting perspectives about the underpinning institutional logics. This paper describes a process for stimulating this engagement to develop a shared understanding of systemic problems, challenge prevalent institutional logics and identify individual and collective actions that change agents might undertake to stimulate system innovation. To achieve this the process included (i) multiple actors from the AIS, (ii) steps to prompt reflexivity to challenge underlying institutional logics, (iii) an iterative process of practical experimentation to challenge current practices, and (iv) actions to encourage generative collaboration. Problem structuring was used to support potential change agents to develop a shared understanding of three systemic problems and understand the role that inter-relationships, perspectives and boundaries play in reinforcing or destabilising current practices and institutional logics. There is early evidence that involving multiple actors from the AIS in challenging underlying institutional logics and encouraging generative collaboration is stimulating project-level actions and recognition of wider AIS barriers and opportunities. This confirms the benefits of collective system analyses for identifying and addressing structural changes and extends this to potential for system innovation of the AIS. A challenge still to be addressed is how to simultaneously resolve innovation project-level actions with AIS-level actions.

Keywords: System innovation, agricultural Innovation systems, problem structuring, reflexivity, soft systems methodology

Introduction
In response to earlier identified shortcomings of a science-driven, linear, technology transfer approach to innovation in New Zealand (Davenport et al., 2003; Leitch & Davenport, 2005; Morriss et al., 2006; Ministry for Primary Industries, 2013; Turner et al., 2014, 2016), there is interest in bringing together relevant actors from the primary sector to increase innovation in a coordinated and interactive fashion through co-innovation (Dogliotti et al., 2014; Hall et al., 2001; Klerkx et al., 2012). However, the ability of actors to co-innovate is influenced by the structural composition of the Agricultural Innovation System (AIS); the presence of actors, their interactions, the institutions that influence their behaviour, and supportive physical, financial
and knowledge infrastructure and incentives (Klein-Woolthuis et al., 2005; Nettle et al., 2013; Wieczorek & Hekkert, 2012).

Often systemic problems are related to the absence or weakness of these structures (Wieczorek & Hekkert, 2012). To address this, policies that pro-actively stimulate and support co-innovation at the systems level are needed (Wieczorek & Hekkert, 2012). Many countries, including New Zealand, have yet to fully embed such policies (Friederichsen et al., 2013; Minh et al., 2014; Nettle et al., 2013; Schut et al., 2015; Turner et al., 2016) by addressing the institutional logics underpinning systemic problems (Kivimaa & Kern, 2016; Fuenfschilling & Truffer, 2013; Turner et al., 2016). Institutional logics are “the socially constructed, historical patterns of material practices, assumptions, values, beliefs and rules by which individuals produce and reproduce their material subsistence, organise time and space and provide meaning to their social reality” (Thornton & Ocasio, 1999: p. 804). For example, in the New Zealand AIS science-centred innovation focused on revenue generation from science-driven knowledge development is a prevalent blending of science and commercial institutional logics. This is attributed to public sector reforms in the 1990s when the Government invested in science to support policies pursuing economic goals to increase the relevance of knowledge development for innovation (Turner et al., 2016).

Some authors (e.g. Borrás, 2011; Leitch et al., 2014) argue that innovation policy learning therefore needs to make visible these underpinning institutional logics in order to generate new analyses and potential solutions for systemic problems that have proven difficult to resolve. Research on system innovation (e.g. Fischer et al., 2012) has shown this requires active engagement with potential change agents, such as policy makers, researchers and industry leaders, who may hold different and potentially conflicting perspectives about broader systemic problems and underpinning institutional logics (Beers et al., 2015; Turner et al., 2016). This engagement would seek to develop a shared understanding of systemic problems, challenge prevalent institutional logics, and identify actions that potential change agents might individually and collectively undertake to bring about system innovation in the AIS.

The aim of this paper is to describe a process for achieving this using key systemic problems and their underlying institutional logics to stimulate dialogue, formation and ongoing interaction among actors, in what we refer to as Communities for Change. The activity described in this paper is part of a large Government-funded programme, Primary Innovation, that seeks to facilitate change in the New Zealand AIS to effectively support co-innovation in the primary sector (Botha et al., 2014). Our contribution to the literature on AIS is addressing a challenge identified by Turner et al. (2016) – that of developing interventions in the AIS in order to institutionalise policies to stimulate co-innovation (Howells & Edler, 2011).

The paper is organised as follows: the next section provides a description of the methods used to implement system innovation of the New Zealand AIS; the following section presents results so far from the initial stages of the formation and ongoing interaction among Communities for Change around key systemic problems, and we conclude the paper with a discussion of the main insights on potential for triggering system innovation in AIS.

**Methodology**

The aim of the process described here was to actively engage a diverse and distributed Community for Change in reflexive policy learning to collectively challenge and address
institutional logics underpinning AIS-level systemic problems. To achieve this, a collaborative process was designed with four elements (Table 1).

Table 1. Elements guiding the design of the process for triggering system innovation derived from AIS and system innovation literature

<table>
<thead>
<tr>
<th>Element</th>
<th>Rationale for the element</th>
<th>References</th>
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<tr>
<td>Include multiple actors from the AIS</td>
<td>To engage and motivate multiple actors in maintaining a strategic focus on systemic problems relevant to them and wider structural change in the AIS. This encouraged the inclusion of a heterogeneous group of actors from multiple sectors: Government, research organisations, industry, farmers and growers</td>
<td>Amankwah et al., 2012; Gildemacher et al., 2009; Hermans et al., 2015; Totin et al., 2012</td>
</tr>
<tr>
<td>Support reflexivity to challenge underlying institutional logics</td>
<td>To support reflexivity by actors on underlying institutional logics regarding systemic problems and potential solutions</td>
<td>Arkesteijn et al., 2015; van Mierlo et al., 2010; Kivimaa &amp; Kern, 2016</td>
</tr>
<tr>
<td>Encourage an iterative process of practical experimentation that challenges current practices and supports systemic changes</td>
<td>To encourage an iterative process of practical experimentation that challenges current practices and supports systemic changes, by encouraging innovative actions that may prove useful in bringing about systemic change. This enables: (i) a process that is flexible enough to respond to new understanding of the systemic problem and potential systemic instruments; (ii) the seizing of new opportunities as they emerge; and (iii) the development of solutions that are better tailored to the systemic problems</td>
<td>Smart et al., 2007; Douthwaite et al., 2002; Hueske et al., 2014; Klerkx et al., 2010; Beers et al., 2014</td>
</tr>
<tr>
<td>Encourage generative collaboration</td>
<td>To encourage actors to collaborate in ways that are generative so that the outcomes of the whole are greater than could be expected from the sum of actions of the individual actors involved.</td>
<td>Beers et al., 2006; Franco, 2013; Midgley et al., 2013</td>
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These elements were used to guide the design of the process described in the following sections. Additionally from a practical standpoint the process also needed to utilise fit-for-purpose, low-cost processes and infrastructure to work with a Community for Change distributed throughout New Zealand and with limited time to contribute. These considerations limited the opportunities for face-to-face meetings.
Identifying key systemic problems in the AIS

To engage and motivate multiple actors to maintain a strategic focus on systemic problems relevant to them and wider structural change in the AIS, 30 actors in the AIS were interviewed using a systemic policy analysis framework (Wieczorek & Hekkert, 2012) to take a holistic innovation systems view (see Turner et al., 2014, 2016 for details). The individuals interviewed were assumed to play a key and catalysing role in shaping the direction and speed of innovation (Turner et al., 2016). The semi-structured interviews probed the actors’ roles in the New Zealand AIS and the perceived systemic problems (or barriers) to innovation. The interviews were also used to identify different needs from enhanced innovation. This information was used to link potential solutions to actor needs. Interviewees were then brought together in a workshop to collectively validate, reflect on and explore the key systemic problems.

The interviews, workshop and subsequent data analysis identified underlying causes of systemic problems that hinder effective functioning of the New Zealand AIS, which were then clustered into three themes (Turner et al., 2016). Table 2 describes these themes, the systemic problems they relate to and the underlying institutional logics.

Table 2. Underlying systemic problems in the New Zealand AIS, explanatory institutional logics and associated themes (Source: Turner et al., 2016)

<table>
<thead>
<tr>
<th>Systemic problems</th>
<th>Institutional logics</th>
<th>Themes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competition for resources for individual innovation agendas and activities</td>
<td>Competitive science in silos</td>
<td>Coordination of innovation agendas and activities</td>
</tr>
<tr>
<td>Insufficient capacity in small to Medium-Sized Enterprises to undertake market formation, entrepreneurial activities and knowledge development</td>
<td>Laissez-faire innovation</td>
<td>Build entrepreneurial activity to support implementation and commercialisation</td>
</tr>
<tr>
<td>A focus of science organisations on science-driven knowledge development to generate revenue</td>
<td>Science-centred innovation</td>
<td>Embed other forms of knowledge in research projects</td>
</tr>
</tbody>
</table>

We used Value Add Documents (VADs) (Beers et al., 2015) to describe the three themes (Table 2) in order to support actors’ reflexivity on institutional logics, underlying systemic problems and potential solutions. Each VAD was structured to include (Beers et al., 2013; 2015): (i) a description of Primary Innovation research activities; (ii) identification of a systemic problem in the New Zealand AIS, from the multiple perspectives of different actors in the AIS; (iii) relevant research results; and (iv) multiple potential activities that different actors might carry out to deal with the problem. The three systemic problems have distinct foci that overlap. The VADs were not intended to provide change agents with a definitive diagnosis and
prescription for change, but served to stimulate discussion among them about what actions might be possible and/or desirable by different actors in the AIS.

**Stimulating reflexivity and coordinated action in the AIS**

The purpose of establishing Communities for Change was to engage AIS actors with innovation system level change in a way that would stimulate reflexivity and lead to coordinated action in the AIS. To encourage actors to collaborate around each of the three systemic problems (Table 2) in ways that are generative, problem structuring methodologies (see below) were used to support change agents to develop not only a shared understanding of these problems, but also to understand the role that inter-relationships, perspectives and boundaries play in defining issues and potential solutions (Midgley et al., 2013). This explicitly systemic approach opens up new framings, strategies and actions (Franco, 2013).

**Community for Change Workshops**

To date there have been two workshops aimed at establishing the Communities for Change drawing on invitees from across industry, Government, and research organisations in the New Zealand AIS. The first, with seven participants, had the explicit purposes of: (i) creating a shared ambition for change; (ii) beginning collaborative problem structuring to understand and plan for relevant change; and (iii) forming Communities for Change around each systemic problem. The second workshop, with 20 participants, had a similar purpose.

Each of the workshops used the VADs as ‘catalysts’ for problem structuring and as triggers for action. As such they can be considered boundary objects (Klerkx et al., 2012); an entity that has sufficient shared meaning between diverse actors to enable collaboration but sufficient plasticity of meaning to enable each actor to use the object in their own situation (Star & Griesemer, 1989). The workshops followed the four design elements (Table 1):

1. multiple participants from a range of expertise were gathered;
2. systems thinking tools were used to support critical reflection on what constitutes the problem area and prompt new problem framings leading to alternative institutional logics that might contribute to systemic change (‘problem structuring’ – Mingers & Rosenhead, 2004);
3. possible change initiatives that were co-created in an interactive and iterative manner;
4. the process brokered the bringing together of solution elements to promote outcomes greater than participants could devise separately.

The core of the workshops was the second element; make visible how different institutional logics shaped how problems were understood to structure dialogue among participants with differing viewpoints and generate fresh perspectives on ‘the problem’ and action planning. Soft Systems Methodology (Checkland, 1999) helped participants from diverse perspectives consider how to express the desired system transformation, who that transformation may affect, who may be needed to make it happen, what underlying assumptions may shape the transformation, who functions as the effective ‘owner’ of the system and what factors are givens in the environment around the system that may influence outcomes. Activity Theory (AT) (Engeström, 2001) teased out potential components operating together in key activities. This enables groups with diverse viewpoints to consider what formal or informal procedures, enabling technologies, divisions of labour and collaborations make up a given activity, and what might be worth introducing in an improved activity.
Online Network Hub
An online network Hub was used to encourage an iterative process of practical experimentation that challenges current practices and supports systemic changes, while also addressing a key challenge of maintaining dialogue among a distributed community of time poor participants. The Hub is a purpose-built social networking site to support sharing resources, hosting discussion and reporting actions by change agents working on each of the three systemic problems (Table 2).

Experience shows that realising the collaborative potential of the Hub is neither automatic nor simple (Ellison et al., 2015). There is currently limited understanding of how social networking sites may function for knowledge management and collaboration (Razmerita et al., 2014). Social networking sites have been classified into: (i) information dissemination and sharing; (ii) communication, collaboration and innovation; (iii) knowledge management; (iv) training and learning; (v) management activities; and (vi) problem solving (Razmerita et al., 2014). The Hub attempts to facilitate all six. Peters and Manz (2007) argue that three interdependent antecedents are necessary for virtual collaboration: trust, shared understanding and depth of relationships. These typically need to be established and nurtured through face-to-face interaction. For this reason the online Hub communities will be invited to further face-to-face workshops. In addition the Hub will be actively facilitated by members of the research team, and contributions to the Hub discussions and resources will be made from people generally trusted.

Evaluation of the process for triggering system innovation
In the two Community for Change workshops, feedback sheets were used to: (i) evaluate the extent to which participants experienced the process design elements (Table 1); (ii) evaluate the extent to which participants identified with the description of the systemic problems (Table 2); and (iii) gather intended actions for systemic change. Workshop participants scored statements from 1 - strongly disagree to 10 - strongly agree. The data from feedback sheets were supplemented with outputs from the workshops.

Follow-up interviews, three months after the last workshop, were undertaken with 14 of the workshop participants. The interviews, conducted by three programme team members, explored four themes through semi-structured questions: (i) the extent to which participants experienced the process design elements in the workshop; (ii) to what extent participation in the workshops is supporting their understanding of co-innovation and encouraging them to take relevant actions in New Zealand’s AIS; (iii) actions taken and intent to take further actions at the system level; and (iv) what participants need in order to effectively work as a group to improve primary sector innovation, including participating in the online Hub.

Results
Here we present evidence to date of progress toward triggering system innovation, organised by the extent to which the participants experienced the guiding elements for the design of the process (Table 1), identified systemic problems and motivated actions.

Evidence of process design elements
Feedback sheets and follow-up interviews provided evidence that participants perceived the design elements (Table 1) as present, especially in the face-to-face workshops. In particular, there was a sense that the process was accommodating multiple perspectives and providing a systems view of innovation.
Including multiple actors from the AIS

Interviewees agreed that a range of perspectives were present, and this enabled consideration of the wider context of innovation and an understanding of others’ points of view, including recognition of shared issues. A challenge is that the breadth of perspectives made it difficult to identify a focus (goal or vision) for action. A few interviewees identified the need for more industry representation in the Community for Change, including farm advisors, especially as these actors were seen as key to implementing co-innovation.

Reflexivity to challenge institutional logics

There was limited evidence that reflexivity to challenge underlying institutional logics was achieved, however, one interviewee observed: “By having industry present at the workshop and enabling them to voice their concerns you opened up the dialogue and enable that to challenge of the current regime.” Interviewees from research organisations did, however, identify tensions in the current AIS: (i) an emphasis on science outputs that encouraged scientists to share ideas only once they were well formed; and (ii) an emphasis on generating revenue for research organisations that did not encourage time to understand multiple innovation agendas and actor expectations. This suggests that these members of the Community for Change are beginning to question embedded institutional logics.

Process of practical experimentation

Interviewees identified a number of existing and planned actions that challenge current practices. These tended to be at the project-level, e.g. by providing practical, readily accessible tools such as monitoring and evaluation, AIS diagnostic questions and experts to support the implementation of co-innovation. More broadly there was reference to investigating different models of science-industry interaction. These models and associated practices were identified as more tangible for actors to work on as a group and have “better scope for change and influence.” The need for focus within the Community for Change around a practical area (or project) in which to collectively test systemic actions (perhaps through identifying and experimenting first at a project level) was called for. There were fewer examples of practical experimentation with systemic changes, although one interviewee highlighted the need for Government agencies to resource the collection of statistics that evidence the impact of co-innovation.

Generative collaboration

Interviewees suggested that the beginnings of generative collaboration were present, referring to trust, a common language and hence the opportunity to share perspectives, which stimulated a recognition of new perspectives. One interviewee highlighted intermittent face-to-face interactions as a challenge. However, examples of the need for generative collaboration were identified, such as the desire from a research organisation member for research funders to stimulate demand for co-innovation. The need for generative collaboration was also recognised in terms of the inter-relationships among the systemic problems (Table 2).

Evidence of being motivated and able to take action

Identifying with systemic problems

Feedback sheets from the workshops provided evidence that participants did identify with the systemic problems and they themselves experienced them in their day-to-day activities. Participants at the second workshop agreed that the systemic problems identified (Table 2) were ones they recognised (Average score = 7.9 out of 10, with a range of 4 to 10, from 14
responses) and that they were also dealing with (8.0, range 5 to 10). However, there was less agreement with the solutions identified prior to the workshop (6.4, range 3 to 10) or confirmation that they might be able to contribute to the solutions (7.0, range 3 to 10). The aim of the second workshop was to increase the intent of participants to embark upon solutions by involving them in identifying solutions that they could contribute to. To this end, participants at the second workshop were more positive about where possible changes could be made (7.4, range 3 to 9) and felt challenged to take action (7.5, range 6 to 10).

The follow-up interviews suggest that members of the Community for Change identified with the desire to implement co-innovation in projects. This included to better understand what co-innovation means in practice for different Government, industry and research actors; use a co-innovation project as a focus of action for the Community for Change; and work together to create tangible success. There was a view that the terms co-innovation and co-development were being more widely used in the AIS, but that these concepts had different meanings to different actors.

**Planned actions by the Community for Change**

We found limited evidence of actors beginning to develop systemic instruments. Actions are being taken, however these tend to be at the project-level, e.g. implementing co-innovation in existing projects, tools to support co-innovation and ways to extend the use of co-innovation into other projects. Another example was the plan to run a co-innovation showcase at Fieldays, New Zealand’s largest agricultural event, to encourage agribusiness companies that traditionally compete to co-innovate instead.

Other actions described linking with other participants to share knowledge or to take coordinated action by linking separate activities in their organisations. Examples included: (i) learning how another research organisation had developed Key Performance Indicators for encouraging co-innovation; (ii) utilising knowledge from Primary Innovation in other innovation projects and organisational changes; and (iii) developing university courses to build capabilities for co-innovation, innovation brokerage and entrepreneurship by science students.

**Evidence of the beginnings of a distributed Community for Change**

Twenty people attended the second one-day workshop and 32 individuals signed up for the Hub in response to an email invitation and, for some, a follow-up conversation. This action by Community for Change members suggests a first step toward distributed online collaboration. At the time of writing, seven of the 32 signed up have elected to join a specific theme group. However, activity on the Hub is low and the team is trialling strategies for stimulating and supporting collaboration using the Hub.

Interviewee feedback on using the Hub was mixed, with some indicating they would be unlikely to use the Hub due to a lack of time or a preference for face-to-face interaction. Community for Change members that did indicate an interest in using the Hub, emphasised the need for new information to be regularly added and for reminders to contribute to the Hub.

**Discussion**

There is evidence of the beginnings of a Community for Change through multiple actors developing wider perspectives of innovation and the AIS, and identifying opportunities to challenge underlying institutional logics. Such collective system-level learning towards transformative structural changes has previously been observed in the Dutch poultry (van

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Mierlo et al., 2013) and agricultural (van Mierlo et al., 2010) sectors. This system-level learning has already increased networking and coordination of activities among the Community for Change to support co-innovation, however actions planned tend to be at the innovation project-level, rather than the AIS-level. This may be due to participants in the NZ context: (i) still developing their understanding of co-innovation as a practice within their own realms of experience and influence before committing to actions that might embed it across the AIS; and (ii) feeling limited in their capacity to enact change at the AIS-level.

Moving from project- to system-level changes

Our findings suggest that moving from project to AIS-level change remains a challenge. Members expressed a desire to investigate different models of science-industry interaction, such as co-innovation. These were identified as more tangible to work on as a group and have “better scope for change and influence.” Simultaneously there were calls for top-down commitment to co-innovation, e.g. in Requests for Proposals, so that the co-innovation practices are first mandated and then become business as usual.

Simultaneous AIS and project-level change suggests a need for better linking of project-level implementation of co-innovation with barriers and opportunities in the New Zealand AIS. This is similar to niche and regime relationships in the multi-level perspective (Geels, 2004; 2010) where transitions in the making feature important boundary-crossing processes between initiatives and their environment (Beers et al., 2015). The Community for Change included tactics to support these boundary-crossing processes through: (i) the inclusion of project-level actors with system-level actors in the Community for Change; and (ii) the Value Add Documents’ translation of innovation project insights into potential strategic-level actions (Beers et al., 2015). A future step could be organising the Community for Change around a specific innovation project to identify actions they can simultaneously take at these different levels in order to further stimulate co-innovation in the project.

Agency at the system-level

A need for leadership to stimulate AIS-level change was identified and expressed as a sense that large changes are needed at the organisational and AIS-level, which are beyond their individual influence. The concept of institutional entrepreneurship may help to resolve this tension between system-level institutional change and limited actor agency to enact this change (Battilana et al., 2009; Bremmer et al., 2014), by identifying actors that are able to strategically transform existing or create new institutions (DiMaggio, 1988). Tactics that these institutional entrepreneurs may apply to implement change projects (Pacheco et al., 2010; Battilana et al., 2009) include: (i) framing and re-framing by developing a vision that can convince others; (ii) coalition building by mobilising others to support change; and (iii) motivating others to achieve and sustain the vision.

There is evidence of some members of the Community for Change implementing the first tactic. For example, the inclusion of the Ministry for Primary Industries’ extension framework, which includes co-innovation as an approach, in Over the Fence (Casey et al., 2015) and in the Ministry’s Science Strategy (Ministry for Primary Industries, 2015). This high-level endorsement of co-innovation as a desirable practice is shaping expectations of innovation project funders and influencing project planning and management across primary sectors. This example and other institutional entrepreneurship tactics could be concrete actions encouraged and supported in the Community for Change.
Conclusion
Our findings provide early evidence that involving multiple actors from the AIS in challenging underlying institutional logics and encouraging generative collaboration is stimulating project-level actions to enable co-innovation and recognition of AIS-level barriers and opportunities. This confirms the benefits of collective system analyses using an innovation systems perspective to identify and address structural changes in the AIS (Bremmer et al., 2014; van Mierlo et al., 2010; 2013). It also suggests that such collective system analyses can enable identification of actions that may address underpinning institutional logics with the intention of enhancing the performance of the AIS. A challenge still to be addressed is how to simultaneously resolve innovation project-level actions with AIS-level actions, reflecting niche and regime relationships in the multi-level perspective.

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Navigating the unknown - practice-led collaborative research for the improvement of animal welfare

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Abstract: There is a growing policy interest in agricultural innovation generated through practice-led collaborative learning processes. While there is a considerable body of work on how local innovation is generated and facilitated in the field of natural resource management, far less has been done in the area of farm animal welfare. Using the egg-laying-hen sector as a case study, the EU-funded Hennovation project is testing mechanisms to facilitate practice-led innovation in sustainable animal welfare through development of ‘innovation networks’. Up to 12 innovation networks, involving producers and laying-hen processors, have been mobilised at local, national and European level. These are supported by a variety of actors and moderated by external facilitators. This paper presents a framework for the management and facilitation of practice-led collaborative innovation processes in sustainable animal welfare. This framework has been developed and is tested through action research and a Delphi-style consultation process and includes key steps and guiding questions allowing the facilitators to assess and monitor their intervention in innovation processes. Practice-led innovation processes are network specific and evolve as the actors within the network come together to share common problems, experiment with possible solutions and learn. The end-results of these processes, in terms of outputs, are often unclear at the outset and thus planning for them raises specific methodological challenges. In focusing on collaborative approaches to innovation, this project contributes to the integration of science and practice leading to solutions designed to deliver lasting change in animal welfare practices.

Keywords: Practice-led, innovation, collaborative learning, innovation networks, facilitation, animal welfare

Introduction

There is a growing policy interest in on-farm agricultural innovation generated through practice-led collaborative learning processes. The EU H2020 research strategy, for example, is currently promoting a multi-actor approach to innovation that includes a high level of farmer engagement (SCAR, 2013). The interest in practice-led innovation stems from the realisation that, despite large investment, there remains a significant gap between scientific research and the adoption of applied science into farm practice (Akrich et al., 2002). Practice-led innovation responds to the demand for innovation in practice to solve problems using practical knowledge and creativity at the local farm level.

While there is a considerable body of work on how local innovation is generated and facilitated in the field of natural resource management, far less has been done in the area of farm animal welfare. Using the egg-laying-hen sector as a case study, the EU-funded Hennovation project is exploring and testing mechanisms to stimulate and facilitate practice-led innovation in sustainable animal welfare through development of ‘innovation networks’. In short, the project’s mission is to promote practice-led innovation, instigate innovation networks, develop the skills of participants and facilitate the interaction and learning of individuals within the network.
Formation of Innovation networks

Innovation networks, involving producers and laying-hen processors, are mobilised at local, national and European level. These are supported by a variety of actors such as veterinary surgeons, researchers and industry and are moderated by external facilitators (Figure 1).

Currently there are 12 innovation networks established and running in the United Kingdom, The Netherlands, Sweden, Czech Republic and Spain. Network size varies from five to eight producers with a variety of support actors e.g. veterinarian, feed company, scientist and pullet rearer, based on the specific topic addressed by the network. The laying-hen production system varies between groups, e.g. organic, free range and more conventional cage systems. One of the networks includes producers of several production systems. The networks are exploring a variety of topics based on their need and ideas such as: the effect of light on feather peaking, nutrition to prevent feather peaking, methods of feather scoring, increased communication between pullet rearers and producers, hen predation in relation to feather peaking and new ideas for marketing eggs of non-beak-trimmed birds. Several networks in different countries have identified a similar topic to work on, and this provides opportunities for trans-national collaboration.

Most networks are formed from larger pre-existing groups connected to a specific egg packing company or veterinary practices. After an initial three months of implementation, reflection on network mobilisation and facilitation by the facilitators, revealed that the use of such intermediates is pivotal in enabling network mobilisation. It was also noticed that there is a great diversity within as well as between countries on what motivates producers to participate in a network. In some countries for example mentioning the upcoming EU ban on beak trimming in laying-hens is a motivational factors whilst in other countries it was too controversial to mention this. During the initial reflection, discussion also revolved around the
challenge of overcoming a culture of receiving rather than collectively creating or producing knowledge. Thus some producers were expecting or were more motivated to learn from “experts”.

The role of the network facilitator

The role of the network facilitator in the project is to mobilise the networks, guide the network through the innovation process, promote social learning and encourage engagement with support actors (Klerkx et al., 2012). The facilitators stimulate the co-creation of knowledge (Wielinga & Herens, 2013) which is different from more traditional advisory roles of knowledge dissemination (Roling, 1990). Practice-led innovation processes evolve as the actors within the network come together to share common problems, experiment with possible solutions and learn. The end-results of these processes, in terms of outputs, are often unclear at the outset and planning for them raises specific methodological challenges (Wielinga & Vrolijk, 2009). Thus the question arises how do you facilitate a messy process of which you do not know the end-result. Klerkx and Gildemacher (2012) indicate that facilitators can use existing methods and tools, however facilitating the innovation process is learning by doing. The function and role of facilitators in the innovation process has been widely described in literature (Howells, 2006; Klerkx & Jansen, 2010) however much less is written on how to actually support the facilitator to perform this role. A framework for the facilitation and management of practice-led collaborative innovation processes was developed and is currently being tested by the network facilitators to provide more structure to the facilitation of the innovation process.

Development and testing of the framework for the facilitation and management of practice-led collaborative innovation processes.

Development of the framework

The initial framework was developed by ten facilitators from five different countries in Europe (the United Kingdom, The Netherlands, Sweden, Czech Republic and Spain) during the first workshop for network facilitators in September 2015. The framework was developed to guide the facilitation of the innovation process and to stimulate learning by the facilitator on how to manage this process. The challenge in the development of the framework was that on the one hand it needed to provide enough structure to be useful for the facilitator whilst on the other the framework needed to be generic and flexible enough to accommodate the diversity and unpredictability of the process (Klerkx & Gildemacher, 2012). The framework was built on the experience of the facilitators and they identified six key process steps:

1. Problem identification;
2. Generation of ideas;
3. Action planning and resource mobilization;
4. Practical trialling and development;
5. Implementation and upscaling on-farm;
6. Wider dissemination of the innovation.

During the workshop the facilitators identified key activities for each step. These were captured in the framework as guiding questions to encourage facilitators to think through and reflect on the progress in each step of the process. Questions developed relate to the network functioning and capacity, interaction with relevant support actors, use of a diversity of knowledge and uptake and dissemination of the innovation.
Testing of the framework
The framework is currently being tested and refined through action research by the facilitators and a Delphi style consultation process in three rounds. Tools such as the learning history (Kleiner & Roth, 1996) are used to reflect upon learning. Over a period of 18 months data on progress and reflection is systematically documented by each facilitator in a wiki to stimulate reflection and peer learning amongst the facilitators. Although the framework is presented stepwise the innovation process is not linear. The time allocated for each step cannot be predicted (Klerkx & Gildemacher, 2012) and depends amongst others things on a variety of factors such as network capacity and the specific idea trialled by each network.

Conclusion
Overall there is a large diversity in capacity and functioning of the innovation networks, both within and between countries. This provides a great opportunity as well as a great challenge for the facilitators learning to manage the innovation process. The framework developed supports the facilitators to navigate through the unknown territories of the innovation process. Further testing of the framework as part of the Hennovation project and in other livestock sectors will lead to further refinement and validation of the framework.

In focusing on collaborative approaches to innovation, this project contributes to the integration of science and practice leading to solutions designed to deliver lasting change in animal welfare practices.

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References


Addressing complex challenges using a co-innovation approach: lessons from five case studies in the New Zealand primary sector


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Abstract: Co-innovation can be effective for complex challenges – involving complex interactions among multiple stakeholders, viewpoints, perceptions, practices and interests across programmes, sectors and national systems. However, there is limited systematic research on how co-innovation works in different projects. Approaches to challenges in the primary sector have tended to be linear, where tools and outputs are developed by a few, mostly scientists/researchers, and then extended to stakeholders. A co-innovation approach first deciphers and delineates the biophysical, societal, regulatory, policy, economic and environmental drivers, constraints and controls influencing these challenges at multiple levels. Secondly, stakeholder interactions and perspectives can inform and change the focus, as well as help in co-developing solutions to deliver agreed outcomes. Here we analyse the results of applying a co-innovation approach to five research projects in the New Zealand primary sector. The projects varied in depth and breadth of stakeholder engagement, availability of ready-made solutions, and prevalence of interests and conflicts. The projects show how and why co-innovation approaches in some cases contributed to a shared understanding of complex problems. Our results confirm the context-specificity of co-innovation practices.

Keywords: Co-innovation, innovation projects, co-innovation principles, New Zealand, agriculture, horticulture, pastoral, forestry, Agricultural Innovation Systems

Introduction

Understanding how innovation happens and ways in which research projects can be optimised to increase their innovation potential may enhance rates of adaptation (Hermans et al., 2013) and adoption of technologies from research, science and technology investments. To address shortcomings in technology diffusion and uptake approaches there is increased focus on bringing together relevant agricultural sector actors in a coordinated, interactive fashion through co-innovation (Dogliotti et al., 2014; Hall et al., 2001; Klerkx et al., 2012). Literature on agricultural innovation processes (e.g. Klerkx et al., 2012; The World Bank, 2006) indicates an evolution and broadening of theoretical perspectives. Agricultural systems innovation processes differ from linear, technology-transfer-oriented approaches, being more evolutionary, multidisciplinary and multi-stakeholder approaches, which consider social, economic and institutional as well as technical changes (Klerkx et al., 2012).
Co-innovation is an iterative process that brings together knowledge from many stakeholders, along with changes in technology, markets, regulations and other practices that support the commercialisation and implementation of the knowledge to improve production, exports, profits and/or the environment (Garb & Friedlander, 2014; Klerkx et al., 2012; Leeuwis, 2004; Röling, 2009). This process requires negotiation amongst previously unconnected stakeholders with competing values, worldviews, interests, planning horizons, incentives and accountability (Botha et al., 2014; Johnson & Gregersen, 1995; Schut et al., 2014). Co-innovation practice is context-specific and adaptive: how and when co-innovation is implemented must be tailored to the particular situation and may change over time (Hall, 2005; Klerkx et al., 2010; Neef & Neubert, 2011; Schut et al., 2015). “Explicit or implicit choices are usually made as to who might take part” and “the question of who participates – as well as who is excluded and who exclude themselves – is a crucial one” (Cornwall, 2008, p.275), especially when the transaction costs associated with increased interactions among stakeholders outweigh perceived benefits (Ortiz et al., 2013). While this is increasingly acknowledged, there is relatively limited comparative research unravelling how, under a given overarching programme, different co-innovation projects may work differently (except, e.g. Seuneke et al. (2015)), although this is highly important to stimulate learning within a programme context (Thiele et al., 2007).

These implementation differences are assessed in a large New Zealand (NZ) Government-funded research programme, Primary Innovation (PI), was initiated in 2012 with two aims: i) implement and evaluate the effectiveness of co-innovation approaches in the primary sector (Botha et al., 2014); and ii) identify barriers and enablers to co-innovation in the NZ primary sector (Turner et al., 2016; Turner et al., 2013). To achieve the first aim, the PI programme became involved in five NZ primary-sector research projects where attempts have been made to apply a co-innovation approach. Each of the projects applied nine principles of co-innovation that underpin and inform activity. These principles were adapted from Nederlof et al. (2011) and are presented at this conference by Coutts et al. (2016).

We focus on two co-innovation principles that were applied in practice across all innovation projects: i) take time to understand the problem from many different views; ii) be inclusive in terms of diversity of stakeholders. These principles were seen as those that could most affect a project’s focus and direction. We use interpretations of what constitutes innovation, following stylized innovation models articulated in Klerkx et al. (2012) to indicate the position of each project in the range from technology transfer to co-innovation in the Agricultural Innovation System (AIS). We also use Pretty’s (1995) typology of stakeholder participation to identify different types and degrees of participation reflecting the diversification of the projects’ goals and structures: i) manipulative participation; ii) passive participation; iii) participation by consultation; iv) participation for material incentives; v) functional participation; vi) interactive participation; and vii) self-mobilisation (Pretty, 1995). This typology has its constraints (Leeuwis, 2004; Neef & Neubert, 2011), but highlights the importance of genuine and meaningful participation. We argue that Pretty’s typology remains useful for analysis of the projects over time and across projects.

Three research questions primarily focusing on stakeholder involvement in problem definition in the research projects thus guided our analysis: i) did the co-innovation process result in a change of problem definition? ii) if the definition had changed, to what extent can it be attributed to stakeholder involvement? iii) what were the barriers and opportunities to stakeholder participation shaping problem definition?
Innovation project descriptions
Three projects (Water Use Efficiency (WUE), Tomato Potato Psyllid (TPP) and Timber Segregation) are led by research organisations; the other two (Heifer Rearing and Nutrient Management) are led by industry organisations. The projects started independently at different times, some before the PI programme started in October 2012, and some after. Each has progressed at a different rate because of various degrees of stakeholder involvement, a key part of co-innovation, and varying divergence of worldviews, interests, norms and values, planning horizons, incentives and accountability mechanisms of those involved (Botha et al., 2014; Klerkx et al., 2012).

We introduce the projects individually to provide context for the interactions taking place. The projects serve as case studies deliberately chosen to cover two interdependent characteristics of problems in NZ primary industries that influence the effectiveness of co-innovation: (i) knowledge contestability (Andresen et al., 2000); and (ii) a choice of mechanism for change - regulation (e.g. targets), market signals (e.g. pricing) and voluntary approaches (e.g. information distribution, extension, education) (Röling, 2009). None of the mechanisms for change function in isolation, but some have more influence in certain circumstances than others. The five projects investigate problems ranging from where knowledge is uncontested to highly contested. Where knowledge is uncontested, the scope of the problem is well agreed, while with highly contested knowledge, different stakeholders view the problem scope differently. Knowledge becomes more contested at larger scales as the number of stakeholders increases and therefore competing values and perspectives and potential solutions also increase (Andresen et al., 2000).

**Water use efficiency**
The aim of the WUE project is to improve on-farm irrigation decisions using better characterisation of current irrigation demands and accurate, accessible short-term weather forecasting. This project is being piloted on five NZ South Island farms within an irrigation scheme. The research and PI projects started in October 2012. The farmers are provided with farm-specific observed data on current rainfall, soil moisture, soil temperature, drainage and evapotranspiration, and region-specific 2-, 6- and 15-day rainfall forecasts (Srinivasan et al., 2015). The data are shared with farmers in real-time via a dedicated website and as a daily email. Based on these data, farmers make informed irrigation application decisions. Annually, the farmers, irrigation scheme managers, researchers and other relevant stakeholders (e.g. members of a local catchment committee, personnel from neighbouring irrigation schemes and regulatory and government agencies) meet to review the irrigation decisions made during the season. These meetings are a forum for sharing and discussing ideas, as well as reviewing and refining information provided. These workshops and other formal and informal meetings also refine and reshape the problem being addressed as well as the solutions achievable (Srinivasan et al., 2016).

**Tomato potato psyllid**
TPP is a vector of the bacterium *Candidatus Liberibacter solanacearum* (CLso). This complex became a major problem in NZ potato crops in 2008. The aim of the TPP project is to assist the NZ potato industry to realise export growth by addressing the industry's pressing need for economically and environmentally sustainable control solutions for the TPP/CLso complex. The research project commenced in October 2013, with the PI programme becoming involved in June 2014. The research project entails fundamental research in three, mainly laboratory-
based objectives: (i) sensory cues; ii) population genetic variability, and iii) host plant response), while the fourth objective is ‘knowledge transfer to stakeholders’. The science objectives each have an objective leader, while the fourth objective does not. Knowledge transfer was not planned until complete tools or knowledge were available (at project completion). Unlike in the other case studies, the innovation project leader is not the TPP research project leader.

**Heifer rearing**
The Heifer Rearing project is a DairyNZ-led initiative focusing on the improvement of dairy herd reproductive performance by lifting the proportion of heifers entering the national herd at target live weight. Industry data indicated that 73% of such heifers are 5% or more below target (McNaughton & Lopdell, 2012). This represents a national loss of $120M per annum in dairy farm profit industry-wide (Brazendale & Dirks, 2014). The research project and PI commenced together in September 2013. The project initially formed a stakeholder industry advisory group which completed a causal analysis for understanding the influences on undergrown heifers in October 2013. The number of farmer participants was proportionally low.

**Nutrient management**
The Nutrient Management project focuses on activities on a network of Canterbury commercial farms in NZ’s South Island. This network is part of a large government-funded research programme combining the expertise and resources of three Crown Research Institutes, one University and two industry-good bodies, and targets the twin challenges of reducing nitrate leaching and increasing profitability of arable, sheep and beef, and dairy farms. Experiments are conducted on pasture mixtures and crop sequences, and modelling of plant/soil and animal components as well as farm systems incorporating the options developed. While the topics are technical (Pinxterhuis et al., 2015), the programme approach is based on co-innovation principles to achieve maximum uptake of these options (Edwards et al., 2015). The farmers’ network is involved to co-develop the options with the research and development (R&D) community, test them on-farm and demonstrate to the wider community. The project started with the development of the research proposal from late 2012, incorporating co-innovation principles from the PI programme.

**Timber segregation**
The Timber Segregation project is part of a larger government and industry co-funded programme. Its aim is to increase the value realised from existing forests through the development of cost-effective approaches to characterise and deal with variation in wood properties within and between trees (Moore & Cown, 2015). This will give wood processors increased confidence in the properties of the resource, so that more of the harvested resource is processed into added-value products, rather than exported as raw logs. The project started in October 2013, having been identified as a PI case study 12 months earlier. It thus deliberately set out to take a co-innovation approach during the proposal writing stage as well as during the project itself, particularly as a wide spectrum of views on the benefits of segregation was recognised. The specific research aim was developed through a series of workshops and roadshows with stakeholders from the forestry and wood-processing sectors including technical managers, executive managers and staff from government and sector research organisations. Once the project funding was approved, the detail was revised with the industry co-funding partners. In addition to a governance group, an innovation cluster group has been formed whose membership includes researchers, forest growers, wood
processors, industry associations and segregation tool manufacturers. This group meets annually to share ideas, discuss the research and develop a deepening understanding of problems and potential solutions.

**Methods and analytical framework**

To compare the five projects, the innovation project leaders (all biophysical scientists) and/or other project team members and a social science research team conducted a workshop in February 2016. The people most heavily involved in managing the projects and monitoring outcomes brainstormed the project goals, stakeholders and progress from the proposal stages to the present (February 2016; 2–3 years in for all projects). This paper uses data collected from the five individual projects, as well as personal experiences of the project teams and leaders. Each project was considered in relation to their type of stakeholder inclusion (Pretty, 1995) and their position on the AIS continuum from technology transfer to co-innovation, particularly project flexibility over time, on a scale of 1–5 (Klerkx et al., 2012). This enabled comparisons in terms of project goals, structure and stakeholder involvement and their effects on stakeholders’ understanding of the problem and project focus to be determined.

**How the innovation projects have changed**

**Innovation projects at proposal-writing stage**

In all projects, stakeholders were involved at proposal-writing stage, giving formal and informal input (Table 1) (Pretty, 1995). The projects were also assessed for conceptual, organisational, and institutional features connected with theoretical perspectives on agricultural innovation (Table 2) (Klerkx et al., 2012). Nutrient Management and Timber Segregation, and to a lesser extent Heifer Rearing, used more of an AIS perspective at the proposal-writing stage than the other projects, which resulted in an opportunity to create a shared understanding of the problem and build trust.

**Table 1. Status of the innovation projects at proposal writing stage: problem definition, stakeholder participation and engagement methods used.**

<table>
<thead>
<tr>
<th>Innovation project</th>
<th>Problem/project definition or focus</th>
<th>Type of stakeholder</th>
<th>Engagement methods</th>
<th>Stakeholder engagement (Pretty, 1995)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water use efficiency</td>
<td>Improved irrigation and water use efficiency</td>
<td>Farmers, irrigation scheme, researchers</td>
<td>One-on-one meetings, phone calls</td>
<td>Passive participation</td>
</tr>
<tr>
<td>Tomato potato psyllid</td>
<td>Developing economically and environmentally sustainable control solutions for the TPP/CLso complex</td>
<td>Industry, some larger growers</td>
<td>Formal meetings, phone calls</td>
<td>Passive participation</td>
</tr>
<tr>
<td>Heifer rearing</td>
<td>Increase dairy farmers’ profitability by increasing the number of heifers that meet liveweight targets pre-calving</td>
<td>Dairy farmers and graziers, industry, researchers, private companies</td>
<td>Advisory group meetings, farmer workshops, phone calls</td>
<td>Interactive participation</td>
</tr>
<tr>
<td>Nutrient management</td>
<td>Reduced nitrate leaching from arable, sheep &amp; beef, and dairy farm systems</td>
<td>Researchers, industry</td>
<td>Formal meetings, workshops, email, one-on-one meetings, phone calls</td>
<td>Functional participation</td>
</tr>
<tr>
<td>Timber segregation</td>
<td>Improve the financial returns to growers and processors through better information on the wood properties of the forest resource</td>
<td>Growers, researchers, private companies</td>
<td>Formal meetings, workshops, roadshows, one-on-one meetings</td>
<td>Self-mobilisation</td>
</tr>
</tbody>
</table>

1 Stakeholder engagement types from minimal to maximum inclusion: ‘passive participation’ (people are informed about what is going to happen); ‘participation by consultation’ (people can give their own views); ‘functional participation’ (people participate by creating conditions that are favourable for an external project; ‘interactive participation’ (people participate in joint analysis and decide on follow-up) and ‘self-mobilisation’ (people take their own initiatives) (after Leeuwis, 2004).
Table 2. Analysis of the five innovation projects at proposal-writing stage using six characteristics of AIS (descriptions adapted from Klerkx et al., 2012). Start dates are mentioned in project descriptions. Cell shading indicates the project’s position on the AIS continuum from technology transfer (white) to co-innovation (dark grey); the darker the background, the greater the alignment of activities with AIS.

<table>
<thead>
<tr>
<th>Innovation project</th>
<th>Water use efficiency</th>
<th>Tomato potato psyllid</th>
<th>Heifer rearing</th>
<th>Nutrient management</th>
<th>Timber segregation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree of stakeholder involvement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range of disciplines involved</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scope of the potential impact</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact of stakeholder involvement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Driver</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Position within the wider system</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
In February 2016, the application of co-innovation principles in the projects had led to a re-shaping of the problem/project focus, except in the TPP project (Table 3) which is locked into contracted milestones with a Government funding agency and thus scored `inflexible' in terms of capacity to reshape the problem (Table 4). All the projects moved more towards AIS in most categories over the period in which the co-innovation principles were applied (Table 4). The type of stakeholder and the engagement methods increased for all projects, except for TPP, since solutions are still under development through tightly managed research aims (Tables 1 and 3). Two barriers were identified for TPP. Firstly, the research project had already started before the PI team became involved, so co-innovation was introduced to project team members after traditional project development and delivery processes were established. Secondly, the PI team identified through interviews with key people that the intended knowledge exchange with stakeholders was seen as largely linear (Vereijssen et al., 2015) and engagement awaits the production of technical solutions (e.g. resistant/tolerant cultivars). The PI team has offered support to deliver the knowledge transfer objective.

A significant change in stakeholder type and engagement happened in WUE and Heifer Rearing. In WUE, a co-innovation approach was deliberately embedded at the start. Stakeholders were involved in evaluating the use of weather-forecast-based irrigation practices. Stakeholder views were sought through workshops and one-on-one meetings to ensure the processes and the resulting products were viable and practical. In Heifer Rearing, the project leader DairyNZ proposed a series of regional focus groups in November 2013 to address the lack of farmer involvement with advisory groups. The purpose of these was to gain perspective and solutions from those who would implement them. The emphasis for the solution shifted as a result of these focus groups from a technical approach to increasing heifer live weight to emphasising the relationship between contract heifer graziers and stock owners. Focus groups identified key stakeholders as Beef+Lamb New Zealand and the Livestock Improvement Corporation. In response to the feedback, industry advisory group members were integrated into area-of-expertise working groups and a governance group for the project was established with key stakeholders.
Table 3. Status of the innovation projects after applying co-innovation principles: problem definition and stakeholder participation (February 2016).

<table>
<thead>
<tr>
<th>Innovation project</th>
<th>Problem/project definition or focus</th>
<th>Type of stakeholder</th>
<th>Engagement methods</th>
<th>Stakeholder engagement (Pretty, 1995)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water use efficiency</td>
<td>Improved irrigation, drainage, and water use efficiency</td>
<td>Farmers, irrigation scheme, researchers, regulatory bodies, non-pilot study farmers, farmers from other irrigation schemes, government</td>
<td>One-on-one meetings, phone calls, daily email updates, website, workshops, field days, Q&amp;A sessions</td>
<td>Functional participation</td>
</tr>
<tr>
<td>Tomato potato psyllid</td>
<td>Developing economically and environmentally sustainable control solutions for the TPP/CLso complex</td>
<td>Industry</td>
<td>Formal meetings, email</td>
<td>Participation by consultation</td>
</tr>
<tr>
<td>Heifer rearing</td>
<td>Improve relationships and farm profitability for both dairy farmers and contract growers through heifers that meet liveweight targets pre-calving</td>
<td>Dairy farmers, graziers, industry, researchers, private companies</td>
<td>Focus groups, advisory groups, advisory panel</td>
<td>Interactive participation</td>
</tr>
<tr>
<td>Nutrient management</td>
<td>Reduced nitrate leaching from viable arable, sheep &amp; beef, and dairy farm systems</td>
<td>Farmers, researchers, industry, policy/decision makers</td>
<td>Workshops, focus groups, email, one-on-one conversations, website, media releases, popular articles, conference presentations, journal articles</td>
<td>Self-mobilisation</td>
</tr>
<tr>
<td>Timber segregation</td>
<td>Improve the financial returns to growers and processors through better information on the wood properties of the forest resource</td>
<td>Wood processors, segregation tool manufacturers, harvesting managers, log traders</td>
<td>Focus groups, newsletters, workshops</td>
<td>Self-mobilisation</td>
</tr>
</tbody>
</table>
Table 4. Analysis of the five innovation projects in February 2016 using six characteristics of AIS (descriptions adapted from Klerkx et al., 2012). Project start dates are mentioned in project descriptions. Cell shading indicates the innovation project’s position on the AIS continuum from technology transfer (white) to co-innovation (dark grey); the darker the background, the greater the alignment of activities with AIS.

<table>
<thead>
<tr>
<th>Innovation project</th>
<th>Water use efficiency</th>
<th>Tomato potato psyllid</th>
<th>Heifer rearing</th>
<th>Nutrient management</th>
<th>Timber segregation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Degree of stakeholder involvement</strong></td>
<td>User and developer collaborate in research and extension</td>
<td>One-way flow of technology or knowledge from developer to user</td>
<td>User and developer collaborate in research and extension</td>
<td>User and developer collaborate in research and extension</td>
<td>Co-develop innovation involving multi-actor processes and partnerships</td>
</tr>
<tr>
<td><strong>Range of disciplines involved</strong></td>
<td>Transdisciplinary (e.g. plus sociology and grower experts, with limited stakeholder involvement)</td>
<td>Multidisciplinary (e.g. plus economics)</td>
<td>Transdisciplinary (e.g. plus sociology and grower experts, with limited stakeholder involvement)</td>
<td>Transdisciplinary (e.g. plus sociology and grower experts, with limited stakeholder involvement)</td>
<td>Transdisciplinary (e.g. plus policy makers, with broad stakeholder involvement)</td>
</tr>
<tr>
<td><strong>Scope of the impact</strong></td>
<td>Efficiency gains (input-output relationships)</td>
<td>Production unit-based livelihoods</td>
<td>Production unit-based livelihoods</td>
<td>Production unit-based livelihoods</td>
<td>Value chain, institutional change</td>
</tr>
<tr>
<td><strong>Impact of stakeholder involvement</strong></td>
<td>Modified packages to overcome constraints</td>
<td>Modified packages to overcome constraints</td>
<td>Modified packages to overcome constraints</td>
<td>Joint production of knowledge and technologies</td>
<td>Joint production of knowledge and technologies</td>
</tr>
<tr>
<td><strong>Driver</strong></td>
<td>Responsiveness to changing contexts, patterns of interaction</td>
<td>Supply-push from research</td>
<td>Supply-push from research</td>
<td>Responsiveness to changing contexts, patterns or interactions</td>
<td>Diagnose growers’ constraints and needs</td>
</tr>
<tr>
<td><strong>Position within the wider system</strong></td>
<td>Engaged with policy/decision makers</td>
<td>Science not engaged with policy/decision makers</td>
<td>Aware but not engaged with policy/decision makers</td>
<td>Engaged with policy/decision makers</td>
<td>Aware but not engaged with policy/decision makers</td>
</tr>
<tr>
<td><strong>Flexibility in re-shaping problem (1=inflexible; 5=completely flexible)</strong></td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>3</td>
<td>5</td>
</tr>
</tbody>
</table>
Discussion
Changes in the projects described over time (Tables 2 and 4) suggest a shift in the spectrum towards increasing application of co-innovation principles. There can be a perception that using a co-innovation approach in research projects is more advanced because it is a newer development in social science thinking. However, when a problem is less complex and science can provide a simple solution, a technology-transfer method may be the simplest, most economically viable option, as organisational and regional/state/national policy has little influence on improvements or outcomes. So depending on the problem’s complexity, different approaches need to be chosen, defined as dynamic research configuration by Schut et al. (2014), or dictated by circumstances. The question for each project is which one(s) of the nine co-innovation principles (Coutts et al., 2016) is/are most important to achieve change and when should they be applied to best effect?

The extent and depth to which co-innovation principles were applied differed between projects. Here we discuss how implementing co-innovation approaches affected the first and second co-innovation principles: i) take time to understand the problem from many different views; and ii) be inclusive.

Did the co-innovation process result in a change of problem definition?
When evaluating the shift toward co-innovation, the projects most quickly able to change and adapt were Timber Segregation, Nutrient Management and Heifer Rearing. In all three, the intent to apply co-innovation came before the establishment of project milestones and at the proposal-writing stage, and in two cases (Timber Segregation and Nutrient Management) before funding confirmation.

Nutrient Management has not seen changes in the problem definition as such, but because of the approach (Edwards et al., 2015) and continued engagement of end-users (industry bodies and farmers in the network), some changes to the approach have been made and new R&D questions have been formulated. These guide the project activities with an emphasis on integrating solutions in farm systems and supporting solution implementation on-farm. Similarly for Timber Segregation, the up-front and ongoing engagement with end-users has resulted in changes in the approach to addressing the problem, rather than the problem definition itself. Within this project, the problem definition and approach are constantly revisited.

WUE has seen the most transformational change, with co-innovation principles becoming embedded in the project over four years rather than just before funding confirmation, as with Timber Segregation, Nutrient Management and Heifer Rearing. WUE integrated flexibility by facilitating stakeholder interactions and bringing in additional stakeholders as necessary. The project expanded the stakeholders’ thinking by looking for other opportunities (e.g. economic value of irrigation and drainage management) to enhance their farming, economically and environmentally.

For Heifer Rearing, the application of the defined co-innovation principles did not influence every level of the project because the problem of under-grown heifers is not highly complex nor constrained by organisational/national policy.
TPP has faced the greatest challenge in integrating co-innovation, as PI became involved after project commencement. While the PI team may have a wider view of the activities required to address the TPP problem, milestones were written with a defined view of the science required. Overall, the integration of co-innovation principles at the inception of a project accelerated uptake of the approach and improved responsiveness and buy-in, leading to better shared understanding of the problem and processes required to address it.

**To what extent can the change in problem definition be attributed to stakeholder involvement?**

Except for TPP, the type of stakeholders and engagement methods increased when co-innovation principles were adopted. Managing stakeholder participation is a time-consuming and ongoing process mostly led by project leaders. In WUE an external driver forced change in stakeholder behaviour and thinking. During the study, the regulatory authority introduced limits to on-farm water use and capped the amount of irrigation that can be lost as drainage. This provided an external policy stimulant for farmers to look for supporting technologies. The driver to adopt new practices thus changed from a research-based supply push to stakeholder demand to improve the ability to respond to emerging contexts.

In Heifer Rearing, shifts in the problem definition were incremental, with wider stakeholder engagement and problem exploration having two effects: i) widening the base of stakeholders and organisations involved; and ii) redefining the scope and potential impact, from efficiency gains for dairy farmers to production livelihoods of contract graziers. Widening stakeholder engagement did not change the view of the problem, but confirmed its parameters. The apparent failure of earlier attempts to address problems associated with heifer rearing may be from a lack of emphasis on the relationship between stock owners and their contract graziers and mechanisms for optimising the business practices of both.

In Timber Segregation, engagement was organised two-way, with science managers from Scion and industry research brokers involved in formally building support, and a small group of science leaders engaging with a wide range of forestry sector stakeholders to co-develop the scope of the proposed research. Stakeholder engagement had two broad aims: i) to develop an agreed science programme; and ii) to build co-funding support.

**What were the barriers and opportunities to stakeholder participation shaping problem definition?**

Several project-specific barriers and opportunities were identified that hindered or enhanced the co-innovation process. The ability to respond to stakeholder feedback and insights and therefore the flexibility of the project is driven by individuals within projects (Röling, 2009), more so than the limitations or context of funding mechanisms. Project leaders’ comfort with loosely defined milestones or their willingness to re-negotiate milestones with funding bodies has been the greatest influence on adaptability.

In Timber Segregation the industry could “adapt or die”, so sector motivation for co-innovation was high; while in WUE the social context shifted providing an opportunity “too good to miss”, with researchers and stakeholders “riding the wave” in response (project leader quotes). This leads to the question: “does a co-innovation project have to be the source of innovation (creating new technologies or practices) or, by applying co-innovation, is it possible to adapt existing technologies and practices for application by engaging with the wider context?"
resonating with ideas by Douthwaite et al. (2001). Hence, while co-innovation may have a different aim, it is always useful for adapting technologies to users’ needs or for creating an enabling environment (see also Garb & Friedlander, 2014).

Overall, flexibility and adaptability, common themes across the projects, were important in achieving positive results from a co-innovation approach. However, the institutional setting and the ability to create the space and buy-in for co-innovation also mattered (see also Neef & Neubert, 2011).

**Conclusion**

Our experience confirms the context-specificity of co-innovation practices (e.g. Hall, 2005; Klerkx et al., 2010; Schut et al., 2015). By adopting at least the first two co-innovation principles when developing the proposal, or very early in the project, some projects have adapted to new knowledge brought by stakeholders. In some the focus of the project was changed and in others the approach taken to develop solutions changed. The willingness and ability of project leadership to engage with a range of stakeholders, to change project scope or its research approach, was crucial for continued stakeholder engagement. We conclude from our experience as biophysical innovation project leaders that to be successfully implemented co-innovation requires an adaptable mind-set rather than strict adherence to a single method.

**Acknowledgements**

We thank the Primary Innovation team for their valuable input over the last 2.5 years and the wider innovation project teams for their support. We acknowledge the Ministry of Business, Innovation and Employment and New Zealand dairy farmers through DairyNZ (RD1429) for funding the ‘Co-learning and co-innovation for increased impact’ project (CONT-30071-BITR-AGR).
References


Workshop 1.4: From farmer to “eco-preneur” in multifunctional agricultural knowledge and sustainable regional development: participatory curricula development and implementation of educational measures
Convenors: Dorit Haubenhofer, Thomas Aenis, Maria Gerster-Bentaya and Claudia Brites

Farmers and other rural entrepreneurs will increasingly need to build up skills and gather knowledge in “Eco-Preneurship” in the future, namely to design, develop, implement, manage and/or innovate individual concepts of multifunctional agriculture, like social farming and other Green Care activities. A key to sustainable systems development is the exchange of knowledge between the actors of an innovation system (researchers, advisers and other educational experts, policy and administrative stakeholders, etc.) and the users. There is still a lot of discussion as to whether knowledge transfer can follow the line from research via dissemination to the end-user (“transfer of technology”) or whether it must be done in the form of bi-directional communication as a “dialogue of all stakeholders”. Maybe it depends on the situation and the actors, as well as the learning styles of the so-called “target groups”. Moreover, on the innovation itself: for the transfer of “simple” technology packages, a linear transfer might be suitable which might not be sufficient when it comes to changing a farming system. Furthermore, learning is an ongoing process. Formal learning starts at elementary level, continues in higher education and/or vocational training, and does not end with extension. In other words: such “learning chains” must be developed which enable life-long learning in formal, non-formal and informal learning. Competencies are needed beyond classical technological and economic skills. The management of knowledge transfer is a tricky thing, firstly because it exists in various forms, such as theoretical, scientific and experience-based knowledge. From a research perspective, the main issue might be how to transfer scientific knowledge, which is usually more or less abstract and has often no clear distinctions between book knowledge, hypotheses, and more or less testified theories. Practitioners usually need practical knowledge. Knowledge exchange has to be organised in different settings. It seems as if participation in the curricula development, the implementation of the educational measure and in evaluation plays a key role in success and learning effectiveness and efficiency. This workshop aimed at an exchange of experiences in the creation of various educational measures in different settings. The purpose was to further develop ideas and possibilities for international training options in the field of social farming. We therefore invited papers on case studies as well as papers which reflected learning situations on a meta level. Key questions were: How to organize the learning process? What is the role of the educator? What are good practices and successful learning arrangements? How to fit education units to the needs of the learners? How to organise participation in planning and implementation? How to jointly evaluate the educational unit or the extension programme? How far does participation influence learning effects?
PerfEA: ongoing counselling towards strategic planning processes to implement the agro-ecological transition

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Abstract: Since 2012 the French Ministry of Agriculture has launched an ambitious programme called “Agro-Ecological Project for France”. This programme aims to facilitate and support the agro-ecological farming system’s transition. To support the agro-ecological transition school farms in the French educational system have to propose an agro-ecological strategy. In addition, teachers have to use didactic processes that help learners to understand and manage agro-ecological systems. For one year, six farms within agricultural high schools have implemented a strategic accompaniment method called PerfEA¹ to help them to build and manage a sustainable project for the school farm. On each farm a group comprising teachers, school director, farm manager and farm technicians, has implemented the PerfEA methodology with the support of a facilitator. At the end of the exercise, the participating school farms have defined the values of the organisation (e.g. innovation, sustainability, transmission and sharing of knowledge), its missions (e.g. “the farm is a support to the learning process and site of technical demonstration for students and local farmers”) and its vision of farm development (e.g. “being an organic farm open to a territory and its actors”). A balanced scorecard comprising some strategic indicators (e.g. “protein autonomy”; “number of projects involving farm workers, students and teachers”) was constructed in order to assess and pilot the performance of the school farm. Thinking and designing the strategy and its management tools has to be seen as a learning process. This article discusses how the ongoing counselling methodology as offered by PerfEA, to implement management strategy, and its tools, are learning supports which facilitate the agro-ecological transition. These learnings are both individual and organisational. According to loop learning theories they address to different extents: improvement of practice; revisiting assumption; and reconsideration of underlying values and beliefs.

Keywords: Strategic ongoing counselling, management, learning process, farming system, school farms, agro-ecological transition.

The agro-ecological transition context in school farms

In 2012 the French Ministry of Agriculture launched an ambitious programme called “Agro-ecological project for France”. This programme aims to facilitate and support the transition of conventional farming systems to agro-ecological ones. Based on seven action plans² and the

¹ PerfEA means global performance of the farm
² Plan Ecophyto (aims to decrease the use of pesticides); Plan Ecoantibio (aims to decrease the use of antibiotics); Plan Apiculture durable (aims to preserve and enhance bee production); Programme Ambition bio 2017 (aims to develop organic production); Plan Azote/méthanisation (aims to have a better use of organic manure and to
support of collective action\textsuperscript{3} this policy is designed to support the innovation and facilitate the agro-ecological transition.

In the educational system, this programme is translated by the phrase “learn to produce differently”. This programme aims to improve the capacity of the agricultural educational system to integrate agro-ecology into programmes and didactic process. Teachers are invited to enhance the capacity of students to adopt an attitude of problem finding versus problem solving (Mayen, 2013). School farms related to agricultural high schools are also invited to propose agro-ecological farming systems. These farms have three main missions: i) they should be supportive of diverse objectives of learning (experiment with agricultural practice, learn to manage a project and learn to cope with complexity); ii) they should produce agriculture products and/or services to sustain their activities; and iii) they should be a place for experimentation and should contribute to territorial development by taking part in local development projects.

We think that agro-ecological transition in the French educational system asks people to reflect on their practices (didactic or farming practices) and accordingly their relation to knowledge and to other actors. It also articulates different levels of change from field to territory. Obviously these changes are not always easy for actors. School farms are special places where the articulation between production, pedagogy, experimentation and local development can be discussed and built. The implementation of a strategic reflection about the project of the farm, in a participatory way, can thus provide a support for accompanied transition.

In this article we present the ongoing counselling process of six school farms which have chosen to implement PerfEA (Capitaine et. Al., 2012, 2013). PerfEA is a method to help farmers to build and to manage the strategic project of their farm. After asking how agro-ecological transition questions the educational system, the PerfEA methodology - its principles and some methodological aspects - are presented. Then we ask how this strategic accompaniment is a support to the learning process and how these learnings could facilitate the agro-ecological transition in agricultural high schools.

**School farms: the core of the agro-ecological transition in the educational system**

In France, public agricultural high schools are mostly related to school farms or technical processing plants (cheese production, meat transformation, etc.). There are 190 public school farms and 33 technical processing plants in France. These farms are very diverse and production systems are representative of local agricultural systems: it could be horticulture, wine production, cropping systems, dairy production etc. These farms or processing plants must meet the three main missions discussed above and their governance is specific.

**Main missions of the school farm in secondary schools**

Schools farms have to be a learning support for the students. Teachers can use the school farm support to organise practical works where students can experiment with agricultural practices. Students learn how to milk a cow, how to feed, how to use specific material, how to recognise weeds, etc. It’s a place where students can learn how to use diverse diagnostic methodological aspects: Plan Protéines végétales (aims to develop protein crops); Plan “En seigner à produire autrement” (“teach to produce differently”).

\textsuperscript{3} The GIEE (groups of farmers and non farmers who are associated in order to collectively develop agro-ecological systems), could pretend to better financial support.
tools for producing useful information for farm management. It provides a support for managing collective projects such as organising participation of the farm to agricultural manifestation. The school farm is also a support for economic or global studies which aim to understand the farming system in a specific environment; it’s a way to learn how to think as a farmer.

School farms have to produce and sell agricultural products or services to sustain their activities. They must achieve economic viability with their own production; not easy it could be said for this kind of farm which has employees (just the manager is a civil servant). Except for the investments that are decided on and paid for by the regional public authority, these farms have the same economic considerations as other private farms.

School farms have to offer an environment for experimentation and local development. They are invited to take part in national or local research networks. Additionally, they serve as a place for experimentation, innovation and extension in collaboration with local farmers. They can also take part in local development projects in relation with other actors in the territory (local institutions, farmers, etc.), e.g. they might collaborate with other farmers in a collective renewable energy facility (e.g. an anaerobic digester). In an urban context they can help to create links between rural and urban areas; a place where people can have easier contact with agricultural production.

**Governance, organisation and links with other actors of the local territory**

The decision processes on school farms are quite different to those on commercial farms. The manager is a civil servant; he has to implement the national policy decided on by the French Ministry of Agriculture. The investments, as in all other high schools, are decided on at regional level. Investment decisions take time and are dependent on the regional policy. Consequently the transition dynamic can be noticeably different in these farms. Moreover, due to their mission to define and implement the strategy, school farm managers need to take into account many stakeholders. When an investment or technical decision is taken it has to follow a consideration of the pedagogical effects within the teaching community, the required approach with technicians and workers, and must consider the expectations of other farmers and/or the local community. For instance, in a context of agro-ecological transition, school farms’ managers tell us that they have to take a measured approach to innovation if they want to be in coherence with agriculture reality in the local farming systems.

As a place of pedagogy, experimentation and extension, school farms could play a very specific role in local agriculture and non agriculture development. They are more or less linked with local and regional education and extension institutions. Similar to most commercial farms, they are stakeholders in diverse collective projects (GIEE⁴) or cooperative organisations (CUMA⁵, etc). They have in consequence a very specific place in the local rural network. In the context of transition, this diversity of potential or existing relations with other actors could be seen as a major resource for collective innovation.

**Agro-ecological transition at agricultural school level: an articulation of cognitive, technical, pedagogical and organisational change**

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⁴ The GIEE is a group of farmers and non-farmers who are associated in order to develop agro-ecological systems.

⁵ A CUMA is a co-operative which gathers farmers together to buy agricultural equipment, to obtain specific subsidies, to improve their competitiveness and to organise their work for higher efficiency.
Agro-ecology could be seen as a scientific discipline, as practice and as a social movement (Wezel et al., 2009). As a scientific object or discipline, agro-ecology could be defined as “the application of ecological concepts and principles to the design and management of sustainable agro-ecosystems” (Gliessman, 1998). As a political project, agro-ecology emerges in a different context with the common objective of proposing alternative agricultural systems to conventional agriculture and its socio-ecological negative impacts. As a practice agro-ecology is composed of great diversity in the production system. Nevertheless agro-ecologic systems have common objectives: reduce the use of chemical products, maximise ecosystems’ services and protect biodiversity, insure food security and enhance resilience of systems. Biggs et al (2012) and Duru et al. (2015) identify three proprieties of socio-ecological systems: i) the diversity of biological and social entities; ii) connectivity between biophysical entities as well as social entities; and iii) the state of slow variable (e.g. soil organic matter, water resources, management agencies, social values) determined dynamics of fast variable values (e.g. field management, water withdrawals, income, etc). Duru et al. (2015) also identified four governance principles for agro-ecological systems management: i) understand the socio-ecological system as a “complex adaptive system”; ii) encourage learning and experimentation as a process for acquiring new knowledge, behavior, skills, values or preference; iii) develop participation of stakeholders in governance and management process; and iv) promote polycentric subsystems of governance that structure debate and decision-making among different types of stakeholders. We think that these principles could be relevant for agro-ecological transition at agricultural school level and discuss this further in following sections.

Teaching how to produce in an agro-ecologic way is a major objective of the agro-ecological project for France. Accordingly, curricula have evolved in order to have a better coherence with agro-ecologic principles. New curricula aim to adapt teaching and pedagogic practice to the complexity of farming systems and decisions about farming system management. These new curricula underline the necessity to show the diversity of agricultural systems, to understand their link with social, ecological and economic environments and to work in a multidisciplinary way.

Changing the way of teaching in order to integrate agro-ecology can be difficult for teachers. Actors we worked with identified several barriers or difficulties to change: the need to develop technical competence for teachers who in some cases have a theory based curricula; the difficulty of changing pedagogic practices and habits; the distance between professional practices and students; the difficulty with a multidisciplinary approach; or a lack of recognition of the legitimacy of change by teachers themselves or by students. Moreover, changing the way of teaching could be seen as uncomfortable for the teacher because it introduces a risk for students and for their success in final exams. For Mayen (2013), teaching to learn to produce differently is not only teaching well-identified ways of thinking and actions pre-adapted to situations which are well defined, well categorised and therefore easily identifiable, but also learn to identify and define problematic situations, and to find and to adjust ways of thinking and acting which are not always even listed.

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6 “Teach how to produce differently” is a national action plan composed of four axes: i) renovate curricula; ii) mobilise school farm; iii) enhance regional governance of local actions; and iv) train and support staff and organisation in their transition.
7 Website of Ministry of Agriculture
At the farm level, agro-ecological transition is quite a complex transformation process; it involves technical, social and cognitive change. Coquil (2014) shows that during transition: "autonomous mixed-crop farmers manage new entities, which vary according to farmers: food autonomy of the herd, straw autonomy, animal health, food balance of the herd... They work by mobilising new knowledge, new indicators are acquired step by step during the transition". Thus, farmers re-discovered on their farm resources for managing the transition (Coquil, 2014). Interested in the learning of the farmers engaged in inputs reduction in crop-culture Chantre (2011) supports the same conclusion and highlights that the pragmatic judgments and the development of criteria performance evolved during transition. These examples highlight that agro-ecological transition is not only a technical concern; actors transformed their farming system representation and learned step by step during transition. Mayen (2013) notices that beyond knowledge and skills, the management of agro-ecological systems needs to invest in a special attitude or state of mind characterised by a set way of feeling, thinking, appreciating or acting. For Mayen (2013), this state of mind cannot be taught but can appear, evolve and transform. Additionally, it is felt that it is possible to create a ground in favour of the development of a favourable state of mind for agro-ecology.

Based on these considerations, we hypothesise that agro-ecological transition in agricultural school is based on several learnings of educators (farm managers, workers, teachers, etc.). We propose that this learning may have different levels of intensity and scope (Argyris & Schön, 1978; Pahl-Wostl, 2009) and we propose to address this different level of learning in the triple-loop learning conception (Pahl-Wostl, 2009). The single-loop learning refers to an incremental improvement of action strategies without questioning the underlying assumption. In single-learning loops, actors question if they do things right, with a strategic point of view, the aim of actions is not re-questioning. The double-loop learning refers to a revisiting of assumptions (e.g. about cause and effect relationships) within a value-normative framework. In double-loop learning, actors question if they do the right thing; from a strategic point of view the representation of performance is evolving. In triple-loop learning one starts to reconsider underlying values and beliefs and take a world view (reconsidering the way that knowledge and innovation is building, reconsidering the relation to others and to nature, etc.), what we propose to assimilate to state of mind.

We hypothesise that an effective and sustainable transition requires mobilisation of double- or triple-loop learning where actors reconsider and transform their representation, objectives or values. We also think that this loop learning could be realised in dialogic reflection between actors of the agricultural school. The school farm, given its hybrid aspects, seems to be a good place to support dialogue and reflexivity.

**Strategic accompaniment as a learning process, a way to facilitate the agro-ecological transition?**

**PerfEA: an accompaniment method to build and design sustainable strategy in a participative way**

PerfEA is a method for helping an organisation to have a participatory reflection about its strategy and for helping the formalisation and the implementation of a sustainable strategy. This is a counselling method which aims at developing actors' autonomy and enhancing the empowerment of actors' organisations. From an epistemological point of view, this method has its roots in a socio-constructivism paradigm (Vygotsky, 1978). Interactions between actors
and tools used for helping to design a collective representation of the behavior of the system are also articulated in order to support individual and collective learning.

An articulation of different tools for supporting dialogue, learning, decision and formalisation of a strategy

The PerfEA methodology is composed of four main stages.

The first step is based on an analysis - by the members of the reflection group - of the environment and the objectives of the group. Separate workshops consider a review of past successes and failures, the expression of a vision by projection into the future (3-4 years’ time), the expression of values that drive the organisation, and consideration of the school farm missions, and are used to collect data from the stakeholders. This stage helps the members of the groups to exchange thoughts about the aims of the organisation and to find ways of improvement. A specific workshop is dedicated to identifying the factors that improved or threatened the sustainability of the farm (see next section).

Using the elements identified by the group during the first step, the second step uses the data collected during the first stage to realise a causal mapping in order to help the group to define strategic objectives which are used to build a balanced scorecard as a primary tool (Chabin, 2008). This scorecard can be multi-dimensional, integrating criteria that are financial and non-financial, short and long term, qualitative and quantitative, retrospective and prospective. Using the measurements produced, the scorecard reflects the degree of success of the strategy. It also aims to integrate non-financial indicators that are expected to provide a prospective overview of the company and its environment, which explains why we talk about a balanced scorecard (Kaplan & Norton, 2004). Building the balanced scorecard with actors provides an occasion to discuss the objectives and their level of performance. It’s a strong learning process helping them to build a shared representation of the global performance of the school farm.

The third step is dedicated to defining an action plan (or a scenario of change) which defines the means (financial, technical, human, knowledge...) necessary to implement the strategy. We know that action planning has its limits and that action planning in a highly uncertain context is difficult (such as in agro-ecological transition), but this exercise is still relevant because even if actors couldn’t plan the whole road they could discuss what the next stage should be or how to organise to define it.

The fourth and last step is the implementation of the strategy. During this step the actors put into the strategy into practice. They organise implementation of actions and use balanced scorecards as assessment tools of the farm performance. The realisation of objectives is discussed periodically by the actors. Thus, they can discuss action or experimentation efficiency or reconsider assumptions about objectives.

Specific tools for helping to build a systemic and complex representation of the farm

Bossel framework for helping the construction of a systemic view of the sustainability of the farm. The Bossel framework (1999) is used during the first step of the method in order to analyse the situation of the farm within its environment and to identify which processes enhance sustainability of the farm and which factors are vulnerable. Based on a systemic approach to sustainability, Bossel’s framework postulates that sustainable systems
necessarily meet certain conditions as determined by the relationship between the system and its environment. In this perspective, the framework defines a set of six basic attributes characterising the various types of relationships defining the sustainability of a system in its environment: the existence; effectiveness; security; adaptability; freedom of action and co-existence. For human systems Bossel (1999) completes his analysis framework with the following attributes: reproduction (or reproducibility); satisfaction of psychological needs; and responsibility. During the first step, the group is invited to identify for each basic attribute the positive or negative aspects of the farm. Then the group discusses if the organisation is or is not in control of the identified elements. Thus they can produce a synthetic tool that shows the opportunity/threat and strengths/weaknesses of the farm. This collective inquiry is a way to exchange different representation and to discuss about performance processes.

**Causal mapping: synthetic, analytic and reflective tool.** Causal mapping is the second tool used to help the members of the groups to have a systemic vision of the farm and to cope with complexity. This tool is used to ensure the link between the strategic analysis and the formalisation of the strategy. In practical terms, causal maps are elaborated by the facilitator of the strategic reflection from notes or recordings of the discourses of actors during the workshops. It is a graphical representation which shows ideas or concepts expressed by actors and the causal link between them. The representation of elements in a map helps to clarify their meaning. It shows the causal relationships and the reasoning behind decisions taken. The causal map is both a tool for communication with others and an analysis tool (Cossette, 2003). Therefore, the causal map is a mediation support tool that clarifies thinking and decision making and facilitates agreement on a strategy and the creation of a vision. The use of a causal map to explore the cognitive structures of an organisation is now widespread in management research (Huff, 1990; Laukkanen, 1998). Particularly suitable for strategic approaches (Eden, 1988; Cossette, 2003), the causal map helps to formalise individual and collective representations.

In the accompaniment method, the causal mapping is uses to synthesise the diversity of ideas and representations expressed by the different members of the group during the first stage of the strategic reflection.
The structure of the map serves as an analytical support. It identifies causal links between different entities (ideas, concepts, objectives) and thus facilitates the identification of the processes involved in the structure. It is possible to identify multiple links (more or less interdependent, more or less competitive, more or less contradictory, more or less important) that lead to the achievement of the same objective. These links are part of different coherent sets on the basis of which the strategy will be developed. On farms owned by agricultural education institutions, coherent sets of goals emerge. They are focused on economic, educational and local commitment challenges. These links can also identify the strategic areas that form the basis for the implementation of the farm management project. In addition, the causal map provides multiple analyses that can be used as part of a strategic approach. Therefore, it is possible to perform statistical analysis based on the map. One possible analysis highlights the entities that are essential to the strategy. This analysis provides indicators that will be used to build the balanced scorecard. Causal mapping takes a central place in the PerfEA method because it is:

- a support tool that acts as an intermediary (Vinck, 2000), facilitating the cognitive process;
- an aid that provides a representation of the processes implemented in a structure and facilitates the identification of the core elements of the strategy;
- a tool that takes complexity into account without removing it (Axelrod, 1976);
- a mediation tool that helps to ensure that a group has a shared vision of a given strategy (Eden, 1988).

**Collective strategic reflection**

In order to help agricultural high schools to build and manage a strategic project for their farm, the local Agricultural Agency in the Rhône-Alpes region supported the implementation of the strategic ongoing counselling method PerfEA. Six farms from agricultural high schools chose to take part in the project from September 2014 to March 2016. On each farm a group composed of teachers, school director, farm manager and farm technicians implemented the PerfEA methodology with the support of an external facilitator⁸. In charge of the implementation of the different workshops with actors, the facilitator is neutral. He/she organises and regulates the discussion between actors and helps the explanation of ideas. He/she also produces some intermediary tools for helping actors’ thinking and helps them to formalise the project.

**Table 1. Type of farms and collective engaged in the collective reflection**

<table>
<thead>
<tr>
<th>School farms</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type of production</strong></td>
<td>Dairy production</td>
<td>Dairy production</td>
<td>Goat production</td>
<td>Dairy production</td>
<td>Dairy production</td>
<td>Riding center</td>
</tr>
<tr>
<td>Crop</td>
<td>Beef production</td>
<td>Beef production</td>
<td>Crops</td>
<td>Poultry</td>
<td>Crops</td>
<td></td>
</tr>
<tr>
<td>Sheep</td>
<td>Kennels</td>
<td>Kennels</td>
<td>Kennels</td>
<td>Kennels</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Description of participants and average numbers in workshop</strong></td>
<td>School director</td>
<td>School director</td>
<td>School director</td>
<td>School director</td>
<td>School director</td>
<td>School director</td>
</tr>
<tr>
<td>Farm manager</td>
<td>Farm manager</td>
<td>Farm manager</td>
<td>Farm manager</td>
<td>Farm manager</td>
<td>Farm manager</td>
<td>Farm manager</td>
</tr>
<tr>
<td>Teachers (4)</td>
<td>Teachers (7)</td>
<td>Teachers (3)</td>
<td>Teachers (4)</td>
<td>Teachers (4)</td>
<td>Teachers (3)</td>
<td>Teachers (2)</td>
</tr>
<tr>
<td>Farm worker (1)</td>
<td>Farm workers (4)</td>
<td>Farm worker (1)</td>
<td>Student (1)</td>
<td>Farm worker (2)</td>
<td>Farm worker (1)</td>
<td>Riding animator</td>
</tr>
</tbody>
</table>

Moreover, for maximising feedback about the implementation of the accompaniment methodology a peer group composed of representatives of the six farms was also created. Five workshops were organised to gather the peer group together during the project. These workshops were dedicated to debate about decision making and management difficulties, and used to elaborate synergies between school farms. The first workshop discussed what participants expect from the project and defined the way to implement the method on each

⁸ The facilitator was the first author of the article.
farm. During the second workshop, each representative explained and discussed the main strategic option identified by the group. The groups also discussed how the causal mapping could be used for designing the strategy. During the third workshop each farm manager explained its strategy with the support of their balanced scorecard. The fourth workshop provided an opportunity to discuss the different action plans. The fifth workshop gave a global feedback about the strategies of implementation.

**Learning and changes during the process**

In order to have an overview about learning process during the implementation of the PerfEA methodology, we used different sources of information: i) the elements produced by the organisations during the strategic reflection (intermediary tools such as causal mapping) and the project formalised at the end of the process; ii) the elements produced by the peer groups during reflexive workshops where farm managers and school directors involved in experimentation have feedback discussion; and iii) an online survey sent to every actor at the end of the process whereby they can express what they think about the process in which they took part.

**Formalisation of tools for strategic management**

Each school farm engaged in the experiment has produced intermediary tools (Bossel’s framework analysis, strategic causal maps, etc.) to help them to formalise their project. At the end of the process each school farm has defined the values of the organisation (e.g. *innovation, sustainability, transmission and sharing of knowledge*), its missions (e.g. “farm is a support of learning process and technical demonstration for students and local farmers”), and its vision of farm development (e.g. “being an organic farm open to territory and its actors”). A balanced scorecard, composed of a few strategic indicators (e.g. “protein autonomy”, “number of projects involving farm workers, students and teachers”), was constructed in order to assess the performance of the school farm (cf. Figure 2 for an example). Those documents are seen by the farm manager as tools of assessment of the farm performance which can be used to discuss the results and exchange about the efficiency of the farm management process. They are also a communication tool used by managers to explain the farm project development to a diversity of stakeholders.
### Table 2. Example of balanced scorecard of a school farm

<table>
<thead>
<tr>
<th>Strategic objectives</th>
<th>Strategic Indicators</th>
<th>State of indicators</th>
<th>Desired state for indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improving economic situation</td>
<td>safety margin=GOP-annuity</td>
<td>- 50 000 euros</td>
<td>-25 000 euros before 5 years</td>
</tr>
<tr>
<td>Securing the sale of organic products</td>
<td>% Reservation before slaughter by cow</td>
<td>40%</td>
<td>100% in 2020</td>
</tr>
<tr>
<td></td>
<td>Net margin/product type sold</td>
<td>To calculate</td>
<td>Define step by step</td>
</tr>
<tr>
<td>Improving alimentary autonomy</td>
<td>Amount of concentratre / Liter of goat milk</td>
<td>~ 170g/ L of goat milk</td>
<td>To define step by step</td>
</tr>
<tr>
<td>Being an certified organic farm</td>
<td>Be recertify as organic farm</td>
<td>Certify</td>
<td>Certify</td>
</tr>
<tr>
<td>Participate in the development of the territory</td>
<td>Number of day with demonstration activities or thematic workshops for local stakeholders</td>
<td>7 days</td>
<td>Maintain existing actions and develop actions for agricultural professionals</td>
</tr>
<tr>
<td>Maintain and develop the network</td>
<td>Number of external action in which the farm is involved</td>
<td>3 : one research program on organic farming, a pedagogic program on organic teaching, a comity about local development</td>
<td></td>
</tr>
<tr>
<td>Strengthen the educational role of farm for all educative sector</td>
<td>Number of hour/student/year of utilisation of farm support for educational activity in i) doing agricultural task ii) technical pedagogie iii) economic and global analyse</td>
<td>To calculate</td>
<td>Enhance the economic and global analyse</td>
</tr>
<tr>
<td>Being in a project dynamic (technical and educational) widely shared internally and externally</td>
<td>Number of project involving farm workers, students and teachers</td>
<td>4 projects</td>
<td>At least 3 per year</td>
</tr>
<tr>
<td>Promote technical, educational and organizational innovation</td>
<td>Number of innovative action per year</td>
<td>2 actions</td>
<td>At least an innovative action per year</td>
</tr>
</tbody>
</table>

**Learning process**

Various learnings emerged from the collective workshops organised with the *ad hoc* groups on school farms. According to loop learning theories (Argyris & Schön, 1978; Pahl-Wostl, 2009) we propose to have a special focus on double-loop learning (reconsidering objectives) and triple-loop learning (paradigm, world view, values, in a word: state of mind) because we hypothesise that these levels of learning are necessary to agro-ecological transition in the educational system. Moreover, we propose to distinguish two types of learning. The first is individual; it could be single- double- or triple-loop. The second is collective or organizational; it corresponds to an evolution of the dynamic interaction between actors (new working group, better relation between actors, change of the boundaries of the social-system considering, etc.). Based on the survey we administered, and material products by the peer groups and groups of reflection, we try to highlight what participants have learned.
If the ongoing counselling process has produced a balanced scorecard to manage the farm for the next 4 or 5 years, it also is a learning process.

For most of the participants the main appeal of the process is that it allowed them to exchange ideas and knowledge with other actors. They also highlighted that they have developed better knowledge of the overall operation of the farm from a technical, but also organisational and human point of view (e.g. a school director: "I realised the importance of human relations between farm technician and teacher"). They have a better view and understanding of the key points for farm performance and strategic options for the farm development. Teachers notice that this proximity to the farm allows them to better support students' work on the farm. Teachers in economics who contributed to the strategic thinking notice that the collective and the formalised strategy of the farm can support their work with students about farm management. Hence, actors’ representation in farm management or educational activities have changed.

Each farm has therefore produced their new management tools used for performance assessment: the balanced scorecard and an action plan. The use of this new management tool is itself an organisational change. It can help the organisation to manage the global performance of the farm. We also think that the representation of the performance changed during the strategic thinking: indeed, objectives evolved and were redefined. For example a school farm planned to change from a "maize/herb system" to a "herb/maize system" in order to enhance the proteins autonomy of the farm rather than milk production. From the initial judgment of "a lack of exchange between entities" and "a lack of internal and external communication about farm projects" the "number of inter-entities projects in which the farm is a stakeholder per year" become a farm performance indicator. In other words, this farm should be a place that helps to mix up activities. Finally, we can argue that the balanced scorecard is a strong lever to ease the double-loop learning process.

Many actions or changes planned by the groups are actions related to organisational aspects and information or knowledge management: establish steering group or multi-stakeholder focus group to cultivate a theme; implementations of analytic accounting or of software to manage information about animal systems; recording and sharing the level of educational activities etc.

Strategies also underline the importance of innovation networks and external partnerships (e.g. with local farmers or with public collectives) for the global performance of the school farms. Actors underline that participating in these networks is a way to develop innovative projects (e.g. on conservation agriculture, organic farming, etc.) or to develop experimentation which can help the transition from a technical or pedagogical perspective. It’s also a way to show the dynamic of the farm and the school and to improve its image.

At the end of the process the peer groups underlined that “participative reflection enhances the collective mobilisation of the actors of the organisation”. However, the mobilisation effect was more or less important in the different situations. They also highlighted that the strategic reflection “was a way to drive interdisciplinary work” and a way “to organise dialogue between

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9 Most of the farm managers said that had already had a good global overview of the farm. This point is highlighted by other actors.
10 Of course, some of these actions were revealed by the reflection and others were new.
actors who have not worked together on many occasions”. They noticed that actors have a better understanding of the different missions of the farm and a better understanding of the role of different actors. Actors also argued that “having a shared project, a shared course of action, gave reassurance and helped them to step back”. The farm managers and school directors think that the participatory building of the strategy enhances the legitimacy of the management function.

Finally, during the third peer group workshop, some actors had a reflection about the coherence between agro-ecological transition of the farm and the pedagogic transition to teaching how to produce in an agro-ecologic way. The two transitions are linked and feed on each other. But for actors they are both based on a common ground: “the producer at the heart of production and learners at the heart of his learning.” For actors, both transitions mobilise the same principles which are “accepted uncertainty, accepted that solutions are not always known, accepted risk and the necessity to experiment, the right to error but the need for reflexivity, the necessity to work with multi-disciplinary groups and with networks, etc.” According to these principles, we think that strategic thinking with PerfEA (whilst acknowledging that other tools could be as efficient) is a way to facilitate adoption of this state of mind. But we are conscious that a discourse about principles is different from the adoption of these principles and it is difficult for us to have a view about this level of learning.

Conclusion
In the context of agro-ecological transition, school farms are at the heart of the transition. We show that PerfEA methodology, by supporting inter-personal dialogue and by helping to cope with complexity, can facilitate individual and collective learning. Actors of the organisation have a better comprehension of school farm missions and of its projects. Teachers can easily identify some issues on the farm that they can use with their students. From an organisational point of view the implementation of participatory strategic thinking, supported by an external facilitator, is seen by actors as a way to facilitate the exchange of knowledge between themselves and to increase their empowerment.

The agro-ecological transition mobilises technical changes but has its roots in actors’ representation, world view and beliefs. Agro-ecological transition is questioning farmers as well as educational and extension systems. In each case (farmers, teachers, advisers) the transition requires different levels of learning. We think that there is a common ground, a common state of mind, which is in part the change from a command and control paradigm to a complexity paradigm (Morin, 1990). Actors need to accept uncertainty, complexity, ambiguity and unpredictability.

To conclude we propose to consider advisory activity from a pedagogical perspective. We think that an ongoing counselling process as praxis is a useful state of mind for helping actors and organisations to evolve. In the context of transition, where knowledge, governance and world view evolved, the advisory activity is transformed. In this context, advisors who facilitate individual and collective learning in organisations seem to be very useful.

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Farmer mentoring in Norway—how do different mentoring approaches improve entrepreneurial skills?

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Abstract: Running a small business such as a farm can be a complicated and challenging task, and there is a growing body of evidence on entrepreneurial competences needed to run and develop a farm. Mentoring can support entrepreneurial competences, but how this influences entrepreneurial learning has been explored only to a limited extent. Therefore, two farmer-mentoring programmes aimed at supporting farmers’ learning and development were studied to identify how the concept of mentoring is incorporated, what kinds of learning are stimulated, and what effects on entrepreneurial learning are found. An analytical model was elaborated based on the functions of mentoring - psychosocial and career-related - complemented with the concept of entrepreneurial mentoring and entrepreneurial skills, to identify outcomes on entrepreneurial learning related to entrepreneurial identity, recognition and acting upon opportunities and growth of the business. Findings indicate that the matching process and the qualities of the mentors differ between the two programmes, and they do not fully incorporate the concept of mentoring because they have little focus on helping the mentees to explore options and ideas that they can use to solve their own business issues. In both programmes, the production-oriented knowledge and experience are important. In only one of the programmes is there development of entrepreneurial identity.

Keywords: Mentoring, entrepreneurial learning, entrepreneurial mentoring, entrepreneurial skills

Introduction

There is a growing awareness of the entrepreneurial skills needed to run and develop a farm (Seuneke et al., 2013), i.e. exploit market opportunities and innovate. Professional and management skills are basic requirements for farmers while entrepreneurial skills are essential to create and develop new business activities (Wolf & Schoorlemmer, 2007). Some farmers are more entrepreneurial than others but this is not necessarily due to a lack of certain personality traits but rather due to (the lack of) specific competence and experience (Lans et al., 2013). Farmers develop entrepreneurial skills predominantly through a process of learning-by-doing and less through formal education (Vesala & Pyysiäinen, 2008). Lans et al. (2013) indicate that to acquire entrepreneurship and business management skills, entrepreneurial learning is important. Entrepreneurial learning recognises and acts upon opportunities through initiating, organising and managing the firm in social and behavioural
ways (Rae, 2006). The social approach to entrepreneurial learning relates to a context of interacting with other persons, businesses and others outside the firm. The behavioural part of entrepreneurial learning reflects a manifestation of the learning in the behavior of both the farmer and the farm business. Following ideas from small business-supporting systems from non-agricultural sectors, different kinds of mentoring programmes for farmers have been initiated to support farmers and strengthen their entrepreneurship and farm management skills. While there are some papers that report on experiences with mentoring programmes aimed at farmers (Klerkx & Leeuwis, 2009; Lans et al., 2013), this earlier work is more dedicated to explaining the set-up of these programmes. It is not explicit on the positive and negative effects of such programmes. Overall, few in-depth studies have been conducted of the effects on entrepreneurial learning through mentoring programmes. This is where the paper aims to contribute. Therefore, we investigate here the effects of entrepreneurial learning from two mentoring programmes in Norway. These programmes support farmers in developing and exploiting entrepreneurial and farm management skills. The purpose of the study is to explore how these two mentoring programmes support farmers’ entrepreneurial learning in terms of positive and negative effects.

The research questions are:

i) How do two Norwegian farmer-mentoring programmes incorporate the concept of mentoring?

ii) What kinds of learning are stimulated through these mentoring programmes?

iii) How do mentors and farmers perceive effects on farmers' entrepreneurial learning?

Theoretical framework
Mentoring has increased in scope and is used in various areas of society (e.g. for enhancing general psychosocial wellbeing and assertiveness in different situations of life) as well as for professional situations. As farmers are urged to become more entrepreneurial, the term of entrepreneurial mentoring (St-Jean & Audet, 2009) suits farmers’ situation.

Defining mentoring in the context of entrepreneurial orientations of farmers
Mentoring is explained as supporting people to manage their own learning to maximise their potential, develop their skills, improve their performance and become the person they want to be (Deans & Oakley, 2006). Workplace mentoring involves a relationship between a less experienced individual and a more experienced person. The purpose is the personal and professional growth of the mentee—the less experienced person (Kram, 1983). Mentoring involves transferring personal experiences of doing business and solving specific problems (Klofsten & Öberg, 2008) from the mentor to the mentee. The mentor should not provide business advice or propose solutions to business issues. Instead, the mentor should help their mentee to explore options and ideas that they can use to solve their own business issues (Kent et al., 2003). Mentoring thus is a dynamic process between a mentor and a mentee. The mentor and the mentee form a reciprocal yet asymmetrical learning partnership (Eby et al., 2007). Pawson (2004) found that the nature of the interaction between mentor and mentee affects the success of the relationship. This calls for a description of the characteristics of the mentoring programmes. Elements that describe mentoring include the duration of the mentoring, frequency of interaction, formality of the relationship, matching process, and the qualities of the mentor (Barrett, 2006).
Effects of mentoring on entrepreneurial learning

It is universally held that mentoring results in substantial rewards for mentees (Allen et al., 2004). Kram (1983) identified two types of mentor functions. One is career-related and one is psychosocial. The career-related support enhances the mentees advancement in the organisation and includes the mentor functions of sponsorship, exposure and visibility, coaching, protection, and challenging assignments. The psychosocial support addresses interpersonal aspects of the relationship and refers to aspects of a relationship that enhance an individual’s sense of competence, identity, and effectiveness in a professional role. Specific psychosocial functions include role modelling, acceptance and confirmation, counselling and friendship (Allen et al., 2004).

Farmers are often self-employed, and career advancement in their own organisation is not a topic of concern, but is more likely related to the overall development and advancement of the farm business as a whole. This can be the role of the mentoring programme - to help the mentee to explore options and ideas that they can use to solve their own business issues (Kent et al., 2003). Wolf and Schoorlemmer (2007) relate entrepreneurial skills to the development and advancement of the farm business by identifying three essential entrepreneurial skills: i) recognition and realising business opportunities; ii) developing and evaluating a business strategy; and iii) networking and utilising contacts. These entrepreneurial skills can be a result of the career-related function of the mentoring programme as stated by Kram (1983).

The psychosocial effects are related to the development of the mentee’s competence, identity and effectiveness in a professional role (Kram, 1985). St-Jean and Audet (2009) introduce the concept of entrepreneurial mentoring involving a supportive relationship between an experienced entrepreneur and a novice entrepreneur to foster the latter’s personal development. Taking an entrepreneurial learning approach offers sensible insights into the learning effects of the entrepreneur as a mentee.

Both the psychosocial and the business development functions stated by Kram (1983) are found in Rae’s (2006) framework of entrepreneurial learning, which consists of three major themes related to the outcome of the entrepreneurial learning process.

1. Entrepreneurial identity
2. Recognition and enacting of opportunities
3. Growth of business

The psychosocial function of mentoring can stimulate a personal and social emergence of entrepreneurial identity. Rae (2006) states that acquiring entrepreneurial skills and knowledge is not sufficient. The person who begins to act as an entrepreneur is assuming the identity of an entrepreneur.

Recognition and enacting of opportunities are a result of contextual learning in relation to others, which in this case can be a mentor. During these relational activities, individual experiences are related and compared, and shared meaning is constructed.

Fortifying and growing the business is an outcome of the relationship between the farmer and actors in the working environment. The ideas and aspirations of farmers are realised through interactive processes of exchange with others within and around the farm.
In Figure 1 these theoretical relations are illustrated together with Rae’s (2006) suggested outcomes on entrepreneurial learning.

![Analytical model](image)

**Figure 1. Analytical model**

We are interested in the effects of entrepreneurial competence development. This is highly associated with entrepreneurial learning (Seuneke et al., 2013; Lans et al., 2013). Thus, we explore the effects on entrepreneurial learning using the concept of entrepreneurial mentoring (St-Jean & Audet, 2009) and entrepreneurial skills (Wolf & Schoorlemmer, 2007). These are related to the outcome of the learning process based on Rae’s (2006) framework to explore how the two mentoring programmes fit into these taxonomies of entrepreneurial learning.

**Case selection and methods**

**Case selection**

We use a case-study approach, which is preferred when the aim is to understand complex processes and relationships (Yin, 1994). We studied two cases or mentoring programmes. The research questions compare these programmes according to how they have incorporated the concept of mentoring, which learning is stimulated and the effect on entrepreneurial learning. These two mentoring programmes are newly established and they seem to be quite different at first glance.

A partnership of private agricultural companies, public actors and a farmers’ union in the Mid-Norway region initiated the mentorship programme called Competence Boost. A procurement cooperative, Felleskjøpet, operates the other mentoring programme, Young Farmer. Further presentation of the mentoring programme is a part of the results and describes how these two mentoring programmes incorporate the concept of mentoring.

**Methods**

We collected data from five mentor–mentee pairs in Young Farmer. We joined three meetings between a Young Farmer and a mentor. We first interviewed the mentor and observed the meeting between the actors. Afterwards we interviewed the mentor and the farmers separately. We also interviewed two other farmers in the programme separately. Both these mentees had mentors who were interviewed earlier. One of the mentees had a mentor for swine production (interviewed earlier) and another mentor for the dairy production, who was also interviewed. As a basis for interviewing, we developed interview guides - one for mentors and one for
mentees. The guides covered different topics. We were interested in the programme’s goals and design as well the interaction and communication between the mentor and the mentee, and also how this facilitates learning. We also developed an observational scheme to assist with mentorship evaluation. Interviews and extensions were tape-recorded and the interviews were transcribed. The two interviews with mentors lasted about 1.5 hours and the one with mentees about 30 to 45 minutes. When choosing mentees and mentors, we tried to achieve a variation along dimensions such as geography, producer environment, mentors and mentees and investment. All farmers have swine production, and one of them has dairy production in addition.

In the other mentoring programme, Competence Boost, we selected four of the 16 mentor–mentee pairs for interviews. The farmers had different productions—sheep, diary and eggs. These interviews were conducted as telephone interviews lasting 20 to 40 minutes. We developed separate interview guides for the mentors and the mentees to cover the mentoring programme, the matching process, the need for competence, sharing experiences and how they practically conducted the mentoring.

In analysing the data, we used both the interviews of the mentors and the mentees. A qualitative content analysis (Patton, 2005) is a suitable method for data analysis.

Findings

The mentoring programmes

Here, the two Norwegian farmer-mentoring programmes are presented in terms of their use of mentoring. Core characteristics of the mentoring programmes are summarised in Table 1. The characteristics are based on Barrett (2006) and are supplemented with a description of the ownership and goal of the programme.

Table 1. Elements aimed at describing the mentor programmes

<table>
<thead>
<tr>
<th>Organisation manages the project</th>
<th>Competence Boost</th>
<th>Young Farmer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A project with several contributors.</td>
<td>Input sales and output buying cooperative.</td>
</tr>
<tr>
<td>Goal of mentor programme</td>
<td>More competence among farmers. Increased demand for competence. Increased entrepreneurial attitude.</td>
<td>To secure/improve members performance and to recruit more members</td>
</tr>
<tr>
<td>The matching process</td>
<td>The mentee initiates the mentoring and chooses a mentor among farmers he/she knows or have heard about. Mentees are motivated by starting a new production or investments.</td>
<td>Felleskjøpet assigns mentors to new, Young Farmers. Employees in Felleskjøpet (sellers and advisors) are in a pool of mentors.</td>
</tr>
</tbody>
</table>
Formality

Mentee receive funding to pay a small fee to the mentor. A formal agreement including a plan and a timetable are formulated. Discussions are largely governed by the mentee and the mentees demand for answers to questions. The mentor assists with advice and is a discussion partner. Mentee perceives that good advice was worth paying for.

Young, new farmers who becomes member of Felleskjøpet are assigned a free mentor and other gifts and offerings. Structured meetings where the mentor keeps the dialogue. Transfer expert-based knowledge to farmers. The data-programme “Ingris” supports communication between mentor and mentee within swine-production.

Quality of the mentor

The mentor is an experienced farmer. Competencies were mostly related to farm production or production orientation. No mentor-training programme. Sharing of experience in professional network.

The mentors in Felleskjøpet are mainly experts in food concentrates and feeding or sellers. Some have higher education and less experience in swine production when others have practical experience but less education. Some of them are experts and partially covering narrow topics. Mentors share their internal network in Felleskjøpet with the mentees.

Duration

One year, may apply for two more years if they show yearly progress.

Three years.

Frequency

Three meetings a year. Additional contact by telephone, mail and visits.

Two visits a year. Additional contact by telephone, mail and visits.

Competence Boost was a project initiated by a regional partnership in Mid-Norway. The project ran from 2013 until the end of 2015. The project initiated different competence efforts for farmers and advisors in which one of them was a farmer mentor.

Young Farmer is a mentoring programme developed by Felleskjøpet—a big sales and procurement cooperative in Norway. The aim of the cooperative is to strengthen the economy of farmers in the short and long run (www.felleskjopet.no).

The objective of transferring knowledge to the mentees is common in the programmes, but the knowledge is obtained from different sources. Mentors in Young Farmer have a greater focus on disseminating formal knowledge, while in Competence Boost the mentees have the initiative and ask the mentors for both their knowledge and experience. The recruiting and matching routines cause different motivations for the mentees to take part in the programme. Not all mentees in Young Farmer are aware of taking part in a mentor programme and one mentor said that he was very careful using the term “mentor” when facing Young Farmers
because he was afraid of bypassing the mentee. Mentees in Competence Boost are self-recruited, proactive and motivated to take part.

**Learning taking place in the programmes**

This section presents results regarding the type of learning that results from the different mentoring programmes. Table 2 shows the elements of learning expressed in the two cases, structured according to the functions of entrepreneurial learning as well as psychosocial and career-related learning (Kram, 1983). The psychosocial functions are related to St-Jean and Audet’s (2006) term “entrepreneurial mentoring”. The career-related functions are related to entrepreneurial skills: business opportunities, business strategy and networking.

### Table 2. Elements of learning

<table>
<thead>
<tr>
<th>Competence Boost</th>
<th>Entrepreneurial mentoring</th>
<th>Entrepreneurial skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>I have to be active to develop</td>
<td>Sharing formal knowledge and experiences</td>
<td>Learning how other farmers find solutions</td>
</tr>
<tr>
<td>Share network</td>
<td>Learning to work smart—logistics in production</td>
<td>Learning how to improve results beyond feeding</td>
</tr>
<tr>
<td>Holistic approach</td>
<td>Learning to avoid failures</td>
<td>Gain new knowledge about feed combinations followed by a trial and error process to test new feed</td>
</tr>
<tr>
<td>Support each other</td>
<td></td>
<td>Sharing network with other persons in Felleskjøpet</td>
</tr>
<tr>
<td>Enjoy social contact</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Entrepreneurial mentoring**

According to St-Jean and Audet (2006), entrepreneurial mentoring involves a supportive relationship between an experienced entrepreneur (mentor) and a novice entrepreneur (the mentee) to foster the latter’s personal development. This is a part of the psychosocial function of mentoring (Kram, 1983). The mentees in Competence Boost experience entrepreneurial mentoring. One mentee stated that to develop he had to actively search for solutions and ask questions. Another pointed to networking in the sense of learning how to use the network of different experts to make his own progress. The mentors have not only shared their networks but also contributed to the mentees’ networking skills. One mentee stated that the mentor managed to put together all the advice received from others in a holistic approach. We also found elements of social support including group support and enjoying the social contact. Mentees reported that the mentoring programme is a social event. Mentoring empowered both persons and created fellowship. One mentor stated that when they were only two persons it was possible to be more private indicating that they could go beyond the enterprise and over to the personal area. Taking part in a mentorship programme could stimulate further development of entrepreneurial identity for the mentees.
The mentees in Young Farmer had fewer signs of entrepreneurial mentoring. The main example reported was emerging trust in the mentor-mentee relationship. One mentor stated that as a mentor he had to be careful to not be too challenging.

**Entrepreneurial skills**

We did not find any examples of learning related to business opportunities. There were several examples of business strategy and some examples of networking (Table 2).

Competence Boost focuses on knowledge related to running a production in accordance with how to organise a smart working flow, and how to avoid costly failures. Mentees who were about to start new productions asked questions like: how do you conduct this function in your production? In this case, both the mentor and the mentee had practical experience and they could share this with each other and reflect together. Such discussions offer learning to both persons. As one mentor said – “I always learn something from the others”. The knowledge transfer spans from formal knowledge to practical daily work. Some of the mentors took part in the startup of the production by working together with the mentee. Working together is an arena for transferring tacit knowledge.

In Young Farmer, the focus is on better performance during production that rests on knowledge transfer from mentor to mentee. They also learn about Felleskjøpet and what the cooperative can offer. In our example, the farmers contacted the mentor if they had questions. According to farmers, learning is mainly about feeding the animals. The mentors in Young Farmer reported that the mentees behave very differently. Some are very keen on learning and performing, and others are more reluctant to change. The mentor tries to adapt to the farmer’s needs and goals but also challenges them in some areas. One of the mentees said that he knew that it was smart to take part in professional meetings, but he had not prioritised going.

The mentors also learn. In Young Farmer one mentor stated, “I think I learn something every day”, and another “There are always farmers that find good solutions. If it is functioning well, we bring it further to the other advisors”. One example is from a farmer that wanted another combination of feed. Because of this request, Felleskjøpet developed a new feed for sows based on a new combination of concentrate and this is now under testing. If this functions well, then Felleskjøpet will develop this feed as a part of their assortment.

The mentors shared their networks with the mentees in both programmes, but it is not clear if this resulted in networking activities among the mentees.

**Effects on entrepreneurial learning**

Rae’s (2006) framework for entrepreneurial learning was used to describe the effects on farmers’ entrepreneurial learning. The framework consists of three main themes related to the outcome of the learning process—entrepreneurial identity, recognise and act upon opportunities, and growth of the firm.

**Entrepreneurial identity**

Entrepreneurial identity is developed when the farmer starts acting like an entrepreneur (Rae, 2006). Farmers can be viewed as entrepreneurs because they are self-employed, but this does not mean that they act like one. In Competence Boost, the mentees’ motivation to attend
the mentoring is driven by new production and new investments. This means that prior to the mentoring, they acted in an entrepreneurial way when planning to develop their business. It is not clear if this is an effect of a prior entrepreneurial learning process. In Competence Boost, the mentees reported learning in accordance with entrepreneurial mentoring and effects including opening up to new ideas and the stimulation of networking. Development of networking skills may be a prerequisite for exploiting network opportunities.

The experienced farmer is a role model for developing entrepreneurial identity in Competence Boost. In Young Farmer the mentors have a different background and do not represent a role model for developing entrepreneurial identity.

Development of the entrepreneurial identity in Young Farmer was not obvious. There were no examples that we could identify. We found trust building between mentee and mentor, but it is not clear if this contributes to entrepreneurial identity. Curious mentees ask questions and search for knowledge. Thus, they behave like an entrepreneur. Reluctant and passive mentees do not get involved in discussions and reflections—they are simply instructed on what to do, and this is more common in Young Farmer.

**Recognition and acting upon opportunities**

Recognition and acting upon opportunities is a result of contextual learning and seems to be at the core of both mentoring programmes. Sharing production-oriented knowledge and experiences are found in different ways, from skill-based learning to more entrepreneurial learning. The mentors in Competence Boost are experienced farmers and contribute with their experiences solving daily tasks. The experienced farmers seem to be a good partner for discussion and reflection. Mentees report that learning from an experienced farmer is more valuable in terms of avoiding failure costs, by doing things right the first time rather than increasing revenues.

Mentors in Young Farmers largely have expert knowledge and can transfer this to the mentee. In most cases, the mentor governed the dialogue. The mentors also brought in news from Felleskjøpet. As an example, the mentor introduced a new feed that may increase performance. The Ingris measuring system guided and framed the dialogue if the mentee did not bring other topics to the discussion. The mentoring is directed at increased performance, but they did not report any concrete examples. The Ingris system - together with knowledge transfer from the mentor - may help the mentees to plan and work more systematically. There seems to be a mix between advice and teaching the mentee to solve his own challenges.

**Growth of the business**

The effects on business development and growth are a function of the mentees’ ideas and aspirations, which can be realised due to an interactive process of exchange with the mentors and others (Rae, 2006). In Competence Boost the mentoring programme has been crucial for starting up a new production and making investments. This may be a result of contextual learning, but we cannot exclude that development of entrepreneurial identity can strengthen the ability to develop the business. The engaged and motivated farmers may be even more motivated and improve entrepreneurial skills while looking for new possibilities, attending new networks and searching for new opportunities. In Young Farmer we did not find any sign of growth of the business. The mentees’ focus on cost avoidance instead of increasing the revenues shows little awareness of growing the business.
Discussion
This discussion is structured by the three research questions: how do the mentoring programmes incorporate the concept of mentoring, what kind of learning occurs and what are the effects on entrepreneurial learning?

Different enactments of the concept of mentoring
Our findings reinforce the observation by Bozeman and Feeny (2008) that mentoring programmes vary widely. The differences between the two mentoring programmes create different learning conditions for the mentees. This is for example shown through the different ways of assigning the mentors, by free choice or by designation. The mentors in both programmes appear competent. The matching processes are the main difference between the two programmes, and this results in different conditions for especially entrepreneurial mentoring and development of entrepreneurial identity. The Young Farmer programme in particular lacks the characteristics of supporting people to manage their own learning. Hence, if the purpose of mentoring is supporting people to manage their own learning (Deans & Oakley, 2006), it is easier to succeed if the mentee is motivated as we found the mentees in Competence Boost to be. Our findings underpin that the matching process including the recruitment of mentees influences the condition for supporting farmers to manage their own learning.

In general, mentors help their mentees to explore options and ideas so that they can solve their own business issues (Kent et al., 2003). In Competence Boost, the mentors are experienced farmers. The mentor’s behavior will influence the mentee, and the mentor will function as a role model for the mentee because the mentee will identify himself with the mentor. Experienced-based knowledge is valued and combined with formal knowledge in both programmes. Our examples show that the mentors and mentees in Young Farmer have developed trust-based relationships. The farmers do what the mentor tells them to do according to feeding. This knowledge adaptation does not usually represent a big change in routines by farmers, but it is changing until the farmer is satisfied. In the end this can result in developing the mentees ability to explore options. In Competence Boost, we did not find the same trust building focus - perhaps because the trust was taken care of when choosing the mentor. The characteristics of the mentoring programme (e.g. Barrett, 2006) seem to influence the conditions for entrepreneurial learning and should be elaborated as a part of the analytical model.

Hence, as our findings show, the full concept of mentoring is not clearly expressed in any of the programmes. The personal and professional growth of the mentee (Kram, 1983) is not fully taken care of in the programmes. The Competence Boost programme has a larger focus on mentoring than Young Farmer. This can be related to mentors being experienced farmers and obvious role models and that the mentee having the initiative and setting the agenda. The mentoring process will be shaped by how the mentor perceives his role. None of these programmes has any mentor training and they have to figure it out on their own. Without any instructions and training the mentors will rely on their experiences and this will result in different ways of mentoring in accordance with their competence. This illustrates that the term mentoring is introduced without being aware of the crucial purpose of mentoring to encourage others to explore options (Kent et al., 2003) and manage their own learning (Deans & Oakley, 2006), and indicates the need for a mentor-training programme before initiating mentoring programmes.
**Effect on entrepreneurial learning and identity**

As our findings indicate, the characteristics of the mentoring programme will affect the learning conditions. The foundation of both the mentoring programmes is production-oriented learning. The purpose of Young Farmer is production-oriented knowledge transfer similar to a traditional advisory system (Seuneke et al., 2013). Without any training in mentoring, findings indicate that it is difficult to break out of the advisor role for the mentors from Felleskjøpet. Another obstacle is the mentees vague interests in taking part in the mentor programme, especially when they do not know much about it. However, entrepreneurial learning is not central, but the programmes are related to entrepreneurial skills. This helps mentees to recognise and realise business opportunities in existing production routines. This can hence be seen as contextual learning, where the one-to-one relationship helps disseminate knowledge and share experiences.

In Competence Boost, both the mentors and the mentees report learning mostly related to entrepreneurial skills. Two of the mentees stated that the mentoring was decisive in their investment decisions. This is an example of how entrepreneurial skills can strengthen the entrepreneurial identity and help people act like an entrepreneur. Entrepreneurial skills can then affect self-confidence to develop the entrepreneurial identity. The Competence Boost programme contributes to entrepreneurial identity by empowering the mentee. Here, this can be related to the matching process, where the mentee chose to participate in the programme and selected the mentor.

Following the major themes of entrepreneurial learning according to Rae (2006), it is the purpose of mentoring programmes to nurture development and to help the mentee explore options and ideas (Kent et al., 2003), and develop mentees’ entrepreneurial identity. Developing entrepreneurial identity occurs by entrepreneurial learning (St-Jean & Audet, 2009). However, there are few examples from our findings of entrepreneurial mentoring having an effect on entrepreneurial identity. We found the psychosocial functions (Kram, 2003) of mentoring being in the shadows of product orientation. None of the programmes explicitly stated the role of mentoring as helping the mentee to explore options and ideas that they could use to solve their own business issues (Kent et al., 2003), though it did happen (as discussed in the above section on entrepreneurial learning). The best examples of real entrepreneurial mentoring are found in the Competence Boost programme. The self-recruitment of mentees to Competence Boost gives this mentoring programme a better condition for stimulating the entrepreneurial identity. Importantly, these mentees have already started to develop their entrepreneurial identity by taking the initiative to take part in the mentoring programme.

**Conclusion**

In studying two different mentoring programmes for farmers in Norway within the framework of entrepreneurial learning, we found that the mentoring programmes differed in several characteristics. The main differences were the mentors’ background and competence as well as the programmes’ design. Mentees in Competence Boost choose their mentors from experienced farmers while mentees in Young Farmers are assigned a mentor from Felleskjøpet employees. The matching process and the quality of the mentor in terms of mentoring competences were different and gave different conditions for learning with subsequent differential effects on entrepreneurial learning.

Our study indicates that it seems to be more challenging to facilitate entrepreneurial identity and entrepreneurial skills when there is a too large a mentoring focus on production
improvement. Without being fully aware of the intention behind mentoring, it is easy to rest on the traditional way of learning focused on production, with entrepreneurial learning as a side effect. The core of mentoring as helping the mentee to solve their own business issues (Kent et al., 2003) must be taken care of when designing the mentoring programme. To further stimulate entrepreneurial learning the mentors need training to understand their role as a mentor.

Further research is needed to completely elaborate the understanding of entrepreneurial learning - especially to understand the need to design a mentor programme to cover both the psychosocial and career-related parts of entrepreneurial learning in balance with more production related mentoring.

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From action research to action learning – ecosystem services assessment as a learning platform for students, local land users and researchers

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Abstract: The Spring School in “Landscape and Territory Agronomy” has been organised by an international team of teachers since 2007. The target of landscape agronomy is to address the spatially explicit interactions between farming practices and natural resources at territorial level. It requires an action research approach that we have conducted on different topics all applied to the same region in Pisa (Italy). The case-study based Spring School is a good platform for action learning. So far, we focused on environmental and water management (2007, 2009), peri-urban agriculture (2013) and the ecosystem services provided by agricultural and semi-natural habitat management (2015). These case studies enabled us to elicit the relationship between stakes that are often treated separately. The course was designed for PhD students of various disciplinary backgrounds but all interested in action research related to agricultural land management. In this learning platform, local stakeholders are involved through round table discussions, interviews and the territory game, a participatory territorial foresight. Students can experience the effectiveness of action research by interacting with local stakeholders and they become aware of the complexity of information gathering and analysis in a real situation. Through the interactions with the students, local stakeholders have the opportunity to widen their view on stakes they are concerned with in their every-day life. Compared to pure action research, our learning platform creates a collaborative environment facilitating interactions between stakeholders and therefore it creates a learning device for them as well. In this specific case, the action research methods proposed to the students and used in their interactions with the stakeholders allowed the group to prepare spatially explicit maps indicating where various ecosystem services are produced and where their benefits are delivered according to the stakeholders. These maps were eye-openers for the stakeholders but also for the researchers involved, because it allowed them to bridge the gap towards transdisciplinary approaches to address land management in an agricultural context. Moreover, it highlighted that the main challenge regards land use management and its coordination at territorial level, regardless of the specific ecosystem services stakeholders expect to receive or think they deliver through their activities. In particular, the participatory territorial foresight resulted in innovative land management proposals capable of overcoming more traditional and sectorial perspectives.

Keywords: Landscape agronomy, territory game, transdisciplinary education, provisioning services, regulating services, stakeholder knowledge mapping
The course structure

The various promoters of territorial development – namely farmers and other land managers such as water management consortia, nature reserve managers, and local communities, researchers, technical advisers, policy and administrative stakeholders – have few arenas in which to exchange knowledge. Training courses and educational programmes can provide a ‘platform’ (Lardon et al., 2012) to gather some of these actors and facilitate communication between people with different perceptions about the territory through comparison of hard data and more subjective information based on people’s experiences (cf. Scherr, 2016; Raymond et al., 2010). As far as agriculture is concerned, a specific challenge is to upscale local actions to a territorial level in order to understand how innovation of farming practices is both conditioned and affected by overall landscape management (Benoît et al., 2012). To this end, an international and interdisciplinary team of researchers has organised the Spring School in “Landscape and Territory Agronomy” since 2007.

The structure and aims of the Spring School were presented during previous IFSA Symposia (Moonen et al., 2010; Rapey et al., 2008) and have been maintained in time. Each year, this solid frame of the courses is applied to a specific core theme that is suitable to be explored by a landscape agronomy approach (see Benoît et al., 2012). In particular, the themes are selected for their power to address the relationships between land management issues that are often kept separate at the territorial level. During past editions in 2007, 2009 and 2013, the courses focused respectively on environmental and water management and peri-urban agriculture. The course generally lasts 1 week and addresses PhD students. It usually takes place in spring and the key feature is to combine lectures and activities belonging to the domain of action research, so as to constitute the above mentioned learning platform that provides new experiences, knowledge and information for the students but also for the local stakeholders and researchers organising the course.

There are three types of lectures: i) theoretical lectures to introduce the background of landscape agronomy and of the theme chosen for the Spring School; ii) some applied lectures provide a toolbox grouping information on general action research techniques and case study specific tools; and iii) the final type addresses a characterisation of the study area in terms of land use, agro-pedo-climatic information, economic activities and any piece of data that is relevant to relate the case study with the specific theme of the year.

An action research structure underpins the lectures following five steps: i) a round table with local stakeholders to identify the issues at stake; ii) the assessment of land use management through the interpretation of available maps and databases; iii) field trips to observe the landscape and for open-ended interviews with some key actors involved in land use management; iv) classroom work to prepare a territorial participatory foresight following the method called “territory game” (Lardon, 2013); and v) performing the territory game with local decision-makers, land use managers and other relevant stakeholders.

On the one hand, the five action research-steps are meant to stimulate students to interact at different levels with stakeholders. On the other hand, the lectures provide them with the concepts and the tools to analyse and integrate all the available information provided in the form of maps or databases. Altogether, the integration of lectures and action research builds an action learning platform that fosters three goals:
i) it familiarises the students with theory and practice of action research. In this way, the students can test the method reliability by interacting with local stakeholders and experience the complexity of information gathering and analysis in a real situation;

ii) it has proven to be fruitful also for local stakeholders, who are challenged to observe the stakes they are concerned with in their every-day life from different perspectives;

iii) it helps the researchers to improve the reliability and saliency of their local data elaborations by checking it with the stakeholders and eventually integrating the local information.

For both students and stakeholders, the action learning platform allows widening of individual viewpoints thanks to exchanges between stakeholders who do not meet regularly, and by breaking down the silos between methods and disciplines like agronomy and geography.

In this paper we will focus on the course structure and the main results from the 2015 edition that dealt with the management of ecosystem services (ESs). In the discussion we will provide an overview of the opportunities the four Spring School courses have offered students, local stakeholders and the involved researchers.

**Action research on ecosystem services as a learning platform**

**Study area**

The case study for the 2015 course edition was the urban region near Pisa (Tuscany, Italy). The area covers approximately 49,000 ha (49% of which are agricultural areas) and stretches from the coastal plain to the inland hills with the typical climate and land management conflicts of a Mediterranean landscape (Marraccini et al., 2013). From a geo-morphological point of view the region can be divided in two contrasting areas, the Pisa Plain along the coast and the north-eastern hill system called *Monte Pisano* (i.e., Pisa Mountain). These two areas are connected by the movement and activities of land users and local inhabitants and from previous studies it emerged clearly that the perception of local land users about these areas are very different.

The Pisa Plain is mainly a production area dominated by arable crops and forage. Semi-natural habitats (SNH) are concentrated in the Regional Natural Park (Parco di Migliarino, San Rossore, Massaciuccoli) that is dominated by woodland and covers most of the coastline near Pisa. In the cropped area SNH consist of drainage channels and small, mostly herbaceous, field margins. Water discharge is a great challenge in order to allow farmers to cultivate their fields in a timely manner and avoid water stagnation.

The Monte Pisano is a hilly landscape composed of olive groves on the foot- and mid-hill, and by mixed forest and Mediterranean garrigue, pinewood and abandoned chestnut plantations on the top-hill. Nowadays, most of the olive groves are managed by hobby farmers (Gennai-Schott et al., 2014). About 50% are organic growers and the understory consists of spontaneous vegetation managed through cutting. Dry stone wall terraces characteristic of these olive groves are only partially maintained and collapsed walls are frequently observed (Rizzo et al., 2007). Abandonment is increasing in the area due to the high costs of maintaining the olive groves while harvest is at risk from olive fly attack. Furthermore, the Monte Pisano is at high risk of wild fire during the dry summer period. The patches of olive groves create many SNH connected through the understories and the elements of the terraces system.
The Ecosystem Services as an example to address territorial development

Daily (1997) defined ESs as “the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfil human life”. According to the Millennium Ecosystem Assessment (2005), these ESs can be classified into four main categories: provisioning, supporting, cultural (non-marketed) and regulating services. Agro-ecosystems are composed of cropped and SNH and are therefore at the same time providers and consumers of ESs (Power, 2010). Management practices influence the potential for ‘disservices’ from agriculture, including loss of habitat for conserving biodiversity, nutrient runoff, sedimentation of waterways and pesticide poisoning of humans and non-target species (Zhang et al., 2007). At the same time, good management practices of both the cropped and SNH will reduce the disservices from agriculture while increasing the services from SNH to agriculture and from agriculture to society. From this short description of complex interactions, it becomes clear that land management for ES is an interesting theme to be approached through action research. Due to the multiple spatial and functional relations between the various territorial parts, it is almost impossible to draw clear conclusions about the services an area delivers and receives from neighbouring areas or local land use activities.

The theme of the 2015 course focused on the relation between ESs and land management and the contribution of ESs to territorial development. Interactions between stakeholders and researchers in a running research project on ESs provisioning by SNH (QuESSA; www.quessa.eu) revealed a gap between ESs expected by farmers and the ones actually provided, or even the problems they perceived as originating from SNH. The causes for lack of ESs provision by the SNH could in most cases be brought back to lack of management or mismanagement of the semi-natural areas. From this mismatch came the idea to organise the Spring School around this theme in order to determine the context for future research in a participatory way. Students and relevant actors were guided to assess the local land use typologies and the services these systems deliver both to agriculture and to society. At the same time, the students were required to find out how stakeholders from the two areas (i.e. the plain and the hills) perceived possible services provided to them from the other area or, vice versa, if they felt their area was providing services to the other area. In this regard, it was clear that talking about ESs facilitated the local land managers to formulate an opinion because in one way or another, everyone receives some services from the territory he/she lives in, and consciously or not, may provide a service to the territory through his/her activities. Hence, the choice of ESs appeared as a relevant and salient example to address the territorial development, though remaining a very complex object to deal with. In an action-research context this means that the students performed only the planning phase by analysing the current situation and identifying the possible openings for innovative territorial management aimed at increasing delivery of ESs desired by farmers while having some consensus on alternative management options for the SNH that should deliver these services to farmers and the society as a whole.

Contents and tool presented in the course

The lecture modules of the Spring School 2015 covered the following theoretical lectures: ‘Overview of ESs to and from agriculture’, ‘Overview of SNH typology and management in northern and southern Europe’, ‘How do policies affect land use management’, ‘Farmers’ typologies: understanding behaviour and attitude, conflicts and synergies especially in relation to multi-functionality’, ‘Background concepts of landscape and territory agronomy’ and ‘Governance aspects of ESs’. The applied module (toolbox) consisted of lectures on ‘Spatial
Models’ (*Choremes* in French (Lardon, 2006)), ‘Mapping Local Spatial Knowledge’, ‘Methods to perform local stakeholder surveys’, ‘The territory game’ and ‘Methods for analysing ecosystem services to and from agriculture’. Finally, the case study area was presented by showing and discussing maps, pictures and statistical data about the land use, economic activities and the population.

This information was deemed sufficient to initiate action research by listening to local stakeholders in the round table discussion. Based on the first impressions emerging after the round table discussion (Figure 1a), students formulated the objectives for the field visit and individual interviews with stakeholders (Figure 1b and 1c). This information was processed fostering spatially explicit outputs that highlighted the location and direction of ESs provisioning within and between the two areas, the hills and the plain. These spatially explicit elaborations were combined with the available thematic maps of the study area.

All the elaborations were targeted to prepare the cards and the maps used for the territory game. The cards join spatially explicit analyses of available data and information with a short explanation of the key findings; they are kept as simple as possible, each focused on a single topic (e.g. drainage channels in the Pisa Plain; demography dynamics in the whole area). The maps are blank mute supports for the first two stages of the game. These maps require the students to identify the limits of the study area related to the spatial extent of the selected theme; in addition, they have to select and represent the relevant infrastructure and spatial objects helping the actors to orient on the map without conditioning their expression (Debolini et al., 2013).

The game was played by selected stakeholders and the students, with the latter covering either the role of players or of game managers (Figure 1d). The territory game was guided by a researcher and two students acted as observers taking notes about the interactions between the players. This is very important for the analyses of the results by the researchers afterwards.

We split the class into two groups, dealing with the hill or the plain area respectively. The groups played on separate tables, each with five players. Each player was given a set of three cards and was asked to select the most relevant one according to his/her viewpoint in relation to ESs’ provisioning. The set of cards is given by the game managers fostering the mix across stakeholders. For instance, farmers received cards about water management or demography, whereas local administrators received cards about farming practices. In the first stage of the game, each player presented the chosen card to the other players and together the players had to draw a diagnostic map representing all of the issues they discussed. In the second stage, a new empty map is provided and the game managers guided the players to define a foresight scenario for the local landscape. The players were asked which actions would be needed to develop a shared territorial management of the ESs in the following 20 years. The scenarios need to be exaggerated in a positive or negative sense (paradise or disaster), so as to break the possible locks of the ‘business as usual’ scenario. In both stages, the diagnosis and the scenario, the crucial aspect is that maps pushed the participants to discuss around a spatially explicit representation of their discussion, eventually highlighting agreements and conflicts. In addition, each group must elect a representative to present the scenario to the other group. Finally, the third stage is the formalisation of realistic actions inspired by the scenario and answering the initial diagnosis. These actions draw upon the intense interactions of the first two stages, thus helping to capitalise the crossing of viewpoints.
Results from the 2015 course
The action learning platform gathered results both on the educational and the research sides. In this section we present the main results that emerged from the five action research steps (defined in the first section) that represented the various interactions between students and local actors.

The round-table discussion with the stakeholders and the interviews performed during the field visit were processed and summarised by the students into four maps about ESs’ provisioning. These maps were incorporated into some of the cards played during the territory game. Figure 2 shows the summary of the key ESs and where their service is received. Figure 3 shows the services or disservices agriculture receives from SMH surrounding cropped fields. This issue was mostly highlighted by the farmers. Figure 4 shows the relations between ESs from the Pisa Plain to the Monte Pisano and vice versa, as perceived by the interviewees. A fourth map was created in relation to vegetation management on the Pisa Mountain, because in this area lack of adequate management was frequently indicated as the cause of suboptimal ESs delivery and socio-economic problems in the study area.
Figure 2. Ecosystem services from agricultural and natural areas to society. The north-eastern grey areas indicate the Monte Pisano and the remaining part the Pisa Plain.

Figure 3. Ecosystem services and disservices to agriculture. The north-eastern grey areas indicate the Monte Pisano and the remaining part the Pisa Plain.
From their viewpoint, the stakeholders of Monte Pisano regarded the lack of policy support to sustain olive production as the key issue for land management. In fact they consider that olive groves play a central role in some ESs e.g. erosion control and leisure provision (as manifested by attracting tourists from the region but also from abroad). The abandonment of correct management of pinewoods was pointed out as the main cause of large fires, possibly initiated by the uncontrolled practice of burning pruning residues by olive growers. Overall, a well-managed mountain agroecosystem provides clean water, water regulation and leisure areas to the Pisa Plain. Stakeholders in the Pisa Plain perceived lack of correct management of the drainage system as a key problem for successful agricultural production. Most SNH in the Pisa Plain are woodland areas of a nature park, and are perceived as the origin of wildlife (e.g. wild boars) that damage their crops. Beekeepers value SNH, especially on the Monte Pisano, for the provision of non-polluted flower resources.

Altogether, the action learning platform was successful at providing the students with concepts and tools to elicit and analyse differences in the perception of stakeholders from the plain and hill areas, although these areas are close and within a range of 10 km from Pisa. A common perception was that both areas have a below optimal ESs delivery due to lack of landscape-based management of SNH and infrastructures.

The territory game resulted in a diagnostic map and a foresight scenario both for the Monte Pisano and for the Pisa Plain area. In each scenario the players explicitly addressed the relation they fostered with the other area, respectively the plain with the hills and vice versa, in a 20-year future (Figure 5). As an example, we present the results obtained for the Monte Pisano.
The ESs selected by the various players were biodiversity conservation, water regulation, landscape aesthetics and recreation. Water regulation emerged as the key service of the Monte Pisano, both in terms of production of clean water through infiltration of rainwater and regulation of the water arriving on the Pisa Plain from the mountain area. Correct vegetation management and maintenance of the terraced olive groves, the main agricultural activity, were identified as key actions to be improved. Players unanimously indicated the Monte Pisano as a service provider to the Pisa Plain, especially in terms of water provisioning and run-off regulation. Tourist fluxes was the only ESs they indicated from the plain to the hills. These fluxes indicate further services of the Monte Pisano to the Pisa Plain: the provision of food (olive oil and products from the woods) and recreational space for walking, biking and holiday destinations. In the second stage of the game, the main question was about the future for the services linking agriculture and natural resources of the territory. A revolutionary foresight was presented where participants envisaged giving part of the Pisa Plain back to the water and naturalising the area south of the main river (i.e. the river Arno). This scenario emerged as an extreme workaround for the insufficient drainage capacity of the plain, subject to several reclamations, and also suffering from subsidence near the coast. From the players’ perspective such a scenario would increase the attractiveness of the foothills as a residential area and would therefore increase the management of the related landscape. Traditional knowledge would be used to govern the area and to maintain traditional agricultural systems that would be sponsored by agro-tourism. In this scenario, the upper part of the Monte Pisano would be managed for the conservation of species-rich ecosystems where planted pinewoods would be replaced by native chestnut and oak woods (which are also resistant to fires), all in all contributing to increased carbon storage. Energy production for the local settlements could be secured by exploitation of hot groundwater sources and this would contribute to the reduction of the local carbon footprint. In the newly created alluvial plain, rice production was envisaged as the most sustainable cropping system because instead of fighting against the water, which has a high energy cost and contributes to the mineralisation of the soil, it would make use of the water while conserving soil organic matter.
Meta-analysis of the learning process
Building on the learning arrangements presented in the previous paragraph, we analysed the learning process. First, we addressed the contribution of the action learning platform to the topic of territorial development. Then we focused on the viewpoint of the three major participants to this platform: the students, the local actors and the researchers. At the end of the course both students and researchers discussed the strengths, weaknesses and possible improvements for the Spring School.

Knowledge and experience sharing in landscape agronomy
Classical learning and knowledge transfer arrangements like lectures are well-established methods for PhD courses. Also, within the action learning platform, the lectures confirmed their usefulness to provide all participants with a minimum amount of technical information and lexis needed to grasp the content of some of the issues they encountered during the action research activities. As with the previous editions, the participants of the 2015 course had very diverse educational backgrounds; hence some lectures might have been partly redundant for some but very informative for others. Using the landscape and territory agronomy approach and the ALaDyn framework (Benoît et al., 2012) helped the students to locate the various lectures inside the complete picture (cf. Marraccini et al., 2012). Beforehand, this framework helped the teachers to define the issues that needed to be presented to the students. The goal was to provide them with the necessary knowledge and tools for the action research approach to the case study. After this necessary alignment of knowledge, the course was mainly based on experience sharing between the researchers, students and stakeholders.

In the course, we paid attention to referring to shared terms and definitions. Yet the students faced the lack of this harmonisation in the interactions with the stakeholders. In a real action research situation there would probably be a first phase where all participants would agree on commonly used terminology and definitions and professionals would have the opportunity to explain to other participants which are the technical issues related to their activities. For example, it is difficult for a farmer to understand why beekeepers are upset about the use of herbicides. For the farmer herbicides kill a plant, not the bees. However, there are side effects of herbicides on bee colony health and this technical knowledge needs to be shared by all participants of the action research group otherwise it will cause miscommunication. On the course the stakeholders do not contribute to the alignment and this sometimes causes misunderstandings during the interactions with the students. On some occasions the researchers, who are always present during the interviews and discussions, needed to intervene to provide clarification. This type of gap was also identified in discussions between various stakeholders, for example farmers discussing with policy makers. The same terminology may have completely different meanings for these two groups and they are hardly aware of this. A solution would be to invite the stakeholders to participate in the entire course session and take this as a life-long-learning event also for their own professional development. However, for these professionals it may be difficult to leave their job for an entire week.

Students’ viewpoint
Students appreciated the territory game although they felt it was not easy to prepare and to manage. The first problem in an international learning context is the language barrier. Often the stakeholders do not speak English, therefore the game needs to be played in the local language. Foreign students have difficulty in following all interactions even though teachers translate. Connected to the language problem, there is also a cultural discrepancy. Sometimes to understand the dynamics in a group of stakeholders with opposing viewpoints, you need to
know their background and life style. Of course, in a one-week course this cannot be expected from foreign students. However, they grasp the principle and they can interpret the results. This year’s students also regretted that the course programme skipped the conclusive analysis of the territory game. In fact, from the researcher point of view, that would be the conclusive step in the action research process, before re-iterating interaction with the stakeholders about the findings and the consequence. However, to be able to include that aspect in the Spring School, more days would need to be added and that would result in objections about the length and intensity of the Spring School (which in fact happened in the year we decided to have a 7-day long Spring School). Since it is not the objective of the Spring School to provide a full course on action research, we think that in the end a 5-day course is long enough to give students the possibility to grasp what action research is about and where the difficulties lie. Experience with action research will have to be acquired in the real world, in a real action research project, but we think this course is a good first step for getting acquainted with some benefits and difficulties of this participatory approach to research on territory management.

**Stakeholders’ viewpoint**

Stakeholders are involved in the course as a learning aid for students. Indeed they are normally very motivated to participate. Some of the actors involved in 2015 also participated in past courses. Their enthusiasm is a clear indicator of their interest in the course, but so far we have never interviewed them to formalise their feedback on the learning process. Since they are invited as contributors to the course, they are more relaxed than they would have been in a real life case study on the subject. This may facilitate interactions and discussions amongst them. We have the impression that the analyses presented by the students of the territorial issues were received by the actors as relevant issues and not as criticisms. We have already discussed the possibility of inviting the stakeholders to participate full-time in the course in order to make it a learning experience for them as well; although time and language clearly appear as the main obstacles to making this a success. Alternatively, we could organise these Spring Schools in local languages, with only local students and stakeholders. That would however make it a different type of event.

**Researchers’ viewpoint**

The outcomes of the territory game are unpredictable and are always real eye-openers for researchers. For the example, we developed the ESs theme questioning the services provided by agriculture and by SNH. However, the action learning platform, and specifically the territory game, clearly highlighted that stakeholders perceived a lack of ESs provision eventually determined by the incoherent land management. In the end the researchers were also led to widen their perspective and break the silos. The interesting aspect of the ‘ESs’ theme is that it is wide enough to comprise various stakes at territory level and has the power to identify relationships between stakes that are often treated separately. Focussing on the results, the dissymmetry emerged between the hills and the plain in the provision of ESs, with the Monte Pisano providing more services to the plain. The spatially explicit and integrative methods thus helped to highlight the relevance of the landscape morphology to design innovative landscape management. The goal would be to account for this disparity in the ESs provision and put it in the balance to, for instance, compensate for some dependencies of the hill from the plain (e.g., job opportunities)
Conclusions

‘Ecosystem service’ is a new term for a variety of benefits that are often not recognised by farmers as special features, but seem intrinsic in agriculture and landscape management. It is a new word for something that has always existed, but in this way policy makers at the EU level (in the CAP) have found a way to stress it and assign a value. By selecting the ESs as an example issue for our action learning platform we realised that it is a very wide concept including a lot of diverse aspects, as both ecosystems and society are affected. More generally the course programme that alternated lectures and action research methods proved to be formative for the actors and the researchers as much as it was for the students. For a future course, the analysis of the territory game could be done by students who are interested in this activity as part of a final examination to obtain the full amount of study credits which nowadays are obtained after submitting a final report on the Spring School. However, it needs to be stressed that the territory game can also simply be used as a tool to set the scene and get acquainted with the territorial studies, thus stressing the use of this method for cross-checking research results with the stakeholders and hybridising academic and local knowledge, without performing an in-depth foresight study.

Hybridisation of available hard data from previous research projects with local knowledge helped students to become aware of the complexity of the territorial system and all social and ecological interactions. Altogether, the various approaches and tools that were mobilised during the course highlighted the need to capitalise on the existing knowledge and to operationalise it by crossing different points of view and academic silos. When it is well prepared, the cross fertilisation between an education programme and an action research approach can provide far more results than a single-discipline research project, mainly thanks to the outbreeding between student, researcher and actors' viewpoints.

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References


Participation in extension programme planning for an improvement of smallholders' livelihoods in the MENA region

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Abstract: Farming systems all over the MENA (Middle East and North Africa) region are formed by 'resource-poor' smallholdings. These are often subsistence-oriented family farms with limited land availability, few capital (including animals) and limited access to inputs. Farmers usually are not well-educated or are illiterate. Despite their importance for the region and an urgent need for system development, these farmers are often neglected - particularly by extension. Even if extension programmes exist, they all too often neither cover the knowledge demand of smallholders nor fit to their learning abilities. In other words: extension curricula are inappropriately designed with respect to training content and methodology. Reasons might lie in a centralisation of planning processes and a lack of communication between extension staff, programme planners and their target groups. However, we assume that there is a crucial need to increase smallholder farmers' participation in agricultural extension programme planning. This paper aims at developing some general strategies to improve participation in extension programmes considering the specific circumstances and resources availability in the region. Part of this is an analytical framework of the possible effects of participation in extension on the livelihood of smallholder farmers. The latter might be useful for valuation of specific cases and thus for integration of situational analysis into regular programming. In-so-far the paper serves two purposes: it provides the basis for an empirical analysis; and in the long run for institutionalisation of participatory curricula development in the extension systems.

Keywords: Participation, MENA region, extension, sustainable livelihood

Introduction
All over the MENA (Middle East and North Africa) region, extension is regularly implemented in the form of governmental extension. It is seen as an important development factor, but often both farmers and extension personnel themselves express dissatisfaction with the quality and frequency of their interactions. Services provided by the governmental agricultural extension have no significant influence mainly because they are not directly related to the needs of farmers (Al Shafi‘i, 1996). A reorientation of the extension programmes is necessary to improve the congruence of technical messages and communication strategies (Saito & Spurling, 1992).

This paper aims at developing some general strategies to improve participation in extension programmes considering the specific circumstances and resources-availability in the region. This includes an analytical framework of the possible effects of participation in extension on the livelihood of smallholder farmers. The paper firstly discusses, on a more general level, possible effects of extension on changing livelihood strategies of smallholders, with the extension system in Egypt serving as a case. For this purpose, the Sustainable Livelihoods Framework has been adapted into an analytical framework. The chapter following analyses the role of participation in extension processes, with a focus on programming, i.e. the planning
and re-planning of extension programmes. It then identifies factors which influence participation. We assume that communication plays an important role, and thus have a closer look at communication factors. Finally, we conclude with some general strategies to extension programming. Methodologically the paper is based on a literature review and own experiences of one of the authors (Hassan) in the Egypt extension system.

Extension for sustainable livelihood of smallholder farmers in the MENA Region

Smallholder farmers’ livelihood

Box: Typical farmer in Egypt (a relative of Nagwa Hassan)

He is 54 years old and married. Both he and his wife are illiterate. They live in an extended family and have two sons and a daughter. The sons help their father with field work, and the daughter helps her mother with housework. They own 0.84 ha and rent another 0.93 ha. They have a cow, a buffalo, a donkey and poultry (hens, duck and goose). Their house has only few pieces of furniture. The only source of income is agriculture. He plants wheat, rice, maize, tomatoes, eggplant and sometimes onions. His wife helps him to cultivate and harvest the crops. She also bears the domestic and household work and is responsible for milk production and selling of poultry. He suffers from anaemia and digestive system problems. They do not have any professional communication network or communication tools such as the internet or fax, and thus depend on relatives for a social net. They get their own seeds from the previous season or as a subsidy from the agricultural office; fertilisers they must buy from traders or the agricultural office; pesticides can be bought only from traders, who must be paid at the latest after the harvest season. He does not know a village extension worker and has never participated in any extension activity or training. He feels neglected and marginalised. He suffers from the high price of equipment, high costs for harvesting, and conflicts on irrigation water.

In the MENA region, the majority of farmers are still smallholders. Thus it is quite difficult to characterise "smallholders" because they are by no means a homogeneous group (Chamberlin, 2007). They have in common that they are "... a people who seek to best satisfy their priorities from a combination of activities. These activities compete for limited resources. Moreover, they face a set of local economic, institutional, natural, social and cultural circumstances, which they cannot significantly influence. Scarcity dominates all aspects of their life" (Hoffmann et al., 2009). In other words: they are subsistence rather than market oriented; are short of resources such as land and capital and other assets; they have limited access to inputs and technology; and to formal financial institutions for capital of any sort. Usually they have no insurance against risks and no capital reserve to balance losses and thus are suffering from relatively high degrees of vulnerability (World Bank, 2003; Dixon et al., 2004).

Farming is the principal source of income and the family provides the majority of labour (Berdegué & Fuentealba, 2011; Narayanan & Gulati, 2002). In the MENA region, smallholders often are tenants who own only small and scattered pieces of agricultural land and depend mainly on animal production (cf. Box). Women play a key role. They are involved in field work and domestic and household work, breeding poultry, and they take care of livestock to get milk
and its products. But often they do not have access to key development resources, services and opportunities (Nederlof et al., 2008). Sons regularly look for off-farm work in their village or in a nearby town or even in other countries to improve their life. Daughters help with domestic and household work, breeding poultry etc.

The “means of making a living” in general (Adato & Dick, 2002), and more specifically the different capabilities, assets, and activities of (poor) people to secure the necessities of life, is nowadays often described by the term livelihoods (Ellis 2000; Marisa et al., 2013; Chambers & Conway 1991; Scoones, 1998). Livelihoods are multidimensional and consist of various aspects of living such as the farm income, food security and nutrition as well as access to health services and education for rural children (Swanson & Rajalahti, 2010). The unit of “livelihood” is usually the farmer or the farm household. Poor households’ livelihood is usually highly diversified, including farm and non-farm activities (Adato & Dick, 2002; Yaro, 2006). Livelihoods of smallholder farmers in the MENA region include on-farm activities (such as cash crops, fruit, vegetables, tree crops, horticulture, livestock, poultry and farm wages) as well as off-farm activities (such as non-farm wages, micro-enterprises, salary, transfers, remittances, pensions, credit and savings) (Dixon et al., 2001).

Figure 1. The Sustainable Livelihoods Framework (simplified) and the role of extension
(Source: Chambers & Conway 1991; DFID 1999, modified)

Small farmers’ livelihoods are seen as sustainable if they can cope with and recover from stresses and shocks, and maintain or enhance their capabilities and assets while not undermining the natural resource base (Scoones, 1998). Moreover, they should contribute net benefits to other livelihoods at the local and global levels, in the short and long term and provide sustainable livelihood opportunities for the next generation (Krantz, 2001).
Table 1. Selection of items to measure smallholder farmers’ livelihood *(Source: Chambers & Conway 1991; DFID 1999, modified)*

<table>
<thead>
<tr>
<th>Factor</th>
<th>Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Farm assets</strong></td>
<td><strong>Variable</strong></td>
</tr>
<tr>
<td>Human capital</td>
<td>• Skills, attitudes, education, experience, labour force, health</td>
</tr>
<tr>
<td>Social capital</td>
<td>• Networks, groups, relationships (trust and support), access to institutions</td>
</tr>
<tr>
<td>Nature capital</td>
<td>• Land, drinking and irrigation water, livestock</td>
</tr>
<tr>
<td>Physical capital</td>
<td>• Water, energy, transport facilities, sanitation, equipment for production, communication tools</td>
</tr>
<tr>
<td>Financial capital</td>
<td>• Credit, remittances, pensions, wages, savings</td>
</tr>
<tr>
<td><strong>Livelihood strategies</strong></td>
<td><strong>Variable</strong></td>
</tr>
<tr>
<td>• On-farm</td>
<td>• Crop, vegetables and medical plant production; livestock and poultry</td>
</tr>
<tr>
<td>• Off-farm</td>
<td>• Regular and irregular (migratory) work</td>
</tr>
<tr>
<td><strong>Livelihoods outcomes</strong></td>
<td><strong>Variable</strong></td>
</tr>
<tr>
<td>• Income</td>
<td>• Yield, numbers of livestock and poultry</td>
</tr>
<tr>
<td>• Use of natural resources</td>
<td>• Access to land and water, use of pesticides and chemical fertiliser</td>
</tr>
<tr>
<td>• Wellbeing</td>
<td>• Getting services of education, health, safety, security and entertainment</td>
</tr>
<tr>
<td>• Food security</td>
<td>• Access to enough food for health and an active life</td>
</tr>
</tbody>
</table>

A well-known heuristic model helping to understand - and improve - livelihood “strategies” of rural people is the Sustainable Livelihoods Framework (SLF) (Figure 1) of the Department for International Development of the United Kingdom (DFID). Livelihood strategies are combinations of activities that ensure the livelihood goals. They include production, investment and reproduction activities both on-farm and off-farm. The ultimate goal is an increasing capability of farmers to maintain or improve household assets and to sustain their livelihood “outcomes”, namely reduce poverty and vulnerability, increase income and food security, and finally improve wellbeing of all household members (de Janvry & Sadoulet, 2000). Livelihood strategies depend on the assets of the household which themselves are strongly affected by the vulnerability context (weather extremes, climate change etc.). Table 1 gives an overview of - measurable - indicators which might be useful to describe and evaluate the livelihood factors of smallholder farmers in the MENA region.

**Extension as transformation structure and process**

The SLF distinguishes between two mechanisms which “transform” assets into livelihood strategies and vice versa: structures and processes. Structures are “… the institutions, organisations, policies and legislation that shape livelihoods. ... They operate at all levels, from the household to the international arena, and in all spheres, from the most private to the most public” (DFID, 1999). DFID describes them as the hardware. Processes in contrast are the software: “They determine the way in which structures – and individuals – operate and interact” (ibid.). Processes are multidimensional, overlapping and often bearing conflicts.
Extension is both, part of the transformation structures and the processes (Figure 1). On the one hand it is a set of governmental, non-governmental and private organisations (Anaeto et al., 2012) which form, together with organisations from research and the users, an agricultural knowledge system (Nagel, 1979). Communicative linkages and institutions determine whether the system as a whole or the extension subsystem is working effectively and efficiently (ibid.).

On the other hand there are manifold formal and non-formal processes of bilateral, group and mass communication, of knowledge and information exchange, and of supporting decision making (Leeuwis & Van den Ban, 2004; Tang, 2013). The main goal is to increase farmers’ capabilities to solve problems, i.e. to be able to cope with stress and shocks, to respond to adverse changes in conditions, and to gain access to and to use services and information sources (Chambers & Conway, 1991). In other words: to help farmers to sustain their livelihoods. The focus for MENA’s small farm households, especially the rural poor, is to increase farm income (Swanson & Rajalahti, 2010), which crucially depends on maintaining or increasing crop yields and livestock production (FAO, 2005). The challenge from a macro perspective is to build capacities to improve the current livelihoods of the poor with respect to their circumstances and a sustainable use of resources, thus reducing their vulnerabilities (McNamara, 2003).

Extension systems in the MENA region are regularly ministry-based approaches. Only in a few countries such as Jordan, Lebanon, Syria, United Arab Emirates and Yemen, do the private sector, NGOs, and farmers’ associations exist (FAO, 2005). The Egypt System as shown in Figure 2 is a good example. Agricultural extension there is a government-operated, ministry-based and thus strongly hierarchic system (Rivera et al., 1997). All extension operates under the Central Administration for Agricultural Extension Services (CAAES) which only recently became a subsidiary of the central Agricultural Research Centre (ARC). The main objectives of CAAES are to increase the production of strategic crops, to improve linkages between extension and research, and to further develop the extension approach through monitoring and evaluation (M&E). Both the efficiency and effectiveness of the whole knowledge system are seen as weak. Linkages with research are poorly institutionalised (Shalaby et al., 2011; Zahran, 2003) and thus extension’s contribution to developing research plans is negligible which results in a relatively low user orientation in research (FAO, 2005; Shalaby & Mikhaiel, 2014).
Females are largely underrepresented in the public extension institutions. The percentage of extension workers with university degrees is relatively low and all extension staff on the lower levels are poorly educated. The village extension workers (VEWs) in particular have few technical skills and knowledge. A majority of them have a secondary-level education. Furthermore, their work is made difficult due to a lack of transportation facilities which hinder them from establishing regular contacts with farmers and interaction with higher levels of the extension hierarchies (Abdelhakam, 2005; Shalaby et al., 2011).

**Participation in extension programming**
In MENA, as in many other developing countries, the main means of extension are personal advice and short to medium term training. We have to distinguish between the extension programmes and practical vocational educational measures under these programmes. Programmes set the framework for the concrete activities of extension. Advisory and other educational measures such as training are organised under these programmes. Therefore, curriculum setting of training is always strongly influenced by the programmes.

Ideally the programmes should serve as an organisational base and, even more importantly, a strategic plan for extension work. As an organisational basis they help the agents to achieve
the goals of extension (Harder, 2009) since the programme provides a robust basis for extension activities which are planned and time scheduled. They also create a basis for anticipating what resources will be needed (Oakley & Garforth, 1985). Human resources development is one of the topics of utmost importance, including training, performance assessment and supervision of extension agents (ibid.). As a strategic planning instrument they should systematically identify and assess the needs of the extension clientele and subsequently determine objectives and guidelines for extension work. It is quite obvious that they should be oriented towards livelihood outcomes, and that they should consider all dimensions including ecological goals (McCaslin & Tibezinda, 1997). The term “programming” here is used for all planning activities for the programmes concerning the strategic planning as well as the organisational settings. Strategic plans assess the needs through situational analysis and set priorities for the extension and training activities including the framework curricula development of vocational education measures. On an organisational level the tasks are developing management plans, marketing and recruiting (Gibson, 2001; McCaslin & Tibezinda, 1997).

But even if extension programmes exist, they all too often neither cover the knowledge demand of smallholders nor fit to their learning abilities. In other words, training curricula are inappropriately designed with respect to content and methodology. There seems to be neither established processes nor approved instruments which allow assessing the knowledge demand and defining the training need in a way that is suitable for the existing extension systems. This often leads to disregard of the real needs of the target groups, particularly to ignorance of the voice of the poorest farmers (Nagel et al., 1992; Akinnagbe & Ajayi, 2010) and in consequence to an inadequate flow of knowledge and information to and from farmers. Training curricula are often poorly defined, without consideration of the specific situation and without paying attention to the quality of the learning and decision making process (Hoffmann et al. 2009).

Much has been written on participation, and meanwhile there is somehow a consensus that participation is a condition sine qua non to improve both the effectiveness and efficiency of development approaches; and extension programming is definitely such an approach. Participation in agricultural extension is also a philosophy and an instrument of development (Nagel et al., 1992). As a paradigm, it means a general orientation towards the end users which is expressed by the idea of “farmers first” (Chambers & Conway, 1991). As such, it is “… an objective in itself to see the success and empowerment of individuals and communities in terms of acquiring skills, knowledge and experience, leading to greater self-reliance” (Anandajayasekeram et al., 2008). As a process, participation refers to the whole extension cycle of situation analysis, planning and implementation, and, most importantly, the decision making of a programme namely the setting of its objectives and its evaluation. The situation analysis is important as here the need is (or should be) assessed in a systematic way. Information on a farmer’s situation is to be collected aiming at an understanding of their problems from their perspectives, of their priorities, their livelihood strategies and their resource constraints (Apantaku, 2006). Such information helps to identify the real need for extension and training, and how to build or adjust extension programmes. Participation in the evaluation process helps to identify strengths and weaknesses and re-adjust the programmes.

In MENA, however, extension systems are organised in a strongly top-down way. Centralisation means always that programming is operationalised at higher levels of the hierarchy and carried out by well-educated staff. Participation of the target groups is not
foreseen. As there is little experience with participation in programming and as involvement of people in rural areas demands resources, the question arises of how target groups can be realistically involved? There exist several levels of participation: from passive participation through information seeking and consultations to more active participation by collaboration or co-action. The highest level is achieved when processes are self-driven by actors (Pretty, 1995). However, we think that these forms are rather a continuum than clearly defined levels. What is obvious is that the “higher” the level of participation is and the more active the target groups are the more resources are needed for direct communication, process moderation etc. As resources are limited, it may be that “full participation is not always feasible or desirable” (Kanji & Greenwood, 2001) and that for the situation in MENA even passive forms of participation might be better than non-involvement. The question is on priorities: who can and should participate, how, and in which phase(s) of the programme?

Participation is strongly linked with all kinds of communication. It is widely known that the utmost constraint to participation is a general lack of communication and interaction between and among extension workers and farmers. With respect to Berlo’s (1960) fundamental model of interpersonal communication, the most important factors are with the sender and receiver, the message itself and the communication channels. For the relationship between farmers and extension staff, particularly decision-makers in MENA, we think communication factors as shown in Table 2 play an important role.

Regarding the actors, in principle all participants (rural people, extension workers, managers and researchers) should be involved, but particularly those who know best about the situation on site: the smallholders and the village extension workers (VEWs), who are often farmers themselves. Farmers are the end users of extension programmes and finally decide whether programmes are sufficient.

Table 2. Overview on factors influencing communication between farmers and extensionists, and selected indicators for the specific situation in MENA region.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education level</td>
<td>• Years in educational system</td>
</tr>
<tr>
<td></td>
<td>• Certificates</td>
</tr>
<tr>
<td>Attitudes</td>
<td>• Trust and respect towards smallholders / towards extensionist</td>
</tr>
<tr>
<td>Social network</td>
<td>• Membership in organisations</td>
</tr>
<tr>
<td></td>
<td>• Personal relationships with key persons of community / decision-makers</td>
</tr>
<tr>
<td>Health</td>
<td>• Status, diseases</td>
</tr>
<tr>
<td>Message</td>
<td>• Does the content meet the needs?</td>
</tr>
<tr>
<td></td>
<td>• Sources of agricultural information and advice</td>
</tr>
<tr>
<td></td>
<td>• Access to agricultural information</td>
</tr>
<tr>
<td>Channel</td>
<td>• Access to agricultural information</td>
</tr>
<tr>
<td></td>
<td>• Communication tools (Phone, FAX, radio, TV, internet etc.)</td>
</tr>
<tr>
<td></td>
<td>• Understandability of message</td>
</tr>
<tr>
<td>Intensity</td>
<td>• Persons known or unknown</td>
</tr>
<tr>
<td></td>
<td>• Quality and quantity of contacts</td>
</tr>
<tr>
<td>Persistence / change of clients</td>
<td></td>
</tr>
<tr>
<td>---------------------------------</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Number and type of work of women</td>
<td></td>
</tr>
<tr>
<td>Women’s’ access to extension services</td>
<td></td>
</tr>
<tr>
<td>Experience</td>
<td></td>
</tr>
<tr>
<td>Work years in extension / as farmer</td>
<td></td>
</tr>
<tr>
<td>Attendance in extension or training activities</td>
<td></td>
</tr>
<tr>
<td>Time constraints</td>
<td></td>
</tr>
<tr>
<td>Farming activities</td>
<td></td>
</tr>
<tr>
<td>Non-farming activities</td>
<td></td>
</tr>
<tr>
<td>Extension activities</td>
<td></td>
</tr>
</tbody>
</table>

(Source: Berlo, 1960; DFID, 1999; Anandajayasekeram et al., 2008; Teimouri et al., 2014; Chamberlin, 2007; Berdegué & Fuentealba, 2011; Narayanan & Gulati, 2002)

In reality, only a small minority of smallholder farmers have access to training (Arous et al., 2013; Akinnagbe & Ajayi, 2010). This is particularly the case for rural women and youths. Smallholder participation in strategy development is virtually non-existent. If farmers are involved, these are usually prosperous and wealthier farmers or village leaders who are not necessarily familiar with the situation of smallholders. Due to the established top-down planning processes which do not foresee participation in decision-making, farmers are often not even asked about their perspectives. Furthermore, administrative procedures often do not meet the field requirements and realities (Gikunda & Mutegi, 2015). At the farmers’ and the VEW’s level factors influencing participation are amongst others (Teimouri et al., 2014; Chamberlin, 2007; Berdegué & Fuentealba, 2011; Narayanan & Gulati, 2002):

- Education level: most farmers and VEWs are less educated or even illiterate. They cannot even express their interests or perspectives and feel uncomfortable in relation to (higher) extension staff;
- Health conditions: anaemia and malnutrition are widespread amongst poor people;
- Assets: poor farmers do not even have access to extension services and new information. If they cannot pay extension, they do not participate in programmes, thus they do not demand anything from extensionists;
- Time constraints: many poor people spend a long time searching for off-farm work. VEWs have many tasks other than agricultural extension activities (often they are farmers too);
- Qualification for participation: neither farmers nor VEWs are trained in participation processes as the focus is on technology transfer.

Some general strategies to improve participation in extension programming

It is a bit like a treadmill: because smallholders cannot afford services such as extension they depend largely on their neighbours who also belong to the poor, they do not have access to innovative knowledge and information and techniques, and in consequence remain poor.

Extension programmes, the frameworks for practical advisory work, play in our opinion a crucial role as a framework and orientation for extension and training activities on site. The main reasons for often inefficient programmes in MENA lie in a centralisation of planning processes and a lack of communication between extension staff, programme planners, and their target groups (Zahran, 2003, McDonough et al., 2015). We assume that, in order to meet the needs of the clients, there is a crucial necessity to increase participation of those who
know best about the specific situation in designing and re-designing the programmes: the farmers, and the village extension workers (VEWs). McDonough et al. (2015) for example found positive influences on the performance, production and perception of farmers and VEWs after they were involved in a project in West Noubaria, Egypt.

Due to poor resources, time constraints and social hierarchies in combination with low education levels of farmers and VEWs – which are the main constraints as reported by Shalaby et al. (2011) - they will not actively demand changes to the programmes. Thus it is up to the extension decision makers to involve smallholders. They have to come to the rural areas to analyse the situation and try to involve smallholders as actively as possible - be it through searching for information, giving incentives etc. It might be trivial, but just asking farmers about their needs could be a beginning (Chambers & Conway, 1991; Oakley, 1991; Chambers, 1994).

It should be mentioned that “participation in programming” also requires education of those who participate. Farmers, and maybe also VEWs, need to be educated on how to analyse their production systems with respect to problems, potentials and opportunities, as well as on how to identify their needs. VEWs should be trained on communication skills in general, and in extension planning, implementation and evaluation of extension (and training) activities in particular: “For VEWs … it would require substantial training in how to strengthen farmers’ capacity to assess their business and opportunities and make well planned decisions in farm management, rather than just provide technical advice” (McDonough et al., 2015). This would also strengthen their position and build capacities to influence programming.

Programmes should assess the needs of the clients i.e. the smallholder farmers in a systematic way (van den Ban & Hawkins, 1996). Ongoing planning processes based on an institutionalised M&E System in which the users (smallholder farmers and VEWs) are involved, must be established within the respective extension system. What then is missing is an assessment tool or a methodology for the (participatory) situation analysis which provides information on both the knowledge needs and training requirements of specific target groups, and “need” on a meta level – who to involve in programming and how. We assume that it is thus important to analyse both the livelihood situation of the smallholders, as well as the communication situation between extension staff and their clients, in order to programme both the extension and training content and the means of communication – including decisions on the levels and tools of participation in programming.

The framework developed in this paper, including factors and indicators with special emphasis on communication, is seen as a first step. It could be useful for valuation of specific cases and thus for integration of such approaches to situational analysis into regular programming. Insofar the paper serves two purposes: it provides the basis for an empirical analysis; and in the long run for institutionalisation of participatory curricula development in the extension systems.
References


Workshop 1.5: Pathways towards sustainability in the agricultural knowledge and innovation system: the role of farmers’ experiments and innovations
Convenors: Friedrich Leitgeb, Christian Vogl, Christoph Schunko, Susanne Kummer, Sara Burbi, Katie Hartless Rose and Julia Wright.

Currently, innovation is seen as the key concept for supporting the urgently needed transition towards sustainability in agro-food systems. Recently, clear evidence has been presented that innovation is a dynamic, social, and multi-stakeholder process that implies the participation of a diversity of stakeholders. Participatory action research, citizen science or transdisciplinary research are pioneering approaches for ensuring that not only local knowledge, but also the creativity and enthusiasm of different stakeholders are involved and taken seriously in the related research and innovation pathways. In the agricultural sciences and agroecological sectors, the debate on the role of stakeholders’ participation has been framed in various models in the Agricultural Knowledge and Information System (AKIS) or the Agricultural Innovation System (AIS). Nevertheless, the creative process that leads to farmers’ innovations is rarely studied nor described precisely in agricultural literature. In the context of innovation research, experimenting is considered a dynamic process that runs for a certain period of time to test an innovation. Farmers’ experimentation is the process by which farmers conduct trials or tests that can result in innovative management systems and/or new knowledge suitable for their specific agro-ecological, socio-cultural and economic conditions. Farmers’ experiments refer to trying something new at farm level and learning from the results. Innovations and experiments are different but complementary processes. Experiments contribute to the creation of new knowledge, practices or processes – a precondition for the development or adoption of an innovation. There are two reasons why it is particularly interesting to explore farmers’ experiments in the context of organic farming and the agroecology movement. First, sustainable land use practices are knowledge-intensive. While conventional farmers can use external inputs to handle adverse dynamics in their agro-ecosystem, organic farmers and other sustainably working farmers need to develop specified agro-ecological knowledge to be able to manage their farms successfully. Second, organic farming in Europe was developed by farmers and farmers’ grassroots organisations and by practical experiments and trials of farmers and practical researchers. Academic science and research only played a minor role. The lack of advice and formal research in the pioneer phase of organic agriculture leads to the assumption that organic farmers have nurtured a culture of experimentation. However, it was not only the pioneers of organic farming who experimented. Many organic and agroecological farmers worldwide are presumably actively experimenting to answer questions, to address farm-specific problems and/or to improve their farming system. Based on the multi-stakeholder perspective of innovation development, we encouraged contributions that integrate farmers’ knowledge and farmers’ research approaches into scientific research and development. We sought contributions from different angles such as participatory action research, citizen science or farmers’ experiments and innovations either interrelated to scientific research or done independently by farmers. The workshop acted as a space for multi-stakeholder exchange, where farmers, advisors and researchers could meet alongside each other and share experiences and knowledge about agroecological practices. We also invited papers beyond the farm perspective, looking at experiments of other actors along the whole supply chain of agricultural products or products developed in a certain region. The workshop addressed the development and dissemination of innovation within the farming community at local, regional, national and global level through knowledge networks, like
training courses, social media or other dissemination platforms. The overall aim of the workshop was to identify pathways on how to facilitate farmers’ experiments and innovations, as well as the experiments of other related stakeholders, and their significance for increasing the farming system’s and regional resilience.
Experiments in animal farming practice: the case of decreasing the use of antimicrobials in livestock (France)

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Abstract: Many farmers are engaged in activities that can be considered as experiments, but until recently few of their practices were studied. This paper offers a first characterisation of experiments by dairy, pig and poultry farmers working in organic, labelled or conventional systems. Data (40 interviews) were collected during an interdisciplinary research project on antibiotic use in livestock farming in France. First, we discuss the literature. In line with D.A. Schön's "reflective practitioner model", we agree that farmers mainly carry out informal experiments. Second, we provide an overview of the experimental process (type of farmer's experiment (FE), period, topics, targets and length) and the outcomes (efficiency, transfer, possible impact on antimicrobials use, renewal), drawing on farmers' subjective valuation and qualitative interview data. We find that farmers carry out multiple tests, mainly with alternative medicines. There is a clear tendency of transferring positive tests for a given pathology to one another. Third, we present seven portraits of farmers to shed light on complementary dimensions of experiments: the appeal of novelty, the role of veterinarians and technicians, and the role of farmers' groups and training. Finally, we argue that much can be learned from ethnographic investigation in order to grasp what farmers are experiencing when they endeavour to solve animal health problems.

Keywords: Farmers' experiments, trajectory of change, animal health, antimicrobial use, livestock in France

Introduction
For a long time on-farm experiments were ignored or considered as unreliable (Sumberg et al., 1997; Saad, 2002), but for over two decades now the scientific literature has been highlighting the creativity of farmers in innovation processes. Farmers are currently of interest to academic researchers, who study the concrete modalities of these on-farm experiments
and stress how more participative forms of innovation are preferred to the classical top-down innovation regime (McIntyre, 2007). Endorsing the challenge of developing “resource-poor” agriculture - identified by the Bruntland Commission in 1987 (cited in Chambers et al., 1989) as a “complex, diverse and risk-prone” type of agriculture - offered a key contribution by putting small farm families’ agendas and needs at the heart of agricultural research and extension. While the popular Farmer First Movement has not challenged scientific practices as much as expected, the idea of farmer-centred innovation has advanced considerably in recent decades. In a wide range of agricultural contexts and countries the issue no longer revolves around the reliability and reproducibility of farmers’ empirical experiments, but rather around the understanding of their logic and process in a ‘co-learning’ perspective between scientists and practitioners.

The existing literature devoted to small farmers’ creativity draws particular attention to farmers engaged in agro-ecological transitions. To manage their specific agro-ecosystem these farmers carry out numerous experiments, repeated over long-term scales, that constitute factors of resilience (Vogl et al., 2015; Kummer et al., 2012; Chantre & Cardonna, 2014). Experiments related to animal husbandry have lower visibility than those related to cropping and to soil, seed, pest and fertiliser management, although they may be very frequent. For instance, animal experiments appear in second position in the analysis of frequency of topics for Austrian organic farmers’ experiments, as presented by Vogl et al. (2014) (according to thematic clusters on 134 experiments discussed and 123 interview corpuses). However, little is known of farmers’ experiments in animal health management, which might be as widespread as they are in human medicine (Vornax et al., 2010). For example, when farmers adopt alternative medicine for themselves, they often do likewise for their animals.

This paper aims to provide the first characterisation of experiments by dairy, pig and poultry farmers working in organic, labelled or conventional systems. Data (40 interviews) were collected during an interdisciplinary research project on antibiotic use in livestock farming in France (INRA/TRAJ-GISA and CASDAR programmes). First, we discuss the literature. In line with D.A. Schön’s “reflective practitioner model”, we agree that farmers mainly carry out informal experiments. Second, we provide an overview of the process of experimentation (type of FE, period, topics, targets and length) and the outcomes of such a process (efficiency, transfer, possible impact on antimicrobials use and renewal), drawing on farmers’ subjective valuation and qualitative interview data. Third, we present seven portraits of farmers to shed light on complementary dimensions of experiments.

**Farmers as reflexive practitioners embedded in socio-technical organisations**

Many definitions of on-farm experiments have been given and we may consider them from two different perspectives. Inspired by a “scientific-centred model”, some authors have defined criteria against which an activity may or may not be labelled an experiment. As Vogl et al. (2015) pointed out, the pioneering work of Sumberg and Okali (1997) insisted on two definitional attributes: “the creation and initial observation of conditions and the observation or monitoring of subsequent results” (2015: p. 141). In this perspective, authors make a distinction between proactive and reactive research. They expect not only discrete actions, but a whole process in which “experiments run first on a small scale and expand if the outcome of the experiments is satisfactory”: a process that requires “regular monitoring” and an “explicit mental or written plan before starting” (Vogl. et al., 2015: p. 140). Adopting a broad view of innovation (“a farmer who is for the first time using a new land preparation method, crop rotation, crop variety etc. is an innovator”). Saad (2002: p. 3) considers likewise “that
experimentation is the process by which the innovator generates, tests and evaluates an innovation”.

Departing from this scientific approach, a “practice-centred perspective” claims that all practitioners do experiment to a greater or lesser extent, albeit not necessarily consciously. For example, Bentley (2006: p. 458) suggests that people experiment “naturally”, that is, “compulsively, effortlessly, without achieving dramatic results, at least not every time”. He admits that some experiments are original, while “others simply copy innovations that farmers have seen somewhere else” (ibid: p. 451), and stresses the idea that “a few folk experiments will be of interest to scientists” (ibid: p. 452). Bentley nevertheless considers that experiments are crucial for smallholders - particularly those of developing countries - who find ad hoc solutions on a daily basis in order to save labour or capital.

This second perspective echoes Schön’s reflexive practitioner model. In the 1980s this philosopher and scholar gave further thought to the kind of knowing inherent in professional practice. He brought to light how practitioners solve problems in situations, drawing attention to every detail and abandoning theory to try something new, reframing the situation “in a spiral process of evaluating-acting-re-evaluating” via a “self-reflexive conversation” (Schön, 1963: p. 169). This shift from technical rationality in order to cope with the messiness and uncertainty of practice is key to understanding on-farm experiments. As Schön suggested, the practitioner is not only interested in solving problems; he or she is also interested in the unpredicted effect of his or her experiments. He or she also makes partial interpretations, being able to test several hypotheses simultaneously. We may conclude that practical situations are not very suitable for controlled experiments. Bentley comes to the same conclusion, referring to Latour and Woolgar’s study of Laboratory Life (1986): while scientists essentially work with “inscriptions”, folk knowledges are by contrast poorly “inscribed”. Bentley notes with humour that “an invention that took a few moments to create and a few field visits to document ultimately took a whole PhD thesis to validate” (2006: p. 459).

In line with D. A. Schön’s “reflective practitioner model” (1983), our multidisciplinary research conjectures that livestock farmers are coping with sanitary issues by predominantly setting up informal experiments. Instead of establishing a priori, and hence arbitrarily, a definition of experiments in health management, we seek to draw attention to the ways in which the use of antimicrobials is moving from the ‘outside’, in the wake of policy or market regulations and in response to social demands, as well as from the ‘inside’, according to farmers’ needs and aspirations. From this point of view, experiments constitute part of the practical tool kit that farmers apply to their animal health management. We assume that farmers are engaged in an ongoing process of testing new practices with the objectives of saving labour and reducing medical expenditures. But we also consider that other factors shape their experiments, such as animal welfare, workplace wellness, sanitary quality of products, and civic involvement to fight against antibiotic resistance: all dimensions that have recently been a focus of criticism in France. Lastly, we consider it important to integrate collective actors and organisations into the experimental process. These represent two analytical standpoints that both the science-centred perspective and the practice-centred one tend to underestimate, in favour of an individual cognitive approach. In fact, the definition of “trajectories of change” is grounded in two postulates: first, change in farming practices is based not only on technical and economic factors but also on social and organisational ones; and second, change is the responsibility not of any single actor - in this case the farmer - but of the network of relations that the farmer
weaves with technical and health advisors, feed or medicine distributors, and neighbouring farmers (Fortané et al., 2015).

**A qualitative study: from an overview of farmers’ experiments to some portraits**

To this end, we carried out semi-structured interviews with farmers and key actors of their social network. Farmers’ experiments were not a specific topic on our interview grid but they do appear as a striking result. Livestock farmers clearly give much more importance to experimentation than we expected. The sample was composed of 40 farmers (27 dairy, 9 pig, 4 poultry).

In this research we distinguish 5 types of Farmers’ Experiment (FE) described by the farmers themselves, that we rank in order of importance of the farmers’ initiative and autonomy in experimenting: i) experiments stemming from external recommendations (veterinarians, technical advisers, feed or medicine distributors, professional press, etc.); ii) experiments developed for solving urgent or major health issues; iii) long-term experiments that farmers conduct to increase their autonomy or the farm’s performance or to reduce input costs; iv) collective experiments developed in an autonomous and informal environment; and v) collective experiments driven by agricultural extension services.

Regarding the topics of experiments, we take the farm as the unit of analysis. Farmers often try a wide range of substitutes to antimicrobials (vaccination, technical device, alternative medicines, etc.), sometimes combining several of them for the same pathology. In this case, we add the different combinations we identify on each farm, what we call “mixed cases”. For example: V (Vaccination) + AM (Alternative Medicine); A (Alimentation) + TD (Technical Device) + V (Vaccination) + AM (Alternative Medicine), and so on. Finally, we have 65 topics of experiments for 40 farms.

We also characterise FE modalities, the starting date and the period of time for which they are conducted (see codification in the tables below). We take into account their concrete target (the herd, baby animals, severely infected animals, a sample).

The farmers’ points of view on their experimental outcomes and the decisions they subsequently take are mostly a matter of intuitive valuation. Codification is thus based on subjective farmers’ assessments. Researchers put to one side their own judgments on the reliability of the information, especially with regard to the efficiency of the FEs or their impact on the decrease of antimicrobial (AB) use. FE Efficiency and FE Impact on AB codifications are given in the table below. We also characterise FE Transfer (Same Pathology, Other Pathology, No Transfer), and FE Renewal (Yes, Probably, No more).

Along with this broad description, the seven portraits we propose aim to highlight farmers’ logics of action. The cases have been selected to include every form of production, and a diversity of contexts and techniques or devices experimented with: vaccinations, food supplements, essential oils, homeopathy, etc. In several cases they lead to important and sustainable change. Some farmers implemented and tested solutions with the help of their veterinarians and advisors or within professional organisations.

**Experiments to cope with a growing injunction to change: some results**

Livestock production is one of the main targets of public policies to limit antimicrobial medicines in France, in particular medicines that are essential for human health (ANSES 2014). This reduction would meet consumers’ demands and would be beneficial to the image
of farmers that is regularly tainted by critical media coverage. Antimicrobials are moreover relatively expensive and farmers could stand to gain financially by cutting treatment costs. Many are therefore experimenting with new approaches to the animal health management of their flocks or herds, especially for the prevention and treatment of infectious diseases.

**FE Modalities**

Table 1 shows that the experiments frequently stem from external recommendations by veterinarian practitioners or other key actors of ‘animal health’ farmer organisations (14) that conduct pilot studies in the pig and poultry sectors (5). In a similar way, FEs are self-conducted by farmers in a long-term perspective (9) or to solve emergency cases (7). A few particular FEs conducted in ‘informal’ (non-institutional) farmer groups were identified during the inquiries. They mostly concern organic farmers experimenting with treatments based on unicist homeopathy. Table 2 is congruent with Table 1: FEs take place mostly after the visit of a sanitary adviser or retailer (15+8 mixed cases=23). FEs related to disease incidence are in second position (6+6 mixed cases=12 farms). It is interesting to note that almost one third of the farmers also use their free time to experiment (4+8 mixed cases=12). We may conclude that FEs constitute more than a problem-solving approach. Basically, they are part of the farmer’s animal health management strategy.

**Table 1. Types of FE**

<table>
<thead>
<tr>
<th>TYPE OF FE</th>
<th>Farm Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1= External recommendations</td>
<td>14</td>
</tr>
<tr>
<td>2= Urgent health problems</td>
<td>9</td>
</tr>
<tr>
<td>3= Long-term FE</td>
<td>7</td>
</tr>
<tr>
<td>4= Institutional FE groups</td>
<td>6</td>
</tr>
<tr>
<td>5= Informal FE groups</td>
<td>2</td>
</tr>
</tbody>
</table>

**Table 2. Period of FE**

<table>
<thead>
<tr>
<th>PERIOD</th>
<th>Farm Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>6</td>
</tr>
<tr>
<td>D-E</td>
<td>1</td>
</tr>
<tr>
<td>D-F</td>
<td>2</td>
</tr>
<tr>
<td>D-F-V</td>
<td>1</td>
</tr>
<tr>
<td>D-V</td>
<td>2</td>
</tr>
<tr>
<td>E</td>
<td>3</td>
</tr>
<tr>
<td>F</td>
<td>4</td>
</tr>
<tr>
<td>F-V</td>
<td>5</td>
</tr>
<tr>
<td>V</td>
<td>15</td>
</tr>
</tbody>
</table>

Table 3 illustrates the variety of FE topics and the importance of multiple tests. In total, 65 experiments were carried out within the sample: 18 farmers carried out multiple tests with 7 different combinations of tests. This table also shows that alternative medicines are frequently explored in the FE (10 + 12 mixed cases = 22 farmers). About one third of the FE concerns alternative medicines (22/65 FE). If we consider the 18 “farmers’ multiple tests”, we can see that 17 of them experiment with alternative medicines. The FEs using technical tools (such as metering pump in pig production or internal teat sealant in dairy production) are also frequent (7 + 12 mixed cases = 19 farms). Finally, FEs using vaccines concern just under one third of the sample (3+9 mixed cases = 12 farms). These are initial findings that need to be compared to farmers’ discourse provided in the portraits below. Even if we adopted a non-normative
approach to the definition of an experiment, certain cases have been excluded from our inquiry: cases where experimenting is ‘doing nothing’ while waiting for the animal to recover on its own. This modality is also frequent in human medicine. The idea of “letting Nature” solve the problem and counting on the animal’s immune system is often found in interviews with organic farmers, but this type of farmer is under-represented in our sample. Table 4 indicates that the FEs are mainly run on a long-term basis (19 + 8 mixed cases = 27 farmers). The modality “Regularly” appears for 7 farmers (3 + 4 mixed cases). These two results confirm the main role of FEs in the management of health on farms in our sample.

Table 3. FE Topics

<table>
<thead>
<tr>
<th>TOPICS</th>
<th>Farm Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>AM</td>
<td>10</td>
</tr>
<tr>
<td>TD</td>
<td>7</td>
</tr>
<tr>
<td>TD-V</td>
<td>5</td>
</tr>
<tr>
<td>AM-O</td>
<td>3</td>
</tr>
<tr>
<td>V</td>
<td>3</td>
</tr>
<tr>
<td>A-AM</td>
<td>2</td>
</tr>
<tr>
<td>A-AM-TD</td>
<td>2</td>
</tr>
<tr>
<td>AM-TD</td>
<td>2</td>
</tr>
<tr>
<td>AM-TD-V</td>
<td>2</td>
</tr>
<tr>
<td>A</td>
<td>1</td>
</tr>
<tr>
<td>AM-V</td>
<td>1</td>
</tr>
<tr>
<td>A-TD-V</td>
<td>1</td>
</tr>
<tr>
<td>O</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
</tr>
</tbody>
</table>

Concerning the other descriptors, on 19 farms the FEs concern the herd as a whole or the flocks (poultry) and on 14 farms, animal samples (7 + 7 mixed cases = 14 farms).

**FE outcomes**

Table 5 shows that the FE outcomes range from “good” (14 + 7 mixed cases = 21 farms) to “variable” (13 + 5 = 18 farms). On only 5 farms are FE outcomes said to be “weak”, and “no effect” is mentioned in 5 cases. FEs result in a “small decrease” of antimicrobial use for half of the farmers (16 + 9 mixed cases = 25) and in “no decrease” for 7 of them. In a few cases it seems that FEs result in a slight increase in the use of antimicrobials, when a failure has been followed by an over-use of antimicrobials for safety’s sake. Conversely, 15 farmers (11 + 4 mixed cases) estimate that they experienced a steep decrease of the use of antimicrobials thanks to their experiments.

Table 4. FE Length

<table>
<thead>
<tr>
<th>LENGTH</th>
<th>Farm Number</th>
</tr>
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<tbody>
<tr>
<td>L</td>
<td>19</td>
</tr>
<tr>
<td>O</td>
<td>5</td>
</tr>
<tr>
<td>S</td>
<td>5</td>
</tr>
<tr>
<td>L-O</td>
<td>3</td>
</tr>
<tr>
<td>R</td>
<td>3</td>
</tr>
<tr>
<td>L-R</td>
<td>2</td>
</tr>
<tr>
<td>L-O-R</td>
<td>1</td>
</tr>
<tr>
<td>L-R-S</td>
<td>1</td>
</tr>
<tr>
<td>L-S</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
</tr>
</tbody>
</table>
Concerning FE transfers, there is a clear tendency to transfer positive tests run for a given disease to another disease (21 + 5 mixed cases = 26/40 farms). For example, when a farmer gets a “good” result for the use of an essential oil complex to prevent mastitis, he uses the same product for lameness disorders. However, in one third of the cases there is no transfer (8 + 5 mixed cases = 13/40 farms). The renewal of FE is planned in more than half of the farms (22 + 4 mixed cases = 26/40 farms) and is considered as possible on 9/40 farms (5+ 4 mixed cases).

These results concern a restricted panel, with a heterogeneous representation of the different types of animal production. It is therefore hardly possible to test some of the hypotheses, such as the existence of sector specificities regarding farmers’ experimental modalities or outcomes, or even their effects on antimicrobial use.

**Trajectories of change and experiments**

The aim of these portraits is not only to embody our data. They are intended to shed light on complementary dimensions that could not be taken into account in our descriptors (which remain necessarily simplistic). Three dimensions appear: i) the articulation between farmers’ motivations or interests and the advice that they may find through training, farmers’ collectives or their technicians and veterinarians; ii) the “taste” for experimentation, the appeal of novelty, the “handiwork” (in an anthropological sense); iii) the global thinking about farming practices in which experiments take place and sometimes lead to a reconsideration of their usual techniques.

*Portrait 1: A conventional dairy farm (in the Maine-et-Loire French département), around 75 cows, 2 partners. Individual experiment.*

Tests implemented on this farm focused mainly on essential oils used to treat mastitis without using antimicrobials. These tests started in 2014 after the farmer attended a training course on essential oils. He took the initiative to undertake this training with the Ile-et-Vilaine CIVAM because he could find no help on these subjects in his own local environment. Among this
farmer’s motivations for using essential oils, he highlighted not only the natural aspect of the treatment but also the fact that it was less invasive than an injection of antimicrobials.

Moreover, the farmer pointed out that having less mastitis on the farm enabled him to perform tests on one or two cows without taking too much risk. As soon as he reached 4 or 5 cases of mastitis at the same time, he treated them directly with antimicrobials. The farmer explained that when using essential oils, the disappearance of symptoms and the recovery did sometimes take more time than when antimicrobials were used, but according to his tests the efficacy of oils and antimicrobials was similar. In the cases of relapse or *E. coli* mastitis, he nevertheless used antimicrobials systematically.

Naturally curious, this farmer enjoys using different oils, which he chooses according to each cow’s characteristics and applies on different areas. In addition to being curious, this farmer has quite a systemic view of herd health management, and is vigilant as regards milking hygiene, cows’ positions or the genetic selection of cows with an index of positive “cells”. There are many techniques in preventive treatments for mastitis.

*Portrait 2: A conventional dairy farm, 40 cows, father and son family business with the grandfather’s help.*

According to this farmer, the key to keeping cattle in good health is to adapt the production level. His professional objectives are now geared towards a good technical-economic balance rather than pure technical performance. This choice has led to changes in his farming practice. At the moment he is generally satisfied with the sanitary situation on his farm. He has a preventive approach and pays special attention to feed, the cowshed and hygienic milking practices.

One of the main changes he made was the implementation of selective treatment during the drying-off period. It started quite by chance, just because of a stock shortage in antimicrobials on his farm. As the results were conclusive, he applied the selective treatment (no antibiotics, only a teat obturator) on more cows, even on infected ones, which is not recommended. He then developed a more successful protocol taking into account somatic cell concentrations and production levels.

Today, he has scaled-up the selective treatment in the drying-off period. He uses no treatment in the case of cows that have a very low level of production especially when they are about to be fattened and slaughtered. Aware of the risk, he accepts it because he is able to assess risk factors and to adapt his practices if necessary.

He developed this new practice alone, autonomously, without discussing it with his veterinarian. This farmer feels concerned about antimicrobial reduction, which he sees as an imperative new challenge for all farmers. He is getting ready… and would like to acquire methods or new techniques to ensure successful change and to enhance his preventive approach. He does nevertheless still consider that antimicrobials have their role to play in a curative approach.

Experiments that have been set up on this farm mainly concern homeopathy, but also some solutions that existed before the ‘antibiotic era’, such as traditional remedies (for example oil or cider vinegar). The farmer learned some principles from his homeopathy training in 2002, such as the importance of watching animals and considering animal health “as a whole”. Regarding treatments, he likes to develop his own recipes. He therefore buys ingredients to make his own homeopathic mixes, following some indications in the ‘Boiron revue’. When he tests a treatment, he watches the animal much more closely than usual and usually waits some time before calling the veterinarian (if the problem remains unsolved). Usually his wife does not agree with him on that. The philosophy of these experiments is to try them on just a few animals and spread them slowly to others (this includes “doing nothing”, which can also yield results).

Portrait 4: A dairy farm with labelled raw cheese production, with 4 associates and 4 employees in Burgundy

Milk quality is an essential issue on this farm which produces raw cheese. The animal food system was entirely renovated a few years ago with a drying process in a barn, to improve the quality of the cheese and to acquire more autonomy. Watching and touching animals is very important to detect mastitis early. Phytotherapy (herbal medicine) is used as a preventive medicine: “for us, animal health is observation so there are things that we are being able to treat with phytotherapy… when we see that there is a mastitis, we work with herbal medicine before using any antimicrobials”. This farmer uses treatment that he buys at a retailer but his intention is to learn quickly how to prepare his own treatments. The farmer in this case study used phytotherapy for the first time in an emergency situation (Staphylococcus that antimicrobials could not eradicate) that was impacting the farm’s profitability. He did some research on the internet in order to find new solutions: “so we immediately stopped antimicrobials and we started to sort our herd into three groups, from the most infected to the least infected. And then we started to search for some information about herbal medicine and we got lucky ‘cos someone…it was just by chance, but someone came, from a commercial organisation, that was doing phytotherapy. So we started like that and in about 6 months, the problem was solved, all of our cows became healthy again”.

Portrait 5. A multi-activity farm with vines (40 hectares) and poultry breeding (22 pens), run by a 50 year-old man and 2 employees. Collective tests on Label Rouge “yellow” broilers

The main purpose of the tests was to identify technical improvements to be made: food intake, less antimicrobials use, water quality, etc. The farmer was on the board of directors of the farm organisation. He had been running the farm since he inherited it from his father. He was breeding free-range poultry in pens, what are known as “cabans”. The farmer organisation was running tests on the feed quality by changing/adding some components, and it needed the farmers who were members of the organisation to test the feed on a flock. That was how the farmer became involved in the testing, which could be considered as teamwork initiated by the farmer organisation. To him, this was a source of personal pride.
Portrait 6: A free-range poultry breeding in poultry house, Label Rouge, in the Landes region

This multi-activity farm had 5 poultry houses of 400 m² each. Run by a 50-year-old man who had inherited the farm from his parents, it bred and force-fed various types of “label rouge” poultry (ducks, broilers, guinea fowls, turkeys) for the foie gras industry. The farmer’s experiments aimed at decreasing the occurrence of digestive diseases in chickens, in the hope that this would in turn result in decreasing the use of antimicrobials. It provided a very interesting example of cross-learning between species. This farmer diversified by breeding different types of poultry. He transferred what he observed from one species to another by running tests. He solved health issues on ducks by analysing the water and setting up a system to control the pH of the water. In particular, he wanted to see how the water’s pH could improve the digestive health of broilers and guinea fowl. He also transferred the idea of a higher temperature from turkeys to broilers.

This farmer developed his own tests, without any collaboration with the technical staff of the farmer organisation, but he did also exchange breeding experiences with other farmers. One of his neighbours learnt from him how to lower the pH of water. This shows how learning passes from one farmer to another. The salespersons working for agricultural hygiene companies also played an important part in that process, by offering technical alternatives to farmers.


This farmer took over the family farm in 1994. At the time it had 230 sows but he increased the herd up to 310 in 2006. Almost all the farm buildings had been renovated just before he arrived. This farmer had never changed his cooperative and had had the same technical adviser since 1996. He had also had the same veterinarian (who worked with the cooperative) for many years. He considered economic performance to be very important, and health management to be one of the main parameters of profitability. He did not however consider himself to be someone who was willing to test everything just to try to increase his performance. So the experience of his colleagues (other farmers) that he shared in some collective groups like the CETA or training courses organised by his cooperative were almost more important than ‘just’ the advice of his veterinarian and technical advisor. Related to his economic motivation, he also valued his cooperative’s technical and commercial strategies (he was involved in several bills of specifications) to value certain breeding practices, especially those promoting animal health and welfare:

“This is a whole set of things. When you have projects like that, you have to get some information. You check with your veterinarian and your technician, you ask questions. Right now, I want to renovate my boarding dock, so I asked my technician, I asked my veterinarian. But I also belong to a working group, with some colleagues of mine. So we do a kind of a brainstorming and so you see if you’re right or wrong. But it depends on our characters too. Some are more pioneering than others, they always rush into tests and innovations. Others have more of a wait-and-see approach, they do something only when they’re sure it will work. I’m more in the second category”.

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Conclusion: a call for further in-depth investigation

This characterisation of FE in the case of decreasing the use of antimicrobials in French livestock farming brings to light a wide range of practices that are often overlooked by veterinarian practitioners and sanitary advisers. It could serve as a starting point to extend the investigation in order to obtain a fuller picture of these FEs in health management, as in the example provided by researchers for organic production (Vogl et al., 2015). Other methods are likely to be used and we assume that other issues would appear. In particular, a questionnaire survey completed by farmers would face the tricky issue of health norms and answers would be those expected by scientists and advisors. We nevertheless consider it to be of great interest to push forward this perspective. At the same time, we are convinced that much can be learned from ethnographic immersion if we wish to gain more insight into what farmers are experiencing when they try to solve health problems.

We have found that many farmers are using alternative medicine together with antimicrobials and that a large number of them do not think that essential oils or homeopathy work as well as antimicrobials. That is why they use both kinds of medicine. In some cases this contributes to incremental change in health management, while other farmers choose to redesign their whole herd management system and to stop antimicrobial use altogether. The combination of different kinds of medicine has likewise been observed by Bentley (2006) in Western Salvador. He found that smallholder farmers were using botanic and chemical pesticides alternately for managing pests. Such a strategy of association between conventional and alternative medicine should be investigated further because it seems to be at the core of many farmers’ experiments.

Overall, a majority of the farmers surveyed, whether conventional, labelled or organic, try different combinations. French dairy farmers sometimes use essential oils with local antimicrobials to prevent mastitis. This kind of practice is also found with free-range chicken farmers, even though it seems in their case that experiments are more collectively designed because of the importance of health and technical advisors in labelled production. These experiments are often designed to save on cash expenses but that does not mean that do not have other motivations for changing their practices (such as environmental or public health considerations). Farmers’ experiments leading to a reduction of antimicrobial use should therefore not be analysed as a response to a political, social or professional injunction to remove those pharmaceuticals from animal health practices. In fact, some farmers still use antimicrobials and, in the worst cases, their consumption even increases a little. Most experiments are actually driven by a (changing) way of considering farming and animal health in particular. A reduction of antimicrobials could be a consequence of these experiments but should not be considered as the only or even the primary motivation. The same conclusion can be drawn from the study of conventional pig farmers. Even though the kinds of experiment they carry out are quite different because of the socio-technical and socio-economic configuration of industrial pig production (importance of building management, feed or vaccination choices), and because of the long-term nature of their changes in practices (they not only run “tests”, they also plan them over months or years), their way of constantly re-inventing herd and animal health management is clearly determined by this overall conception of farming. The question that arises here is not whether farmers should reduce antimicrobials or whether they should de-intensify their farming practices, but rather how they are trying to re-appropriate some injunctions, recommendations, and technical and scientific prescriptions in their overall activity of pig, poultry or dairy farming, that fit with their conception of their work.
Ethnographic investigation would certainly more adequately document this aspect of farmers’ experiments.

Acknowledgements
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References


From seed to bread: co-construction of a cereal seed network in Wallonia

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Abstract: After losing its artisan character after World War II, bread is now commoditised as the outcome of an increasingly globalised seed, cereal growing, milling and baking industry. Yet, alternative pathways are emerging to develop a more resilient and locally-adapted cereal system. Our case study focuses on exploring the emergence of a cereal seed network in Wallonia, which gathers farmers, millers, bakers, households and researchers. In this paper we look into the creative process of co-construction of this network, after 3 years of participant observation. We explore how group objectives and personal motivations evolved along with internal and external events. The main objective of this network is to conserve and breed a diversity of cereal varieties adapted to local agroecological food systems. Our results show that: (i) novelties are being produced and tested in farms; (ii) opening up a safe-learning space favours networking of these isolated novel actors; and (iii) collaborative management of cultivated diversity entails opportunities and challenges. We discuss these results in the light of similar experiences of seed networks in Europe and outline questions raised by challenges faced in participatory research on seed. Our conclusions suggest that in order to improve the nutritional quality of bread and develop a more resilient cereal system, collective management of seed and participatory plant breeding programs should be fostered. This will need a reversal of agronomy research approaches and of priorities in food policy.

Keywords: Seed network, participation, co-construction, agroecology, bread, cereals, Wallonia

Introduction

From seed to bread: consequences of the modernisation of the cereal system

In Europe the post-World War II food system established firstly a formal seed system creating pure-line standardised varieties that gradually substituted landraces and excluded farmers’ seed selection practices and knowledge. Another consequence of this evolution was the continuous decline of cultivated diversity, both inter- and intra-specific, resulting in genetic erosion (Bonnin et al., 2014). Losing cultivated diversity also involves loosing associated knowledge, which can be termed as cultural erosion (Vára-Sanchez & Cuellar-Padilla, 2013). This loss in genetic and cultural diversity reduces options for adapting to changing conditions and thus threatens the resilience of farming systems (Hajjar et al., 2008). Because low-input farming has to adapt to greater environmental variability than high-input farming, it needs heterogeneous varieties that have a capacity to evolve and adapt to these changes (Rivière
et al., 2013). Yet today most organic and agroecological farmers sow pure-line (homogeneous) varieties bred for high-external input farming, which are inadequate in the light of the challenges they face (Bueren & van Myers, 2012).

Farmers are not the only actors of the food chain affected by changes in the cereal seed system. Although modern wheat breeding enabled substantial yield gains, almost unilateral focus on this criterion led to downside effects such as decrease of mineral density or selection of a type of gluten, which may produce non-coeliac hypersensitivity. Changes downstream also impacted bread quality: industrial milling and baking practices have favoured white airy bread, with high salt content and low nutritional value, based on standardised flour mixes from cylinder-type mills. In classic bakery training programs, students no longer learn to bake with sourdough or without flour additives (Rémésy et al., 2015).

**Emerging alternative networks and accompanying research**

The global food system is in crisis but due to mechanisms related to path dependency and lock-in, promising alternative pathways towards sustainability struggle to gain legitimacy (Sutherland et al., 2012). Nevertheless, some of these pathways are gaining momentum. On the farmers’ side, a groundswell of change is driven by a quest for more autonomy, through better use of internal resources and lesser reliance on global markets. On the households’ side, a similar change is driven by a desire to reconnect with the land, find local food of better nutritional quality etc. Both sides are connected through the process of repeasantisation and the emergence of novel food markets linking farmers directly to households (van der Ploeg, 2008).

Institutional and research discourses (and practices) are also shifting. Participatory approaches are now acknowledged as an asset to foster innovation. Still there are various types of participation ranging from passive participation to more active forms like self-mobilisation. In more passive forms, the first-concerned actors are not included in co-producing knowledge or in decision-making. Active forms of participation rather try to enhance the skills of rural actors and encourage them to develop and promote their own processes (Cuellar-Padilla & Calle-Collado, 2011). This is the type of participation adopted for example by agroecology, in which we ground our research approach. We refer here to the specific concept of agroecology, defined as an intermediary action concept at the crossroads of science, practice and social movements (Wezel et al. 2009; Stassart et al., 2012). Agroecology seeks to establish a “dialogue of knowledge”, which Rosset and Martinez-Torres (2014) summarised as a “dialogue among different knowledge and ways of knowing” which can “form the basis for construction of new processes”. Other research traditions fuelled the debate on participation, like Farming Systems Research (Darnhofer et al., 2012) or Participatory Action Research (Reason et al.; 2006).

Regarding the seed question, numerous authors underpin the importance of farmers’ contribution to the management of cultivated diversity (e.g. Osman & Chable, 2009; Pautasso et al., 2013). Technical and social innovations have appeared over the last 20 years - e.g. on-farm evolutionary plant breeding (a method based on genetic diversity and natural selection to develop locally adapted populations) (Döring et al., 2011) or participatory plant breeding (PPB). PPB can be defined as the participation of several actors (farmers, consumers, researchers…) in the breeding process and is based on the complementarity of knowledge and know-how of each participant (Cecarelli, 2012). Rivière et al. (2013) suggest a methodology for co-constructing a PPB project between farmers, local organisations and
researchers: each step is collectively defined and evaluated. They outline that co-construction demands time and trust-building.

Aforementioned scientific and societal issues can also be found in the Belgian research and extension landscape, where until today alternative pathways for managing cultivated diversity remained hidden. Very little research has been carried out to understand and appreciate the dynamics, motivations, knowledge and strategies of farmers (and their networks) regarding varietal innovation within the cereal system. It is our assumption that this should be the first step when co-constructing any participatory research project (e.g. PPB) and to developing a sustainable and locally adapted cereal system in Belgium. Therefore we wish to contribute to the debate on the elements needed while conducting research that seeks to understand and support alternative pathways laid out by food networks.

We do so in this paper by looking into the creative process that led to the emergence of a cereal seed network in Wallonia. We also provide some first reflexive thoughts on our role as researchers in this process. First we briefly explain the method used to analyse the co-construction and make explicit our role. Second we present results about the trajectory of the network. We then discuss main outcomes, key challenges and the questions they raise. Finally we conclude with some perspectives on changes needed in order to foster innovation throughout the cereal system.

**Case Study and method**
In Wallonia, although cereals are the second most important crop in terms of land area (wheat representing 70% of cultivated cereals), bread wheat cropping declined to the point where most farmers grow low-quality forage wheat¹ and most bread grain is imported for an increasingly large-scale and globalised bread baking industry (Delcour et al., 2012). Within this context, different actors of the cereal system are reclaiming an active role in defined seed and bread quality (Louah et al., 2015)

Field research started in 2013 by carrying participant observation in farms developing alternative pathways for bread wheat seed, in southern (Gaume) and western (Hainaut) Wallonia. From then on we participated in all meetings and activities of the emerging network (Table 1), whose evolution is described in the results section. As the network grew and consolidated, our research approach evolved alongside and became more action-oriented in order to co-construct this regional seed network.

Grounded in agroecological participatory approaches we look as much on the improvement of the situation as on the process for this improvement. In this paper we focus on the process itself. We conducted a content analysis on meeting reports, notes taken throughout the whole process (group and individual meetings, field trips, workshops etc.) and email exchanges. This enabled us to build a narrative of the trajectory from isolated individual initiatives to the emergence of the network. We then draw on the framework developed by Combette et al. (2015) to illustrate the history of collectives working on cultivated diversity in France, adapting it to our case study. We used a timeline (Table 1) to organise data in order to visualise the chronology of the process and show that the networks’ functioning and activities are continuously evolving. We synthetised and classified data in five categories: group objectives, internal events, evolution of the core group, individual motivations and reflexion, external

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¹ As it is easier to obtain high yields and less risky, farmers generally prefer to sow varieties destined to become animal feed or to produce biogas.
events. Lastly we focused on examining challenges faced in regard of the growing dimension of the network and questions raised, in the light of scientific literature.

Results

**Varietal novelties are being produced in distinct farms**

While carrying participant observation in farms developing alternative pathways for bread wheat seed, we identified two distinct local initiatives. Benjamin\(^2\) is a farmer-miller from southern Wallonia (Gaume). Among other experiments, he takes part in a French participatory plant breeding (PPB) program, which developed an innovative methodology for on-farm breeding (Riviè\'re et al., 2013) in response to the demand of farmer-bakers from the Réseau Semences Paysannes (RSP, French seed network). Benjamin’s motivation is to develop bread wheat peasant populations adapted to his “terroir”\(^3\) and artisan bakery. On his farm, seed-related work is collective. It is both a political choice and a necessity in order to overcome the big amount of work to be done: sowing, harvesting, threshing and seed cleaning and sorting. These collective action moments are also an opportunity to exchange seed, knowledge and know-how. A supportive group of “eaters” helps with work organization.

At the same time, at the other end of Wallonia (Hainaut, Western Belgium), other farmers were also reflecting on agroecological solutions for production and processing of cereals. They gathered together in a very local network of “outsiders” to form the agroindustrial modernisation project: the “Réseau des fermes novatrices” (RFN) which means “innovative farms’ network”. They spontaneously chose to change their practices and establish new relations with other spaces (consumer groups, schools, restaurants…), thus producing novelties (Louah et al. 2015). Among other subjects, they started working together on bread cereals and were particularly interested in testing old as well as modern population varieties of cereals (e.g. the Composite Cross Populations developed by the Organic Research Centre in the UK). This dynamic group organised meetings and field trips to foster exchanges between them but also with other rural actors and researchers. Their wish is to develop new partnerships with scientists (in particular agronomists) that differ radically from the most common linear knowledge transfer model.

Due primarily to geographical distance, these local initiatives were evolving in parallel, with few contacts with each other.

**Isolated initiatives join into a regional cereal seed network**

Farmer-researcher interactions played a key role in triggering a regional network dynamic. Concomitantly to the start of this PhD research project, a growing interest in traditional varieties was arising from actors of the non-industrial cereal chain. People who came to help Benjamin with seed-related work started going back to their farms and gardens with a bag of seed from his population of landraces. They started calling themselves “ancient wheat sowers”. In the autumn of 2013 we suggested structuring a learning group gathering farmers (4), millers (2), bakers (2) and gardeners/consumers (3) from the South-East of Wallonia. The aim was to create a space for knowledge sharing and collaborative learning “from seed to bread” between “ancient wheat sowers” as well as other stakeholders.

\(^{2}\) This fictitious name is used in order to preserve anonymity of participants.

\(^{3}\) Not translatable French word for local land.
This group progressively expanded and transformed into a cereal seed network (now with 82 members) that aims at reconnecting stakeholders from the non-industrial cereal chain and collectively reclaim seed sovereignty. One of the turning points happened in November 2014 when Benjamin induced a meeting between the researcher and two bakers willing to spend time on the seed question in cereals, particularly by favouring knowledge exchange and networking farmers and bakers. The agreement was to start first with a core group that would set a basis for a future network, and secondly to broaden it to actors interested in joining in. A series of observations and objectives were co-defined. The time was judged right to provoke a first wider meeting to confront these to other identified actors.

Thus the networks’ launch meeting was held at the beginning of January 2015. The main criteria for participant selection was trust, guaranteed by peer recommendation. There was also a will to have a strong representation of farmers, thus efforts were made to personally contact potentially interested ones. Mostly bakers came and this has proven to be a continuous challenge throughout the process; while a lot of farmers claim to be very interested in the subject, time is clearly a constraint to their active participation in meetings and group dynamics in general. Bakers, however, generally have more time and it is only one of the few reasons why this collaboration between stakeholders can be so interesting and fruitful. A series of observations were shared with participants as a starting point. These were mainly (i) local initiatives are emerging, from farmer to baker, to develop a non-industrial cereal system, but they are disconnected; (ii) interest in other varieties (landraces, populations, ancient species) is rising but faces the challenge of learning (forgotten or new) knowledge and practices. Participants were then asked to present themselves, their individual reflexions and motivations regarding the network and whether they agreed with the observations made. All of them agreed but some debated the need to formalise a structure, which involves a substantial amount of administrative work. It was also noted that initial group objectives were very large (Table 1). Thus it was agreed to start with concrete actions, which would create knowledge exchange opportunities but also enable actors to get to know each other. This would also nourish further reflexion to progressively refine group objectives. In order to do that, simple communication tools were to be created. Finally it was stated that this regional network does not replace local initiatives and networks, rather it is complementary. Later a name was decided for the network: Li Mestère, meaning in the Walloon dialect a mixed cereal crop, often wheat and rye.

Among actions undertaken until now (internal events) are farm, mill and bakery visits, experience-sharing meetings, technical and practical workshops on sourdough bread making, wheat landraces selection criteria etc. In 2015, after searching several public and associative seed banks for material, in-situ collections of wheat, spelt and oat landraces were set up in several locations of Wallonia. Li Mestère also became a member of the Réseau Semences Paysannes (France). This allowed 6 farmers and 3 gardeners to participate in the French PPB program (with the RSP and INRA-Le Moulon) and thus get familiar with its technical and organisational aspects (Table 1).

External events (Table 1) have also stimulated individual and group motivations and reflexions. These include seminars, workshops, field trips organised by other actors (e.g. other farmers' associations), but also national and international networking of seed initiatives (not only cereal, but also vegetable seed). In parallel, biannual network meetings were times to refine and prioritise group objectives (Table 1). In September 2015, 3 short-term objectives were identified: (i) favour better access to information and technical training (conservation and
breeding, cropping, milling, baking); (ii) set-up a dynamic in-situ collection of wheat, spelt and oat landraces (in several locations); (iii) consolidate the PPB project. Long-term objectives (communication and awareness raising, legal and political support) are to be addressed in a second time according to the process’ evolution.

The evolution of the core group (Table 1) was in parallel to the objectives’ refinement. Until recently, the original driving force (two bakers and a researcher) assumed secretarial tasks and co-facilitation. They also co-constructed information and communication tools to support group objectives: mailing list; shared file storage; flyer; and training material (technical forms). The network is at a new turning point, where it seeks to evolve into a more horizontal structure; for each priority objectives 2 or 3 persons are responsible for its operational framework and implementation. Again it raises the question of whether it should formalise a legal structure in order to appoint a group facilitator.

In the co-construction process presented here, we are both researchers and participants. This increases even more the need for reflexive thinking on our role in this process. As researchers, our role relies on 3 specific contributions within the core group:

(i) Providing technical support for optimising practices of in-situ dynamic management of cultivated diversity (e.g. giving advice on how to sow and manage experimental microplots and how best to conserve seed…);

(ii) Supporting the learning process in order to foster emergence of conditions for knowledge exchange and production. A significant part of our time is dedicated to creating a safe-learning space and co-facilitating the network’s life and activities - the organisation and facilitation of meetings, field visits, training; maintaining personal contacts with members; connecting with other associations/networks etc;

(iii) Understanding the learning process: assessing learning outcomes from the content (of the process) and the process itself.

The emergence of the network was favoured by our involvement and expertise, but co-construction was made possible by the already latent dynamic - in other words, the timing was right.
Table 1. Co-construction of Li Mestère, a cereal seed network in Wallonia (Belgium)

<table>
<thead>
<tr>
<th>Group objectives</th>
<th>Internal Events</th>
<th>Evolution of core group</th>
<th>Time</th>
<th>Individual motivations and reflexions</th>
<th>External events</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Link farmers and bakers around seed through knowledge sharing</strong></td>
<td><em>Collective harvest and threshing of on-farm wheat trials</em></td>
<td>Informal group of ancient wheat sowers</td>
<td>2013</td>
<td>What is a good wheat? How to breed it? Political act to spread seed Bakers’ acknowledgement of cereal quality Collaborate with research</td>
<td>Participatory film on wheat landraces PhD start – participant observation</td>
</tr>
<tr>
<td>Better cereal and bread quality</td>
<td><em>“From Bread to wheat” on-farm workshops</em></td>
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<tr>
<td>Fair commercial relations between actors</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>Create knowledge exchange opportunities</strong></td>
<td><em>“Ancient wheat sower” tours</em></td>
<td>Informal group of ancient wheat sowers and RFN 2 bakers + 1 researcher</td>
<td>2014</td>
<td>Find varieties adapted to “terroir” and test best practices Knowledge on landraces and populations Multiply “seed that matters” Find processing and marketing outlets Peasant-baker status recognition Concrete change happening</td>
<td>PPB seminar in France ECVC seed workshop in Brussels RFN farm visit</td>
</tr>
<tr>
<td></td>
<td><em>Collective harvest of on-farm wheat trials</em></td>
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<tr>
<td></td>
<td><em>Experience and knowledge sharing meeting</em></td>
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<tr>
<td></td>
<td><em>Pre-definition of group objectives, identification of stakeholders and pre-selection of participants for potential network</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>2015</strong></td>
<td></td>
<td></td>
<td>(Need for) structuring network – divergence of views on how Need to expand core group</td>
<td>“Agroecology in Action” – mill visit and experience</td>
</tr>
<tr>
<td></td>
<td><em>Network creation and objectives refinement</em></td>
<td>2 bakers + 1 researcher</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Sourdough bread workshops</em></td>
<td></td>
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</tbody>
</table>
| Better access to information | Field visit  
Study trip to North of France (on PPB)  
RSP membership  
Peasant Cereals Feast (workshops and seed exchange)  
Network meeting: update of objectives  
Seed prospecting and collection set-up  
9 members engage in PPB program (national and pre-sowing meetings)  
Development of communication tools | 2016 | sharing workshop in Flanders  
2 watermill takeovers  
On-farm experiment on SWI (with INAGRO) |
|-------------------------------|---------------------------------|---|---------------------------------|
| Map initiatives and needs     | Network meetings (detail subtasks)  
Workshops on sourdough and landraces  
Study trip to South of France (PPB, gluten)  
Field visits (collections & PPB) | 2 volunteers for each of the 3 priority themes | More training on criteria for choosing landraces |
| Networking (other actors)     |                                 |   | MAP work on alternative bread sector  
Coordination of seed initiatives in Benelux |
Collaborative management of cultivated diversity entails opportunities and challenges

Today Li Mestère remains an informal cereal seed network but gathers around about 82 farmers, bakers, millers, gardeners, citizens and researchers. Within this bread/cereals renewal and accompanying research, a collective management of cultivated diversity is arising. Field trips, meetings and workshops strengthen interactions between actors, intensify seed and knowledge exchanges (between practitioners as well as between the researcher and them), foster on-farm experiments and initiate co-construction of a collaborative research. Finding seed to start this process also required collaborating with others: ex-situ seed banks but also existing groups or seed networks. A couple of French associations that maintain collections of landraces helped Li Mestère by providing seed samples (in larger amounts than seed banks). Networking also made visible hidden novelties being produced on-farm that are orphaned by conventional agronomy research and extension. Some of these novelties tackle problems at the food system level. For example, a young farmer created the first Community Supported Agriculture system adapted to cereals in Belgium, experimenting in this field also created a social and solidarity economy. Other farmers tested novel farming practices. Regarding wheat cropping, one innovative agroecological practice which comes to the fore is the System of Wheat Intensification (SWI). Several farmers of Li Mestère are testing it at the moment. We are co-constructing research with them to assess the potential of these innovative practices, in the light of objectives collectively defined inside the network but also within this parallel collaboration (Table 2).

Table 2. The System of Wheat Intensification: an innovative wheat cropping practice

<table>
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<tr>
<th>The System of Wheat Intensification is named after the System of Rice Intensification (SRI), which was discovered in Madagascar and first described in 2002. Since then, farmers and researchers have begun adapting and extrapolating its principles to a range of other crops, so that we can now speak of a general system of crop intensification (SCI) (Abraham et al., 2014).</th>
</tr>
</thead>
<tbody>
<tr>
<td>SRI has been reassessed while insisting on aspects of basic plant husbandry and soil life, challenging a series of blind spots of the mainstream agronomy and plant breeding that underpinned the Green Revolution. In a nutshell, the SWI consists of a set of interrelated practices based on considerably reduced seeding density to lower intra-crop competition (from the conventional 150-200 kg/ha to 20-40 kg/ha). Together, these practices work synergetically, stimulating intensive tillering, maximal ear development and minimal tiller death. In all, individual plant vigour and total grain yield are improved with minimal cost or external inputs, therefore addressing the need for ecological (re)intensification and having a positive impact on farm autonomy. Interestingly, the low densities also change the phenotypic expression of the genotype, which has huge consequences for plant breeding. Some (conventional) plant breeders now challenge the standard practice of high seeding density in wheat that became entrenched during the twentieth century as there is a trade-off between yield potential (through tillering) and competitive ability.</td>
</tr>
<tr>
<td>The obvious question then is: what if this practice is combined with evolutionary breeding? Can the local adaptation process of populations be enhanced through selection within an SWI environment? In order to explore this, a master thesis student is carrying out an on-farm experiment. In this trial we compare how a pure-line vs. a population behave under SWI vs ‘normal’ density (following the farmer’s usual practices). This work also includes a survey of farmers practising different variants of this system.</td>
</tr>
</tbody>
</table>
The encouraging rapid growth of this network broadens out the realm of the possible but also raises new challenges and in fine questions to be examined. Two main challenges are currently being experienced within the network. The first one is linked to legal issues. From the beginning, the question of (il)legality was raised. Formalising a network means at the same time enhancing visibility of ‘hidden’ practices (thus exposing members) and creating a strong solidarity web (reaction and claim power). It is also a means to legitimise the existence and purpose of these practices. Yet recent evolution of (inter)national legal frameworks and seed property rights jurisprudence have enhanced concerns on farmers’ rights in general, and in particular related to seed sovereignty. This situation breeds distrust regarding collaboration with research or private seed industry or even seed artisans, fearing predominance of individual or commercial interests, or even biopiracy. This raised the question of how to collectively define and agree upon rules for the use and circulation of seed. The second main challenge faced today by the network is its long-term durability perspectives. Indeed it could be hindered because of the voluntary nature of most work done. To systemise and possibly legitimise this kind of action-research, a longer-term financial security could be necessary - for a network facilitator and for research partners, including farmers. This could generate a leverage effect for a regional PPB project or new and fruitful collaboration between different research areas (eg. social and natural scientists), in order to lead transdisciplinary systems research - from seed to bread. However funding has proven difficult to obtain for such a transversal approach because most funding goes to highly specialised object-oriented research. This raises the question of how to legitimise this type of research.

Discussion
This case study of co-construction of a seed network is limited to a specific crop and region. However our results have a broader significance when put in perspective with other research found in literature. Firstly we link up with other similar studies on seed networks in Europe. Secondly we discuss challenges for participatory research and on-farm management of seed.

Experiences from other seed networks in Europe
The main outcome of our work is that it highlights that ever more farmers, but also other stakeholders, are reclaiming an active role in the cereal system and leading their own experiments. Informal local networks are emerging in Belgium with different starting points (e.g. find cereal seed adapted to organic farming practices vs. find market outlets for organic cereals) yet joining in a broader regional movement. Combette et al. (2015) claim that the generation gap in seed and associated knowledge transmission, very marked in western Europe, is one of the reasons why collaborating is almost a necessity for anyone willing to start working towards seed sovereignty. According to their experience with a French seed network, creating knowledge exchange opportunities can result in co-producing new knowledge and practices. Also collectively tackling a problem induces a faster (and eventually more lasting) progression than when facing it alone. According to Pimbert (2011), farmer networks and other types of platforms are “key for mobilising capacity for social learning, negotiation and collective action for research into the management of agricultural biodiversity”. Indeed food systems’ modernisation generated disconnection and disembeddedness resulting in a loss of autonomy and identity (Milestad et al., 2010). In these “safe spaces” the unvoiced can gain confidence to dialogue, frame alternatives, build alliances and act upon their food system. However, authors have pointed out that such spaces can also reproduce certain forms of exclusion (e.g. gender) or power issues if some precautions are not taken (Reason & Bradbury, 2006).
Challenges for participatory research and the on-farm management of seed

The young network on which our study focuses faces challenges, even more acute in the light of its rapid expansion. Can different perspectives and insights still be equally integrated when the number of involved members or geographical distance grows? This also demands a continuous self-reflexion on the way the network integrates with the real world and how it develops and communicates within it (Combette et al., 2015). At this point challenges faced by the network bring forward two main questions: i) how to collectively define and agree upon rules for the use and circulation of seed; and ii) how to perpetuate the network and how to legitimise this type of action-research, in a context where funding is difficult to obtain. Lack of investment in variety breeding has been recognised as one of the factors hindering the development of organic farming in Europe (Chable et al., 2012). But it is not the only barrier. Even when agricultural innovations do exist, they are not necessarily acknowledged and adopted. In Belgium, where our case study is located, low adoption of low-input disease-resistant varieties of wheat has been explained as a consequence of the locked-in situation of the cereal system: the system is in a path-dependency due to factors existing at all levels of the food chain, from farmers to extension services and European policies (Vanloqueren & Baret, 2007).

Another question that arises from this co-constructed process is how can researchers support varietal novelty production, and which change of approach does it involve? Identifying pathways on how to facilitate farmers’ experiments and innovations involves reflexive thinking on the role of the researcher. Based on our findings and literature (Cuellár-Padilla & Calle-Collado, 2011; Louah et al., 2015; Pimbert, 2011) we argue that, in order to formulate farmer-relevant research questions and carry out research aimed at solving real problems, a radical reversal in the relative positioning of researchers towards farmers (and other actors of the food system) is required. As Pimbert states “this form of co-operative inquiry and participatory knowledge creation implies a significant reversal from the dominant roles, locations and ways of knowing”. In other words: since they are the only “experts by experience”, farmers take the lead and researchers accompany their quest for answers to their questions thanks to their access to tools and scientific knowledge. We no longer seek to integrate practitioners’ knowledge to scientific thought through diverse forms of ‘participatory research’. We rather seek to contribute to the development of safe-learning spaces that produce new knowledge for action. However adopting this collaborative research approach does have its challenges, in particular for young agronomists: gaps in academic education related to systems and collaborative research, time discrepancy between field and academic research, dealing with uncertainties and reflexivity etc. The researcher-facilitator needs to be comfortable with diversity, surprise and the unusual (Pimbert, 2011). Nevertheless, if we can overcome these difficulties and find new collaborative ways, co-constructed research offers great potential as novelties are directly produced (thus adopted) by actors involved. Results from participatory plant breeding programs in Europe and around the world are encouraging and provide valuable methodologies and tools (Cecarelli, 2012; Rivière et al., 2013).

Our findings corroborate the 3 key challenges identified by Pimbert (2011) for participatory research and the on-farm management of seed in the European Union: (i) transforming knowledge into more holistic and transdisciplinary ways of knowing; (ii) scaling-up and institutionalising participatory plant breeding and agroecology; (iii) reversing policies and legal frameworks for equitable rights of access, use and control over seed. Regarding our case study of bread cereals, policies should foster community-oriented research and development.
to respond to the existing demand of both farmers and the artisan bakery sector, which is directly linked to household demand. This involves a systemic approach to quality to increase the nutritional value of bread via health conscious choice of varieties, higher quality of flour type and improved baking processes.

Conclusions and perspectives
Our case study focused on the co-construction of the first Belgian cereal seed network as an example of one alternative pathway with regard to cereals for human nutrition (bread cereals in particular). This incipient seed network seeks to reintroduce diversity in cereal cropping (seed and practices) and answer the bread quality concerns of artisan processors and households. To achieve these goals, seed and knowledge are exchanged within a safe-learning space gathering different actors of the cereal system: farmers, bakers, millers, gardeners, citizens and researchers. In order to improve the nutritional quality of bread and develop a more resilient cereal system, we suggest fostering collective management of seed and participatory plant breeding programmes. This will need a reversal of agronomy research approaches and of priorities in food policy.

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The role of Internet and social media in the diffusion of knowledge and innovation among farmers

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Abstract: The impact of the use of information technology (IT) has been gaining relevance recently in the way it can facilitate communication in the agricultural sector. Farmers can share innovations and knowledge alongside solving problems through social media, or other uses of the internet. Farmer-to-farmer knowledge sharing is an important source of information, but potential obstacles to effective communication can include distance and the amount of time farmers can invest in knowledge sharing activities. The Internet has therefore become an effective way to overcome those obstacles. The internet allows farmers to share their experiences (which traditionally would have been done over a farm gate), via YouTube, web forums and online groups. There are Twitter feeds that farmers can access to ask questions or to share experiences. Whilst some conventional farmers are also using these tools, they have become a lifeline for farmers hoping to or currently farming more sustainably. These farmers are likely to be disparate throughout the UK and may no longer share with their neighbours, but instead rely on social media for advice and mentoring. Key annual farming events are broadcast live via Twitter. Farmers and other participants are encouraged to share highlights of the conference sessions, their comments on the speakers and the event itself, allowing others unable to attend to receive information from the event. Internet and social media have a growing role in the diffusion of knowledge and innovation within the agricultural sector, allowing a greater number of farmers, researchers and practitioners to share information and experiment so as to facilitate innovative farming practices.

Keywords: Social media, farmer innovation, agroecology, internet.

Introduction

When evaluating farmers’ knowledge in relation to various agroecological farm management practices, it is important to consider that even though some farmers acquire information from family-led or traditional practices, Ingram (2008) pointed out that farmers tend to lack in-depth knowledge of specific scientific phenomena e.g. in relation to chemical or physical processes in soil management. In fact, farmers are more likely to rely on experience limited to their farm or that of someone close to them such as a family member or relative (Ingram et al., 2010). However, peers-exchange remains an important source of knowledge for farmers, in particular regarding current hot topics such as greenhouse gas emissions or more broadly, the sustainability and environmental issues related to the agricultural sector (Klerkx & Jansen, 2010). As a result, networks of influence represent a valuable source of information for farmers as well as providing advice and support (Klerkx et al., 2012). Examples of such networks in the UK include groups with a differing focus: they can be specific interest groups (e.g. Pasture-Fed Livestock Association), have a geographic focus (e.g. Tamar Valley Organic Group), or a political focus (e.g. Conservative Rural Affairs Group), and they can span local, regional or national levels.

Rural communities in the UK have struggled for many years with slow internet connection, limiting farmers’ opportunities to access internet communication outlets or platforms to
engage with the wider community and globally (Helsper, 2011; Ofcom, 2013). As a result the
internet has been slow to become part of everyday life in many farmers’ lives in the UK.
However, the development and introduction of smartphones, broadband and 3G mobile
networks have provided opportunities for farmers to connect with their peers in spite of the
distances separating them. Farmers can use internet tools such as web forums (for discussion
and debate), carry out internet searches, access the digital versions of farming magazines
(Farmers Weekly, 2016a) to acquire new knowledge, query problems and access information
on their phones, even in the middle of a field. Moreover, social media, such as Twitter,
Facebook or a Google group, enables them to instantly communicate (over an electronic
hedge), with online peers who they may never meet face-to-face, but who they can advise,
sympathise with and relate to (e.g. a farmer in a tractor in the Scottish Highlands can easily
reach a farmer in Cornwall). Finally, several studies suggest that farmers tend to prefer
kinaesthetic (‘learning by doing) or audio/visual learning to other learning styles (Franz et al.,
2010; McLeod, 2006). The use of IT allows farmers to view or record videos, listen to
recordings and watch live web-streaming of conferences, with the subsequent benefit of
enabling them to develop their knowledge and learning without having to leave their farms.

The need for more interaction and collaboration between farmers and researchers in order to
promote innovation and knowledge exchange is highlighted by the surge in initiatives such as
the Soil Association Field Labs (Soil Association, 2016). Open to all farmers, regardless of
their farming system (i.e. conventional or organic), the labs are aimed at encouraging farmers
to voice the issues and problems they would like to see researched, and then promoting the
sharing of information on innovative technologies, practices and collaborative research
programmes that can foster greater environmental sustainability between the farmer and
researcher.

In a recent study on farmers’ attitudes to climate change, a series of interviews were carried
out by researchers, followed by a focus group meeting to engage with all the participants and
develop future action in a collaborative environment with the researchers (Burbi et al, 2016).
The focus group was organised over a day, allowing for sufficient time to travel. However,
several farmers could not attend the meeting because they had limited or no staff to replace
them at the farm when away. In order not to lose the opportunity to engage in the discussions,
some farmers who could not attend called the researchers prior to the meeting, voicing the
topics they were more concerned about and would have liked to discuss during the focus
group. Other farmers acted as rapporteurs, collecting information from those who could not
attend and reporting on the results of the meeting. Alternatives were found, but it has to be
considered that family-run farms or small-scale farms often rely on a limited labour force who
cannot stay away from the farm for extended periods of time, sometimes even for just one day.
Distance and time may therefore hinder the opportunity to engage with other farmers and
researchers in person, making the internet medium a more attractive option for them.

This paper describes the authors’ research on the use of IT learning. An initial review of the
literature helped to identify issues, which were then examined in farmer interviews and focus
groups across England.

**Methodology**
The authors interviewed a total of thirty farmers, farming mixed arable and livestock systems,
with a combination of conventional and agroecological techniques. The interviewees were
spread across England. The interviews were aimed at acquiring information on how the
farmers accessed and implemented learning. The interviews were followed by two focus groups, which encouraged peer learning and further consolidated the data gathered through the interviews.

**Issues facing diffusion of knowledge and innovation**

**Farmer knowledge exchange**

Contacts and interactions with other farmers, especially if they are happening regularly, can influence greatly a farmer’s attitudes and perception of innovation (Rydberg et al., 2008). Influences external to the farmer’s immediate community can come from the media and extension officers, as well as consumer groups. Swanson and Rajalahti (2010) suggest that one of the greatest challenges facing the agricultural sector in the UK, as well as in other European countries, is that over the past 30 years governments have gradually reduced the funding for extension and advisory work. This has resulted in extension services having varying degrees of efficiency and impact, because they now rely mostly on private companies providing agricultural consultancy services in a rather fragmented manner (Oreszczyn et al., 2010). In England, it has been observed that some farmers who rely on networks of influence (i.e. a farmer’s own family and peer-to-peer exchange group) to acquire and exchange knowledge among peers tend to resort to agricultural consultants only when these networks of influence do not succeed in providing the farmers with the advice needed (Klerkx & Proctor, 2013). Such premises foster even more fragmented and inconsistent external advice. Moreover, according to Buhler (2002), since more than a decade ago, funding for agricultural research in the UK has been shifted from collaborative projects involving both farmers and researchers to a system that relies on private funding, therefore reducing government expenses on extension services. Buhler further comments that this seems to be influencing the reluctance that some farmers show in adopting new technologies or innovative practices (2002). More recently, Islam et al. (2013) has observed several case studies in the developing world and concluded that the combination of formal and non-formal education (i.e. inside and outside the classroom) has a positive impact on farmers’ uptake of innovation, as opposed to approaches that focus just on technical advice, without taking into account the social implications that such innovations could have on farmers’ livelihoods. The combination of formal and non-formal education and interaction with researchers has multiple advantages. It can be considered a step forwards in trying to compensate for the reduction in government funding by generating knowledge transfer activities and promoting advances and innovation in the agricultural sector, fostering knowledge sharing and ensuring transparency. This is vital because it also helps to ensure that the advice provided takes into account not only the technical aspects of an innovative practice, but the social and economic implications of it as well, giving the farmers the opportunity to choose the best option based on the farming system adopted (Islam et al., 2013; McKenzie, 2011). Therefore, two-way communication represents a broader approach to extension; it enables farmers and researchers to share and co-generate knowledge whilst enabling researchers and policy makers to gain a deeper knowledge of the underlying factors that can influence the decision-making process in the case of farmers and the means that the sector uses to exchange and generate knowledge on innovation (Kings & Ilbery, 2010). As a result, such collaborative action can be considered beneficial in that it focuses on information directly of interest to the farmers in a practical way, and it attempts to avoid neglecting the environmental, social and economic implications that could also interest policy makers as well as researchers. The clear benefit from such knowledge exchange and interaction is the opportunity to facilitate the implementation of future policies, such as the
ones focusing on promoting good agricultural practices and, more broadly, the sustainable management of natural resources by the farming community (Islam et al., 2013; Röckmann et al., 2012).

It can be suggested therefore that in order to promote effective innovation in the agricultural sector it is highly important that farmers, researchers and policy makers engage in successful communication. As an example, Burbi et al. (2016) have addressed the issue of climate change; highly debated in recent years and having to face obstacles, related both to scepticism from some farmers and financial limitations, to the adoption of innovative technologies that could reduce the impact of livestock farming in terms of greenhouse gas emissions from manure storage and treatment. The authors found that farmers tend to state that they would like to have access to unbiased scientific knowledge on climate change. This was likely to be related to the sense of confusion experienced by some farmers, combined with a lack of trust over government action. As a result, farmers expressed a preference for direct interaction with researchers and scientists and preferred collaborative work focused on finding practical solutions for the implementation of innovation (much like the Farm Labs project mentioned above). In such a context, it can also be considered that scepticism and confusion could result in opposite reactions from farmers: some could be discouraged from taking action and engaging with a wider community of farmers and researchers; whilst others could be motivated to look for knowledge originating from other resources, especially if such alternatives are considered more valuable by the farmers themselves.

Access to IT

As mentioned in the introduction, rural areas of the UK still lack access to broadband and experience slow connectivity (Ofcom, 2013), which can limit farmers’ online access to knowledge and innovative techniques. Furthermore, slow connectivity can result in access to social media taking significantly longer than a farmer has time to spare. In addition, lack of experience of using social media can slow down a farmer’s access and use of sites such as Twitter and Facebook (Hartless Rose, 2016). Another issue the farmers interviewed have experienced is the risk of missing useful information due to the speed of its flow online, or the difficulty in finding specific, relevant, reliable and applicable information amongst the mass of online sources of knowledge (Hartless Rose, 2015a).

Ultimately the internet represents an accessible means to obtain knowledge and to promote the interactions between farmers and researchers across the country that may otherwise have little chance to engage in face-to-face interaction.

Possible solutions based on IT technology

Internet

Most farming magazines and newspapers in the UK (such as Farmers Weekly and the Farmers Guardian (2016)), now have digital editions while more localised farming regions also now release digital editions of their news (Three Counties Farmer, 2016). Farmers can access news, listings and other information relevant to their activities. They can also share links to specific information or news with their peers, or leave comments directly on websites.

Although it is important to acknowledge that there are still rural areas in the UK where broadband and 3/4G mobile internet connections are weak, it has become common to use the phrase ‘Google it’ to find out information about specific topics of interest. Moreover, with
the introduction of smartphones and tablets, answers to questions can be found instantaneously, even outside of the farmhouse. Search engines can be used to identify the best value suppliers for specific products, to look up products before ordering goods, to learn a new technique or simply to book a ticket for an agricultural show (RWAS, 2016).

Alternatively, web forums such as The Farming Forum (TFF) have become popular places for discussions amongst the farming community in the UK. It allows farmers from every spectrum to debate, discuss, advertise and share knowledge on a variety of topics. As with every online community where participants come from a wide range of differing backgrounds, discussions may occasionally turn into heated exchanges of opinions between participants passionately sharing their own views on specific topics, but overall discussion topics are useful for those who use the forum to gain knowledge or find innovative ways of improving their farming (TFF, 2014).

Massive open online courses such as the Farmers Weekly Academy, allow farmers to keep up with their Continuing Professional Development (CPD) by signing up to online courses and expanding their knowledge (Farmers Weekly, 2016b). As another example, Lancaster University offers a free online course on soils of 4 weeks duration, with the possibility of watching classes online in basic or high definition (depending on the student’s internet access speed) as well as downloading transcripts of each class for reference. At the end of the course, which is expected take approximately 3 hours per week of study, students will be issued with a certificate of attendance (Future Learn, 2016). The flexibility of such courses can be seen as an advantage in the case of farmers who spend most of their time running their farms. They may have limited time to spend online or it may be difficult for them to keep to a regular schedule to attend classes, even in the case of online classes at fixed times during the week.

Interest groups also provide specific courses that can interest farmers, in particular those adopting agroecological practices. For instance, RegenAG UK (2016a) has been organising courses for a number of years, led by practitioners from various backgrounds and aimed at farmers, as well as researchers and the general public. Even though these courses are not online and require farmers to leave the farm for at least 1 day, the internet medium represents a source of knowledge that is easy to access and allows farmers to explore a variety of options in terms of courses, one-day events or workshops on the topics that most interest them at a specific moment in time. The courses are also followed up with resources sent to the attendees via email. Training is also offered by organisations like Holistic Management International (HMI, 2016b), the Biodynamic Association UK (2016) and the Permaculture Association UK (2016b). These institutions provide free access to a range of information and knowledge bases that could interest farmers. They also list courses available throughout the year, some of which, such as the Permaculture Design Course, are available as online learning (Permaculture Association UK, 2016c). An interesting example of how farmers organise themselves and share knowledge among their peers and the general public is the website of the Pasture-Fed Livestock Association, where one can find a section titled “Learn More” and one titled “Research News” (PFLA, 2016b). These sections feature news of direct interest to members of the association (mostly farmers) and the general public, with links to events and other sources of information of easy access. The PFLA itself was founded by farmers and therefore represents an example of self-organisation within the farming community, with the aim of sharing knowledge and innovation adopting IT technologies and social media.
Audio/visual media

Audio or visual media can provide a valuable source of information for farmers. YouTube has enabled farmers, both in the UK and around the globe, to record new techniques that they are using on their farms and share the videos online for others to watch, learn from and use. As an example, through farmer interviews it was revealed that one farmer in Northumberland (in the North of England) was feeling isolated as neighbouring farms were not implementing the same farming techniques. He had however found videos filmed by a farmer in another area of the country, showing successful and less successful implementations of a specific grassland management option (Havard, 2015) and he stated that he considered the videos to be as helpful as the more traditional farm walks (Hartless Rose, 2015b). Although this is just an example and it obviously cannot be generalised, it has to be noted that in recent years it has become more common practice at conferences to have sessions and keynote speakers broadcast live via YouTube or other similar online video channels (IPCUK, 2015; ORFC, 2016). Videos can also be broadcast using software such as Skype (Kasesalu & Tallin, 2003), allowing farmers to follow what interests them the most in spite of the distance. Farmers who could not attend an event such as the Oxford Real Farming Conference (ORFC, 2016), either due to financial reasons, distance or limited time available can then retrieve videos and transcripts of each session online. The farmers interviewed also followed live updates from the events via Twitter or Facebook (Hartless Rose, 2015b).

Social media

Twitter has become a way for some distantly diverse farmers to chat as well as debate and exchange information. Some farmers belonging to groups such as #ClubHectare (Twitter, 2012) or the account @AgriChatUK (Twitter, 2011a) often greet each other at dawn, or whilst eating their lunch, sharing knowledge of how their day has gone. Following its establishment in the US, AgriChatUK debates topical farming issues every Thursday between 8-10pm. Whilst some farmers feel that AgriChatUK has peaked and has become less relevant (Hartless Rose, 2015c) there are still very lively discussions each Thursday amongst regular Twitter users. Among the latest topics addressed during the Thursday online meetings was "How to use IT effectively to make better business decisions" (17/03/2016), which further highlights the importance that IT tools are gaining in the agricultural sector. Furthermore, farming conferences such as the Oxford Real Farming Conference use their Twitter account (2011b) to broadcast to those who cannot attend the event, and ask for questions during the plenary debates from Twitter and Facebook users.

Facebook pages and groups are an increasingly popular platform for farmers, in particular those farmers adopting management systems such as holistic management (HMI, 2016a), permaculture (Permaculture Association UK, 2016a) and, more globally, about sustainable farming across the globe (Farmers for a Sustainable Future, 2016). Some farmers also use Facebook to connect with their peers in the same area. This is the case with the Warwickshire Rural Hub (2016), which organises regular meetings and farm visits for their members, free of charge, and share practical, up-to-date information regarding National Farmers’ Union (NFU) membership and activities, rural payments or other legislative requirements farmers need to be aware of, whether they farm conventionally, organically or follow other guidelines. RegenAG UK is particularly active on Facebook, sharing information on courses aimed at farmers and the general public, including researchers (RegenAG UK, 2016b). It even has a space dedicated to biofertilisers, which is a topic of great interest among small-scale farmers choosing not to apply industrial fertilisers (RegenAG UK, 2016c). Farmers are also using...
Facebook to become more political about issues that they feel strongly about, for example in the under-30s branch of the Farmers Club (2016). The use of social media isn’t limited to farmers outside the mainstream agricultural sector, i.e. conventional or organic, but has become a widespread communication tool even for Farmers’ Weekly and Farmers’ Guardian, who feature links to their social media accounts on their website.

Google groups are another example of a means for farmers to share experiences and interact, overcoming the issues of distance and financial limitations to attending events, conferences or even farm walks organised by farmers’ groups. The Pasture-Fed Livestock Association (PFLA, 2016a) are frequently asking questions or sharing experimentations with each other via their Google group, with advice offered alongside. Access to the group is open to all PFLA members and supporters. Researchers can also be given access, in order to communicate with members of the association, seek knowledge exchange or conduct surveys on a number of topics of interest to farmers such as climate change, soil health, farm management or grassland productivity.

**Conclusion**
Farmers across the UK face a number of challenges with regards to attending activities and events that promote knowledge exchange among their peers, as well as engaging in co-learning programmes with other researchers. Issues such as the cost of attending conferences and courses, or the distance and the time farmers have to take off from their businesses in order to attend, can reduce the motivation to engage in knowledge exchanges, potentially slowing down the uptake of innovative practices on-farm. Limitations in the use of IT and social media still include access to fast and reliable interconnections and the availability of spare time to browse through the mass of Twitter feeds, Facebook updates and forum feeds. However, the internet and social media are becoming increasingly useful in enabling farmers from across the whole country (if not the globe) to share views and experiences, successes and failures, creating online communities that contribute to the diffusion of knowledge and innovation across the agricultural sector. Moreover, a number of initiatives provide free online courses for farmers, whilst social media platforms such as Twitter, Facebook, Google groups or YouTube have the multiple benefits of promoting farmer-to-farmer exchanges, as well as the broadcasting live of national and international events and conferences. Such growing interest in the internet and social media is likely to help avoid the feeling of isolation that some farmers may experience, especially those farming in remote areas of the country, or who have smallholdings or are implementing agroecological practices and may be reluctant to follow advice provided explicitly for conventional or organic farms. This leads to the possibility of research institutions further adopting social media as a means to communicate with farmers, collect data and information for research and create continuing interaction, albeit online, between farmers and researchers in the UK as well as globally.
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An agronomical framework for analysing farmers’ experiments

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Abstract: Transition towards sustainable agro-food systems questions how farmers use and build new agroecological knowledge. First, as the efficiency of biological regulation processes depends to a large extent on each specific farming situation, farmers cannot just apply technical packages built elsewhere. They have to adapt or even to create agroecological knowledge to fit their own situation. Second, farmers engaged in agroecology have to act with uncertainty, for example concerning the dynamics of the systems or the long-term effects of a practice. Hence, the issue of farmers’ experiments returns to the forefront, although its contribution to the farmers’ learning process was observed long ago. We built an analytical framework derived from the agronomic experimental process to describe farmers’ experiments and discuss the learning processes. The framework is used in a heuristic way to re-read the literature on farmers’ experiments. Experiments are described in 3 phases: (i) design (objectives, experimental design planned, modalities compared, location); (ii) management (indicators to monitor the systems, ways to collect them, reaction to unexpected events); and (iii) conclusion (interpretation of data to assess the systems tested and build new knowledge). Results are two-fold: the framework enables us to describe the diversity in farmers’ experiments as described in the literature, even if few articles are precise enough to fully complete the framework; the framework is used to describe three experimenting situations coming from a case-study of producers located in the South of France. This communication should be regarded as a contribution to the debate on the relationships between learning and innovation processes, and on the possible synergies between scientific and empirical knowledge.

Keywords: Farmers’ experiments, farmers’ learning, agronomic experiments, on-farm experiment, factorial experiment, system experiment, agroecology

Introduction

Transition towards sustainable agro-food systems questions how farmers use and build new agroecological knowledge, for two main reasons. First, as the efficiency of biological regulation processes depends to a large extent on each specific farming situation, farmers cannot just apply technical packages built elsewhere. They have to adapt or even to create agroecological knowledge to fit their own situation. Second, because of the gap in scientific knowledge and of the agroecological systems’ intrinsic characteristics, farmers have to act with uncertainty, for example concerning the dynamics of the systems (e.g. biological regulations) or the long-term effects of a practice (e.g. weeds population with no-tillage practices). Hence, the issue of farmers’ experiments returns to the forefront with the recent developments in agroecology (Darnhofer et al., 2011; De Tourdonnet et al., 2013; Kummer, 2011) although this learning process was observed long ago (Johnson, 1972; Richards, 1989).
Based on previous definitions of farmers' experiments (Quiroz, 1999; Rajasekran, 1999; Saad, 2002; Sumberg & Okali, 1997), we define it as a process in which farmers plan the introduction of a new way of farming on their farm, implement it, take the necessary means to follow it up, and finally evaluate the results. We limit our definition to cropping activities such as new crop species, varieties, cropping practices, farming material and technologies. The term "new" refers either to a completely new way of farming coming out of their mind, or simply to something already implemented elsewhere but new for them, and that must be adapted for their farm. Nevertheless it must be noted that, despite the definition attempts, the boundaries of farmers' experiments remain fuzzy. Can we say that farmers planting trees on the whole farm area in an agroforestry perspective are experimenting (or are they only majorly redesigning their farm strategies)? Can we say that farmers who change soil tillage because of an extreme climatic episode one year are experimenting (or are they only adapting their cropping practices to unpredicted events)?

The topic of farmers' experiments encompasses a large range of definitions and, consequently, perspectives on analysis. Moreover, the importance placed on farmers' experimentations for building and learning more sustainable systems is very variable among articles, from a minor aspect to the main topic. Some studies reveal generalities of farmers' experiments (Bentley et al., 2010; Quiroz, 1999) while others build typologies to describe the diversity among farmers' experiments (Kummer, 2011; Millar, 1994; Rhoades & Bebbington, 1988). Other articles review specific topics: meaning of a farmer's experiment, profiles of experimenters, factors stimulating or inhibiting experimentation, characterisation of farmers' experimentation (Leitgeb et al., 2008; Saad, 2002). But even in this kind of review, the individual process of experimentation is not so developed. Most articles have been written by social scientists or agronomists involved in development programmes such as Farmers Field Schools (FFS) or Participatory Rural Appraisal (Angstreich & Zinnah, 2007; De Souza et al., 2012; Defoer, 2002) who were more interested in the collective learning process than the concrete courses and procedures of the experimentation. As a result, little is known about the process of the experimentation itself. Today, to foster the transition to more sustainable farming systems, it is important to better understand how farmers learn how to change (Chantre & Cardona, 2014), and in particular how their own experiments can ease technical changes through learning.

Farmers' experiments are sometimes compared to scientific ones but the reference to science is too often reduced to a single kind of scientific experiment (factorial trials) whereas a much larger diversity exists (De Souza et al., 2012; Debaeke et al., 2009). In this communication, we propose to use the concepts, steps and diversity of methods used by scientists in experimentation to analyse farmers' experiments. We built a conceptual framework to describe farmers' experiments based on the agronomic methods of experimenting and on previous studies on farmers' experiments. Far from considering science as a compulsory reference, the aim is to use it as a heuristic tool to describe farmers' experiments. The article is organised as follows: we first outline the two main approaches in agronomic experimentation and present the conceptual framework; we then illustrate it with farmers' experiments coming from literature; and finally we use it to fully describe three experimenting situations in our case study, implemented by some French farmers on arable and vegetable crops (Catalogna, PhD in progress).
Two approaches to scientific experimentation in agronomy

Scientific experimentation in agronomy has taken many forms during the development of the discipline. Starting from mono-factorial experiments (e.g. crop yield depending on the amount of N-fertiliser applied), it has been enriched by numerous forms of experimentation with different objectives and complementary roles. We will not make an exhaustive list of them but rather focus on two fundamental approaches - factorial and system experiments – both of which we consider to be of use to understanding how farmers experiment.

Historically, factorial experiments spread with the development of chemical inputs and statistical analysis capacities in the 19th century (Maat, 2011). Their objectives are to identify the effect of one or a few factors on a system. The theoretical principle is to formulate hypotheses on the factors most impacting crop functioning, and to compare situations where different modalities of these few factors (called “treatments”) are implemented, all else being equal. The treatments are set up on small plots and careful attention is paid to the spatial plot arrangement, for statistical reasons. The treatments are often compared to a control, whose definition depends on the study aim: the most common situation; a situation with no input; etc. For statistical reasons, each treatment is replicated. Factorial experiments all follow a common pattern, i.e. the succession of three steps: designing the experiment in advance, managing it in real time, and analysing the results. Despite their great contribution to knowledge building in the past, they are questioned by the evolution of farming context. They suffer from a major drawback: several cropping systems differing by the sole controlled factor(s) are compared without checking the consistency of each system (Debaeke et al., 2009). Even when scientists multiply the factors taken into account and the replicates in different environments, multi-factorial experiments still suffer from a reductionist approach (Reau et al., 1996).

To deal with this problem, some agronomists have developed a new way of experimenting called “system experimentation”. It aims at testing the capacity of innovative cropping systems to attain the objectives for which they were designed (Meynard et al., 2012), for example low-input cropping systems. The idea is to assess only the few systems in which the combinations of techniques seem relevant to reach the given objectives and fit local conditions. This enables the drastic reduction of the number of combinations to set up, and the taking into account of a larger number of techniques than in multi-factorial experiments. Moreover, the crop management sequence of each crop is not entirely planned in the experimental design, as it is in factorial experiments, in order to face natural hazards. Scientists, instead, plan and assess decision rules, which become objects of evaluation as well as the effects of the systems themselves (Debaeke et al., 2009). System experimentation thus partly questions the previous 3-step model of design/management/analyse. The main drawback for system experiments is how generic the results are, because the knowledge built, by nature, is closely linked to the specific situations. Deytieux et al. (2012) proposed the organisation of multi-site networks of system experiments to cover a larger array of situations and search for more generic knowledge. Since system experimentation aims at assessing cropping systems as a whole, one wonders if they are closer to the farmers’ way of experimenting.
Building a conceptual framework to analyse farmers’ experiments

Derived from the previous analysis and previous studies on farmers’ experiments, we propose a conceptual framework for analysing farmers’ experiments based on 3 phases - design, management and conclusions (Figure 1).

Design phase: This phase describes how farmers formulate objectives (e.g. assessing the effect of different factors or assessing a system that seems coherent and suitable for their case), how they design the experiment and how they choose where to implement it. Depending on what is tested and how the experimental design is planned, farmers’ experiments are classified either as factorial or system. Factorial refers to farmers’ experiments that analyse the effects of the introduction/modification of one or a few factors. System refers to farmers’ experiments that define overall objectives and establish a cropping/breeding system based on logical technical choices to achieve them. Even if control and replicates are more suitable to factorial experiments, they can be included in farmers’ system experiments as well.

Management phase: This phase is focused on the nature of the indicators to describe the biotechnical system and on the methods for acquiring data for further evaluation. These methods can vary widely among farmers and they influence the nature of the information farmers memorise. Casagrande et al. (2012) showed for example that organic farmers elaborated information on weeds very differently from each other. Agronomists do not manage unexpected events in the same way in factorial or system experiments (see below). Moreover, Stolzenbach (1994) used Schön’s theory about practitioners’ experiment to describe farmers’ experiments with 3 dimensions: hypothesis testing; exploration; and move-testing. The two latter dimensions explain that farmers do experiment even if they are not able to predict what is going to happen and, thus, how they are going to observe it and react to it. The point is to understand how farmers deal with unexpected events during their experimentation.
Conclusion phase: Kummer (2011) showed that one of the most important output of Austrian organic farmers' experiments was new knowledge. We differentiated two levels of learning which both involve the use of comparison and indicators. The first one is an evaluation of the outputs of what Hoffmann et al. (2007) call a black-box experimentation—e.g. ‘the colder stream water was bad for the early rice’ (Bhuktan et al., 1999). It constitutes a new pragmatic knowledge even if the causal mechanisms are not known in detail. Evaluation refers to the way farmers assess the success or failure of the experiment, or ranks different modalities (treatments or systems). The second type of learning refers to the explication of results, i.e. how farmers interpret the results. Understanding mechanisms is a way to avoid confusing effects in the agronomy theory, but is probably not the sole or even the main way of learning for farmers.

Despite the framework being split into 3 phases, they should not be seen as strictly successive: as a cook checks a meal when it is simmering, farmers may not wait patiently for the ending of their experiments to assess the results. Millar (1994) showed that testing, validation and evaluation often occur simultaneously for farmers while Leitgeb et al. (2014) reported that one third of the 72 Cuban farmers surveyed adapted their methods during the course of the experiment.

Selection of scientific articles
Keywords used in the scientific review on Web of Science and Gscholar were: "farmers' experiment", "farmer" + "trial", "farmer" + "experiment"}, "expérimentation paysanne". We excluded articles in which farmers' experiments are not described precisely. We focused on experiments dealing with technical innovations or farming practices and excluded those dealing with commercialisation, food processing or social organisations. At the end, we analysed 47 articles or book chapters.

Case study
The case study consists of experiments realised by three vegetable and cash crop producers in the Drôme department, France. They are part of a larger survey for a PhD study (started on February 2015) aimed at describing and analysing farmers' experiments in a perspective of agroecological transition. At the moment, 19 farmers have been surveyed, who have experimented with agroecological practices related to conservation agriculture and functional biodiversity. Experiments were spotted during both a first phone call and a face-to-face interview and discussed with open questions based on the framework (Figure 1). In this communication, the three experimenting situations were selected because the description of the experiments during the interview was very precise and because they cover the two experimentation types: two can be related to factorial experiments (functional biodiversity and conservation agriculture) and the last one to system experiment (conservation agriculture). The first two farmers have a longer experience in agriculture than the third. Farmer 1 is cultivating vegetables under greenhouses. Farmer 2 is cultivating arable and vegetables crops, and Farmer 3 cultivates only vegetables. Farmer 2 and 3 are organic farmers.
Literature analysis

**Design phase**

The objectives of experiments and their origins

Farmers’ experiments emerge as soon as an idea relevant enough to be tested appears. Deciding to test an idea can be immediate (e.g. trying a new variety) or can take a few years (Scheuermeier, 1997). These ideas constitute farmers’ hypotheses: by experimenting, they confront their ideas to reality and therefore test their hypotheses. But the main difference with scientists is that the hypotheses are usually rather implicit. Anyway, we can distinguish two types of hypothesis. One is strongly linked to farmers’ practical expectations: farmers want to see “if it works”. The other is less precise: something new is experimented with but there are no clear expectations about it; farmers seek “what happens if...”. Leitgeb et al. (2014) noted that 68% of the Cuban farmers surveyed had positive expectations about their experiments, 6% had negative ones and 26% had neither positive nor negative expectations and just wanted to see the feasibility of the experiment.

The source of idea can widely vary: it is brought by a neighbour – e.g. seeds (Bhuktan et al., 1999), as part of a development programme - e.g. modern rice variety extension in Cambodia (Mak, 2001), or from local observations and personal skills - e.g. in Nepal, a new way of grafting to facilitate fruits picking up (Scheuermeier, 1997). Kummer (2011) identified 13 different sources of ideas for Austrian organic farmers, the most important ones being their own idea, the other farmers and the literature.

Objectives can be solving a problem when it is clearly identified, or simply improving the farmer's livelihood. When problems are clearly identified, some authors classify the experiment as a “problem solving experiment” (Kummer, 2011; Millar, 1994; Rhoades & Bebbington, 1988). Hocdé (1997) even said that farmers are experimenting to find practical solutions to problems. In other cases, Scheuermeier (1997) observed situations where farmers' problems are defined back once the experimentation is implemented.

Planned experimental design

In the literature, numerous examples of farmers’ experiments related to factorial experiments were found. Most of the time, it concerns a new variety or input with various number of treatments. For example, Rajasekran (1999) reported farmers testing dozens of banana varieties. In East Anglia, Lyon (1996) described farmers experimenting with various doses of herbicides or straw shorteners for cereal crops. In Nigeria and Guatemala, farmers experimented with chemical fertilisers mixed with traditional organic ones in order to find effective low-cost fertilisers (Hocdé, 1997; Phillips-Howard, 1999). We also found cases where farmers were testing different environments for a new variety, for example from upper hills to low and swampy fields (Bhuktan et al., 1999) or from pure culture to mixed with other varieties (Pottier, 1994). Farmers can also realise multi-factorial experiments (Bentley, 2006; Bhuktan et al., 1999). In Nepal, a farmer compared two varieties (the traditional one and a new one), muddy and clear nursery water and spring vs stream irrigation after transplanting (Bhuktan et al., 1999). Control and replicates, that are fundamental for scientists in the factorial experiment approach, were found in farmers' experiments mainly when they form part of a participatory research project like FFS or Local Agricultural Research Committees (Braun et al., 2000). In Lyon’s study however farmers did not use replicates and mostly compared their experiment to their own fields in previous years, thus in time rather than in space (Lyon, 1996). In the same
way, half of Cuban farmers surveyed repeated their experiment at a subsequent date, but very few used a control (Leitgeb et al., 2014).

The farmers' experiments relating to the scientific approach of system experiment tested a coherent combination of technical choices instead of few factors. It concerned different subjects: a new way to cultivate a crop (Bentley, 2006; Quiroz, 1999; Wettasinha et al., 1997), a new rotation or association of crops (Baars, 2011; Buckles & Perales, 1999; Millar, 1994), agroforestry systems (De Souza et al., 2012; Millar, 1994), animal breeding (Kummer et al., 2012; Scheuermeier, 1997) or animal and crop synergies (Mouret, 2013). In Sri Lanka, instead of burning straws, a couple of farmers experimented with a new system by bringing back straws in paddy fields and reducing the amount of fertilisers they used (Wettasinha et al., 1997). Another farmer tried to imitate the “environment” of cocoyam he had seen in a complex agroforestry system in southern Ghana and, thus decided to shade cocoyam by planting it under mango trees (Millar, 1994). He also associated it with other crops: cassava, ginger and palm plants. An Austrian farmer experimented with free-range pig keeping and chose robust pig breeds as well as alternative fodder, and progressively redesigned the whole system (Kummer et al., 2012). Information on the presence or absence of a control and replicates is quite scarce in the literature. The only cases we found of farmers replicating a system experiment were correlated with a co-working with scientists (Baars, 2011; Buckles & Perales, 1999).

**Size and localization of the experimental design**

In factorial scientific experiments, the aim is to understand the effect of some particular factors. Thus many other factors are controlled and plants are grown in almost ideal conditions. This is often far from reality, as farmers usually have to deal with heterogeneous conditions at farm scale, with some plots that can be far from ideal. Some of them choose to experiment in their worst conditions, where problems are the most important. A farmer tested deliberately a potentially root-rot resistant variety of cassava in his most infected field (Saad, 2002). Rajasekran (1999) reported that Indian woman farmers experimented with banana and coconut in poorly drained soils. In an agroforestry development project, Brazilian farmers started to experiment with agroforestry at the most degraded sites of their properties (De Souza et al., 2012). In other studies, farmers deliberately chose their most fertile field to try a new variety (Richards, 1994). It seems that the diversity in the location choice is linked to the farmers' objectives: in the first case, the farmers were testing the relevance of the practice/variety to tackle a problem; in the second, the farmers wanted to discover the growth potential of new varieties.

Most of the time, experiments are realised on a small scale (Quiroz, 1999; Saad, 2002), a small plot for crop production or a few animals for breeding (Kummer et al., 2012; Mouret, 2013). However, Baars (2011) described how a farmer implemented his experiments on large plots for ease of work, and how he also took account of specific interactions within on-farm management such as repeated grazing.

**Management phase**

**Indicators**

In the literature analysed, farmers usually used a lot of indicators to assess their experiments. Most of them are visual (Kummer, 2011; Leitgeb et al., 2014). Mexican farmers experimenting with velvet beans in association with summer maize observed the evolution of soil fertility and
structure, soil erosion, soil moisture, weed population, and damage to maize from soil pests (Buckles & Perales, 1999). Phillips-Howard (1999) reported that Nigerian farmers experimenting with chemical fertilisers used up to 22 indicators: growth performance – germination; growth rate; penetration of soil; leaf drying - and product form - size; shape; hardness; weight; as well as market values - taste, smoothness, color, perishability, etc. (Phillips-Howard, 1999). Quantitative indicators are less frequently used. Both can be used simultaneously. For example, in Java, farmers participating in a FFS about integrated pest management both observed pest behaviour and counted the average number of pests and predators (Winarto, 1994). A Nepali farmer experimenting with a new rice variety used both qualitative indicators such as germination rates, tillering rates, developing stage, size of panicles and number of grains and a quantitative one - yield (Bhuktan et al., 1999).

Information about how farmers acquire their data is much scarcer. Sri Lanka farmers relate that they felt between their hands a smoother soil texture for assessing straw incorporation on paddy fields (Wettasinha et al., 1997). They used both visual and touching indicators. They uprooted rice plants and observed tillering rates, green intensity and roughness of leaves, and root length and resistance.

Finally, we found few papers concerning how farmers record data. According to Lyon (1996), they may keep records but most of them remember results. Leitgeb et al. (2014) showed that three quarters of the interviewed farmers in Cuba trusted to their memory and did not document their experiments. Leitgeb et al. (2010) however showed that 62,5% of the Cuban urban farmers interviewed took written notes. Kummer (2011) showed that more than half of the Austrian organic farmers surveyed documented their experiments as well.

Unexpected events
Unexpected events often occur during experiments as farmers are trying to cope with complex systems (Lyon, 1996). We consider as unexpected an event that is external (physically or conceptually) to the planned experiment and that influences conclusions in terms of evaluation or learning. However, we found few articles describing what events occurred and how farmers reacted. A farmer interviewed by Stolzenbach (1994) related how he decided to adapt his experiment: he saw that the fertilised groundnut he was testing grew very high and he was scared that the gynophore would not be able to reach the soil; he decided to earth up these groundnuts, modifying his experimental design; he then compared fertilised and earthed up groundnuts to flat culture of unfertilised groundnuts. Baars (2011) reported how a farmer followed his intuition and discovered an adequate management of clover, i.e. an additional clover harvesting in November that was not planned at the beginning of the experiment.

Conclusion phase
Evaluation of results
Little information is available about evaluations of results, most of them being implicit in articles. Leitgeb et al. (2014) showed that 60% of the Cuban farmers surveyed made direct comparisons to assess the performance and the outcome of an experiment. Almost 90% of Austrian organic farmers interviewed by Kummer (2011) used comparison to assess their results, mostly with their own experiences and those of other farmers. When trying different modalities (for example varieties), farmers may rank them (Bhuktan et al., 1999). Kummer et al. (2012) reported a farmer who classified plants between supporting and inhibiting wild plant species in a vineyard. Counter intuitive fact can be verified, for example, that fewer seeds yield
more (Bentley et al., 2010). Evaluations may occur very soon during the experiment. In Nepal, a farmer quickly dropped a treatment ‘muddy water’ because he noticed very soon that seeds sown just after puddling did not germinate very well (Bhuktan et al., 1999). Finally, farmers may refuse or accept an experiment due to labour or capital intensiveness (Bentley, 2006; Stolzenbach, 1994).

Explication of results
Explications can result from a direct interpretation between indicators and evaluation. A Nepali farmer learned that a rice variety was more suitable in the lower altitude, swampy land because it had “vigorous roots and sturdy tillers requiring ample water” (Bhuktan et al., 1999). Explications can be rather affirmative or more hypothetical: “the straw may have contributed to making the plants more hardy and less vulnerable to insects” (Wettasinha et al., 1997). Some explications can also be a base for new experimentation. For example, a Punjabi farmer who was experimenting with nursery for muskmelon explained some loss of seedlings because of the lack of nutrients and warmth. He then decided to experiment with sowing in cow dung (Bajwa et al., 1997).

As an intermediate conclusion, our framework enabled us to describe the farmers’ experiments described in the literature, but few articles were precise enough to allow full completion of the framework. That was the issue assigned to the case study.

Case studies
The framework enables us to investigate and describe the process of on-going experiments of three farmers (Figure 2).

Farmer 1: seeking for a practical solution
Farmer 1 experimented with a new biological control strategy against thrips, whiteflies and aphids under greenhouses in a mono-factorial trial. He chose to experiment with it in all of his greenhouses. This could seem unsafe but he was already unable to control pests with insecticides. Moreover he trusted the biocontrol company because he was already using some of their predators. During this experiment, he and the company expert used different indicators. “We were not looking for the same things; Macrolophus are not evident to see. We have a different approach: I was looking to see if aphids were multiplying, they were looking to see if Macrolophus were present, if they laid eggs”. At the end of the experiment, he could not be sure that the Macrolophus were entirely responsible for the good pest control because he noticed other predators. The company expert told him that Macrolophus took part in controlling pests. The farmer concluded that he had found an efficient combination of practices (introduction of Macrolophus associated with natural predators and no insecticide spraying) rather than finding if Macrolophus alone was better than chemical insecticide. This is an illustration of cases where farmers are first looking for a practical solution to a problem. They do not need to prove initial statements; an unexpected event (in this case the presence of other natural predators) is welcome if it creates a new and reproducible situation that solves the problem, even in a factorial experiment.

Farmer 2: incomplete bi-factorial experiment which opens up new questions
Farmer 2 experimented in a bi-factorial way with two clover mixes and two soils: white-purple clover on acid soil and limestone soil, and crimson clover on limestone soil. “You cannot compare those fields, even yields”. As one treatment was missing, Farmer 2 extrapolated the growth rate of crimson clover in general, regardless of the type of soil. He concluded that
white-purple clover was better than crimson clover on acid soils, whereas from a scientific perspective the conclusion would have been impossible. The conclusion is maybe influenced by practical reasons: is it possible that having only one type of clover mix to manage is more convenient and would be preferred in any case (white-purple clover developed well on both soils). Moreover, Farmer 2 was not able to measure the competition between wheat and clover because he did not compare it with a normal wheat field: “Maybe I’m not allowing for wheat competition with clover [year1] with the following crop [year2].”

Farmer 3: results spread over time
Facing a huge problem with time spent ploughing, Farmer 3 experimented with the permanent garden beds method. On the first cropping bed, he immediately had the confirmation that it was more effective and he implemented it on the whole area. A first objective (stop ploughing) was immediately achieved and could explain why he chose to experiment on a large area. A second result, concerning soil life activity was reached during the experiment, thanks to earthworms. After three years, he noticed more fungi. Other indicators concerned work ease and soil “My fields are more and more easy to work […] When it rains, all fields are flooded except mine”. Farmer 3 therefore reported that he reached his objective as regards soil life after 5 years. While innovation has already been adopted by the farmer, this experiment still provides new indicators and results compared to the initial objective of solving a problem of time.
<table>
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<td><strong>Biological control</strong> : Release of <em>Macrolophus</em></td>
<td><strong>Intercropping</strong> : Clover sown in wheat</td>
<td><strong>Cropping method</strong> : Permanent garden beds</td>
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**Design**

| Ideas, source of ideas and objectives | A biocontrol company technician suggested to Farmer 1 a generalist predator (*Macrolophus pygmeus*) that could control both aphids, thrips and whiteflies. He tested if *Macrolophus* was more efficient than chemical insecticides. | Farmer 2 wanted to direct sow clover in wheat in order to have an already standing green cover after wheat harvesting. A previous mix of 4 clovers was costly and success was variable. He tested more simple seed mixes to look for the best clover. | Already convinced by no tillage practices, Farmer 3 visited a French farm with a no-ploughing cropping method where crops were grown on permanent garden beds. He tested if permanent garden beds would allow both having more time and improving soil life on his farm. |

| Planned experimental design | One factor tested: large spectral insect control technique Two treatments: biological (*Macrolophus pygmeus*) and systemic chemical insecticide (Karate) No control. Replication : NA | Two factors tested: clover species mixes (white and purple clover mixed and pure crimson clover) and soil types (acid and common limestone-silty clay soil). Came up with 3 different treatments: crimson clover on limestone soil (x 2); crimson clover on acid soil (no replication); and white-purple clover on acid soil (x 2). 4th treatment was not tested. No control | System tested: shaping of beds with two new tools (rotovator and vibrocultor). Ridges for all crops except small ones such as carrots that were conducted on a flat bed. No walking on beds except for hard harvesting crops (potatoes). Control: previous system based on ploughing. Replication : NA |

| Size and choice of localisation | All greenhouses : half of greenhouse for each treatment | 1 ha of crimson clover on acid soil on 1 hectare, 1.5 ha of crimson clover (x2) on limestone soil, 2 ha of white and purple clover mixed on acid soil. One 2m wide strip of white-purple clover (next to crimson clover). | Whole area (1 ha). |

**Management**

| Nature of indicators and data collection methodology | **Company experts**: observed presence of *Macrolophus* during the whole season (adults, eggs and larvae). **Farmer 1** : Spotted outbreaks of aphids and observed their size evolution. In September hit a plant (tomato for example): checked if there was a cloud of whiteflies or not to estimate pest infestation level. He also observed damage on plants and length of harvesting period. No written data. | Indicators concerned mostly clover visual information collected after wheat harvesting: growth step of clover (growing or seed stage), height, colour and biomass (he estimated dried organic matter produced by clover of 1.5-2T/ha). Only sowing rates were written down. | Observed earthworms abundance (worms, castings) Soil colour, stickiness (under shoes after a rain) and smoothness Time spent How felt during action : tools ease of use Heard earthworms moving when it rained and water getting back in their galleries (suction noise after jumping on wet soil) Each permanent garden bed was represented on Excel to facilitate crop rotations. |
Other natural predators were noticed (Encarsia, ladybug) under biological greenhouses.

After a first reaping of a crimson clover on acid soil, he ploughed quickly (August) and sowed rape. But the other crimson clover fields that were reaped were ploughed later because the following crop was wheat (November). On those fields, crimson clover seeds germinated after a rain in late August and densely covered the soil.

**Results and conclusion**

In the short term, there were fewer aphids under chemical greenhouses. In the long term (season), biological greenhouses were less overrun by aphids. There was little damage on plants under biological greenhouses. Aleurods developed less under biological greenhouses. Tomatoes were harvested until November for the first time. *Macrolophus pygmeus* is more efficient at controlling both aphids, thrips and whiteflies in the long term than the chemical insecticide.

After wheat harvesting, crimson clover was dried and went to seed although white-purple clover was still green and alive. Moreover, there were less white-purple seeds in wheat: those clovers were lower and grew slower than crimson clover. White-purple clover seems more interesting.

This system took one third of the time compared with ploughing methods. Soil was easy to till on permanent garden bed, softer and not sticky. Permanent garden beds combined with ridges were darker and exhibited more microfauna. Permanent bed cultures are more suitable than the plowing system.

**Explication, what was learned**

Whiteflies and thrips are controlled in the long term by *Macrolophus* because they need time to develop. It is possible that other natural predators that were already here helped to control pests under biological greenhouses.

Crimson clover reaches flowering and seeds steps faster than white-purple clover.

Keeping fine soil on surface stimulates soil life. Ridges increase surface so increase oxygen exchange and so enhance soil life. Moreover, a furrow between ridges creates (because of shadow) a wet and fresh climate that suits soil organisms better.

**Figure 2. Description of 3 farmers' experiments using the Design, Management, Conclusions**

**Discussion and conclusion**

We now discuss the capacity of the framework to describe and understand the farmers’ experiments from the literature and the case studies.

First, in both cases it was possible to classify a specific farmer’s experiment to the factorial or system approach but farmers’ experiments do not necessarily belong exclusively to one approach. For example, the Malian farmer who tested groundnut with and without fertiliser in
Stolzenbach’s study (1994) started to experiment in a factorial way. In retrospect, we can also consider that he experimented in a systemic way: adapting the other cultural practices to the situation resulted in a new coherent system. In the same way, system experiments on individual farms can sometimes be analysed as a multifactorial experiment from a collective perspective, in which each farmer’s situation was reduced to a sum of factors and constituted a treatment (Buckles & Perales, 1999; Coulibaly et al., 2012). Moreover the degree of complexity in farmers’ experiments varies greatly (Hocdé, 1997; Kummer, 2011) from “simple trial to see, to […] experiments with scientific requirement” (De Tordouinnet et al., 2013). Classifying farmers’ experiments as factorial or systemic can be difficult when farmers do “simple trials” in an exploratory phase: as they first test only one new thing (e.g. a variety) and progressively solve the new problems arising in a more systemic way.

Second, replication was a notion quite difficult to identify in farmers’ experiments. For instance, in the case study, we do not know if Farmer 1 used each greenhouse as a replicate or if he compared each group of greenhouses treated as a whole. The same question arises for Farmer 3: is each permanent garden bed used as a replication or do they constitute a whole? Probably the difficulty in addressing the question of replication is that farmers consider them less useful as they do not try to statistically prove their experiment; the only cases of farmers replicating a cropping system experiment were correlated with a co-working with scientists (Baars, 2011; Buckles & Perales, 1999).

Third, we noted in the literature and the case study that farmers are using a lot of indicators both in factorial and systemic approaches. Simple aggregating indicators (e.g. yield) are hard to interpret alone; more precise indicators only inform a particular aspect of the experiment (e.g. root length, earthworm population). Farmers usually combine both. They use a lot of qualitative and tacit indicators during the experiment, as they do for managing their crops (Casagrande et al., 2012; Navarrete et al., 1997). Rich qualitative information is acquired that can help farmers to interpret the experiments and build new knowledge. Contrary to what scientists usually do, farmers do check every element that may impact the farm, from the field to the market. Some indicators are planned at the beginning of the experiment, while others are discovered during the experiment. The reason is that it is nearly impossible to anticipate all the interactions resulting from the implementation of a new practice. Therefore, we agree with Seamon and Zajonc (cited by Hoffmann et al., 2007) that the way farmers create and use indicators belongs to phenomenology, i.e. is grounded in direct experience.

Finally, the literature analysed is mostly implicit on what was learned during the experimentation process. Learning is rather studied from a long term perspective (Chantre, 2011; Mak, 2001). Chantre (2011) studied learning on a long time scale through the combination of multiple experiments and other ways of learning. An interesting point resulting from the case studies is that new knowledge resulted not only from the planned experimenting process, but also from unexpected events that were a source of serendipity. For example, Farmer 1 finally concluded that a combination of two predator species could control the main pests whereas he had just wanted to test if one of these species could do so. Farmer 2 discovered an unexpected behaviour of the crimson clover.

Our framework must be regarded as a tool to survey and describe farmers’ single experiments and to compare them in a more systematic way. Based on this characterisation, it is possible to initiate reflections with farmers, on how to select information to record or why the farmer did
not manage to conclude. It is also possible to discuss the conclusions alongside other farmers' knowledge and scientific results: for example, what conditions would be necessary to reach similar results or how to adapt the tested practice to other conditions? The framework could be used in farmers' groups as a participatory tool to exchange information on the on-going technical changes and to facilitate mutual learning. This potential use is being tested in a participatory project studying the social and technical innovations of farmers' groups in agroecological transition (COTRAE project, http://www.psdr.fr/PSDR.php?categ=103&lg=FR#ancre398). Nevertheless, as the framework focuses on single experiments, it should be completed by a larger analysis of the farmers' change and learning processes which are not linear (Kummer, 2011). Each experiment should be regarded as a reflexive support for further ones and an element in a larger learning process. Middle-term phenomena like experiment scaling-up (Millar, 1994; Mouret, 2013), incremental improvement of an experimented practice (Bajwa et al., 1997; Bhuktan et al., 1999) or nestedness of experiments (Kummer, 2011) are based on spatial and temporal combinations of single experiments. They should be studied to better equip the agroecological transition.
References


Better than best practice: using farmer field trials to identify adaptive management options within complex agricultural systems

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Abstract: Agricultural systems are widely recognised as being complex, dynamic, and diverse, and consisting of many uncertain or unknown components and interactions. However, management recommendations are often derived from highly controlled experiments that reduce the complex working of the system to artificially simple relationships that are typically investigated in isolation under the assumption of “all else being equal.” Such reductionist experiments are appropriate for investigating certain aspects of agricultural systems, but do not estimate the reliability or robustness of the effect of specific manipulations, which is what is implied by “best management practice” recommendations. These limitations are illustrated here through the preliminary results of an ongoing project in Senegal and The Gambia, where a network of farmer field trials tests, and largely rejects, current recommendations for rain-fed crop production, while suggesting potentially more reliable alternatives. These results also demonstrate the research value of experiments that are embedded within a complex system, both as a stand-alone method and as a part of a more integrated approach to the study of complex agricultural systems. While this approach may lead to general recommendations, it can also identify a range of potentially adaptive practices, thereby encouraging multiple adaptive pathways, a result that makes this approach particularly valuable in diverse and understudied systems.

Keywords: Complex systems, soil fertility, farmer field trials, best management practices, Senegal, The Gambia

Introduction
The concept of “best management practices” in agriculture refers to attempts by researchers to develop and prescribe broadly appropriate and reliable management recommendations to farmers. This approach is a deliberately integrated alternative to one-dimensional interpretations, and might balance productivity with input efficiency, cost-benefit analysis and environmental externalities (Ryan et al., 2012). However, the specifics and appropriateness of these recommendations are strongly dependent on the breadth, quality and relative inclusion of the researchers’ knowledge, as well as their personal bias towards certain issues, such as production over externalities or vice versa (Roberts, 2007). More critically, the output of this approach is often a specific plan that is assumed to be broadly suitable for adoption, such as an integrated fertiliser use protocol. While there might be a “right source, right place, right timing and right application method” to achieve maximum effect size or input efficiency under certain conditions, it cannot always (or even often) be assumed that there is also a single management plan that is “right” or “best” for a broad group of farmers (Giller et al., 2011; Ryan et al., 2012). The wide variation found in agricultural systems results in such diverse conditions and constraints that adopting a specific “best management practice” might be
adaptive for one farmer but maladaptive for a neighbour (Giller et al., 2009). While these integrated interpretations of agricultural systems may be improvements over one-dimensional analyses, the underlying prescriptive approach remains problematic.

The more that is known about an agricultural system, the better that recommendations can be tailored to the known system diversity and behaviour, thereby reducing the possibility of “best” recommendations being unreliably adaptive or, worse, reliably maladaptive (Giller et al., 2011). However, the less that is known, the greater the risk of inappropriate interpretations, making these recommendations potentially dangerous in relatively understudied or particularly diverse or complex systems. In some cases, the best available information may simply not be good enough to justify “best” recommendations, particularly if there is no measure of the reliability of a practice across the relevant diversity of the target system. Despite this risk, it is still common to develop and prescribe recommendations that are based on simplistic assumptions rather than sufficient knowledge of relevant system behaviour (Vanlauwe & Giller, 2006).

An alternative approach in understudied situations is to embed agricultural research within working agricultural systems to implicitly capture the relevant complexity, uncertainty, and variability of the target system (Shennan, 2008). This approach considers farmers and researchers as complimentary specialists, and is in direct contrast to the more conventional top-down model of research and extension, where farmers are not explicitly included in the former and are passive recipients of the latter. While farmer-researcher consultation is a critical component of any agricultural research, the use of farmer field trials is emerging as a rigorous experimental method and legitimate tool for investigating complex systems, rather than simply an extension strategy to demonstrate recommended practices (Snapp, 2002). This embedded strategy is currently being applied on a large scale in Senegal and The Gambia through coordination of an American university, a UK-based international non-government organisation, regional cooperative farmer organisations and hundreds of individual farmers (Table 1). This paper is a preliminary report on this project and is divided into two parts. The first is a discussion of the theoretical issues underlying this approach, with a focus on the concept of a “(complex) system perspective” as a deliberate epistemological position with implications for research design. The second part describes the project, the methods and some of the initial results. While preliminary and incomplete, these early results show the benefits of this strategy for testing prescriptive hypotheses, and reveal some trends that suggest relevant interactions and alternative options that are not well researched or recognised in the literature.

Complex systems theory and experimental methods
A system is a set of independent components that interact to produce some shared emergent properties. A complex system is one where the processes within the system and the patterns that emerge are not linear, straightforward, or otherwise easily predictable (Zeigler et al., 2000). Used in this sense, a complex system is distinct from a complicated system, which might simply have a large number of moving parts. A complex system might be ontologically complex, due to having some probabilistic or stochastic interactions, or it might be epistemologically complex, due to incomplete knowledge of the components, interactions and emergent processes of the system. Any system that requires investigation falls into the latter category and should accordingly be described and investigated as a complex system.

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The concept of a “system perspective” can be found in many of the disciplines that are highly relevant to agricultural sciences. For example, ecology is explicitly focused on the interactions among organisms rather than isolated observations, and the associated concept of an ecosystem is now used throughout the biological sciences (Odum, 1977). “Agro-ecosystem” has been used for decades to describe ecosystems that are managed to produce food and fibre, and current system perspectives on agriculture often draw from the literature on “socio-economic” and “socio-ecological” systems. (Conway, 1987; Young et al., 2006; Giller, 2013). This emerging perspective is a point of coalescence of multiple paradigms, including those that make explicit mention of systems (such as farming systems research) as well as those that do not (such as agroecology and sustainable rural livelihoods) (Chambers & Conway, 1992; Wezel et al., 2011). However, this approach has a much longer history and the term “farming system,” for example, was used in the early 1800’s to argue that the interaction of topography, climate, infrastructure and labour force made Scotland’s Orkney Islands more suited for smallholder production than large-scale industrialised agriculture (Shireff, 1814).

The adoption of a system perspective is often closely associated with an attempt to rigourously describe the system of interest, which can be referred to more specifically as system analysis. This analysis might focus on the system structure, the equivalent of a schematic diagram identifying components and potential or common interactive pathways, or the system behavior, which would be a more pragmatic description of how the system responds to various stimuli without necessarily describing the internal mechanisms (Zeigler et al., 2000; Giller, 2013). This system analysis is primarily a descriptive activity, but the resulting explicit understanding can be used to design experiments to further investigate that system.

A common approach to experimental design is to conduct manipulative studies that investigate a small number of interactions under highly controlled conditions and the assumption of “all else being equal.” This method is to deny complexity as such, as from a system perspective this “all else” can never be assumed a priori to be irrelevant to the interactions of interest. This approach is therefore reductionistic as it presumes to reduce complexity to a series of simple interactions that can be investigated in piecemeal fashion, as if a single complex three-way interaction was analogous to three simple two-way interactions.

An alternative is to design composite investigations that manipulate or measure many of the diverse components and complex interactions that have been recognised as potentially relevant to the processes of interest. These composite experiments, also known as “integrated system experiments,” are growing in popularity and improve on some of the shortcomings of the reductionist approach, but are not without their own serious drawbacks (Shennan, 2008). Being more complicated by design, these experiments are also more complicated to implement and interpret, and often require significantly higher research investment in terms of time, funding and expertise. In addition only recognised complexity can be incorporated into a composite experiment, making them, like reductionist investigations, susceptible to being undermined by unforeseen or unappreciated components and interactions. Therefore, while composite investigations are an example of applying a system perspective to experimental design, it is still accurate to describe them as an “outside looking in” perspective on complex systems.
An alternative means of applying a system perspective to agricultural experiments is through an “inside-out” or “in-situ” approach where the experiment is embedded within the known and unknown complexity of the system of interest. Unlike composite studies, these embedded investigations might focus on manipulating and/or measuring a single variable rather than multiple related variables but, unlike reductionist methods, such experiments are perturbations of a relatively intact complex system rather than manipulations of an artificially simple one. This experimental approach to complex systems is widely used in ecology to study ecosystem responses to changes in specific variables, such as with enclosure or exclusion field trials and large-scale free-air CO2 enrichment experiments (Tilman, 1989; Ainsworth & Long, 2005).

These three experimental approaches to complex systems - reductionist, composite, and embedded - are not in direct competition but rather are each well suited to different questions or interests. Reductionist investigations are appropriate for identifying if a specific interaction or effect is possible or estimating what the effect size might be under certain highly specific conditions. However, unless the system is known to be relatively simple, constant, homogeneous and well-understood, this approach cannot be trusted to estimate the overall robustness of a specific interaction or the reliability of a specific effect size across diverse conditions. The ability to more effectively do so is one of the strengths of embedded investigations, which in turn are not appropriate for estimating a maximum effect size of a specific process and not well suited for investigating potential mechanisms. Of the three, composite investigations are most apt for clarifying complex interactions and identifying the specific circumstances under which the benefits of a practice might outweigh the costs and risks associated with adoption, but they require extensive and accurate knowledge of the system to do so. These respective strengths and weaknesses are recognised by research programs that apply multiple approaches to a targeted system or specific studies that augment a reductionist or composite experiment with an embedded component, an approach that is sometimes referred to as a “mother-baby” design (Snapp, 2002). Even when this integration is not possible within a single study, embedded experiments alone can be used to test specific hypotheses such as “best management practices” and can identify robust ways to manage system behaviour even when the mechanisms of the complexity are not well understood.

**Rainfed farming systems in West Africa**

Rainfed agriculture is the primary means of both subsistence food production and income generation in rural parts of Senegal and The Gambia, with most of it occurring on sandy and semi-arid upland soils with low soil organic matter. Uncultivated fields are routinely found to have less than 1% soil organic carbon (SOC), even within only the top 5cm, while the percentage in cultivated fields is much less and can be as low as 0.15% (Tiessen et al., 1998; Peters, 2000; Elberling et al., 2003). As 0.5% SOC is globally used as a rough threshold to identify severely degraded soils that are not well suited for agriculture, it is likely that soil fertility is a common constraint in this region. In addition, there has been limited development and distribution of newly developed crop varieties, and most farmers do not have access to seed stores that might offer high quality seed stock. While traditional methods of seed preservation and exchange are still common in many areas, it is likely that some proportion of farmers in this region, perhaps especially the poorest ones, are working with low quality seed stocks or poorly adapted varieties.

The use of organic amendments, inorganic fertilisers, and high quality and locally-adapted seed stocks are therefore likely variables that can be manipulated to increase crop production,
and through that, the production-dependent aspects of food security in rural Senegal and The Gambia (Vanlauwe & Giller, 2006). While these three variables are often key components of agricultural recommendations, the interaction is not necessarily part of standard “best practice recommendations.” For example, while all three might be considered “good,” this doesn’t address how adopting a new crop variety might compare with increasing the fertilisation of the current variety. In addition, of course, the effect of any specific practice can be highly variable due to local variation in availability, soil conditions, application logistics and other characteristics of diverse agricultural systems that influence farmer practices, treatment effects and cost-benefit interpretations (Vanlauwe & Giller, 2006; Smith et al., 2011).

The current official recommendations for fertility management of upland crops in Senegal and The Gambia range from 150-200 kg NPK per hectare annually with the same rate of urea application for non-legume crops (Posner & Crawford, 1992; ISRA 2005). Specialised NPK mixes such as 6-20-10 or 8-18-27 are recommended but widely unavailable, and so often replaced by the more ubiquitous 15-15-15. These general recommendations come with no further clarification given for the relative influence of other variables that are known to be relevant to production, such as field history, socioeconomic conditions, or variation in rainfall and associated ecological characteristics. The recommendation of inorganic fertiliser is not, for example, described in association with the use of local organic amendments, despite the common cultural use of these inputs and the increasing scientific evidence of effective integration of the two (Place et al., 2003). In addition, it is not stated whether the recommended rates reflect the productive ceiling, which is the common target of agronomists, or some unstated cost/benefit calculation, such as any farmer must make.

New crop varieties are a major part of many agricultural recommendations in sub-Saharan Africa, and are often presumed to be well adapted, to the extent that they are often referred to as “improved” rather than “new” varieties. This presumption, however, is based primarily on highly controlled reductionistic studies and is rarely tested across the spatial or social variation that occurs within the scale at which they are recommended. The Gambia has limited capacity to develop or test new varieties, and while Senegal does, the rainfed crop trials occur primarily at research stations in the central Thies region (ISRA 2005, Figure 1). The local development and testing of new varieties often selectively excludes many of the stresses that are expected in farmers’ fields, such as weed pressure, intermittent drought and low soil nutrient levels, as well as relevant social and economic constraints such as labour and adoption cost.

**Farmer field trials in Senegal and The Gambia**

This ongoing project is a large-scale embedded investigation of alternative management practices for rain-fed crop production in Senegal and The Gambia, with a focus on: i) locally available organic amendments; ii) widely available inorganic fertilizers; and iii) nationally-certified seeds, which may or may not be distinct varieties from what farmers are currently planting. Instead of attempting to control for all of the known, unknown and unappreciated complexity found in this region, this two-year project establishes trials of fixed design in hundreds of independent farmer fields across the region, which are then managed by participating farmers under the supervision of project staff. These farmer-led trials are not controlled and replicated in the traditional sense that reduces and thereby denies complexity. Instead, the complexity of the system is constrained by the standardised design, training and supervision of the participants, and the trials are repeated broadly across the diversity of conditions found within the system to document the robustness of any effects.
Over 400 farmer-led trials were established in 2015 within six focal regions in Senegal and one in The Gambia (Figure 1). Four community clusters were selected within each region, with each cluster representing up to three immediately adjacent communities and the clusters spaced no less than 15 kilometers from each other and all within 50 kilometers of the primary regional population centre. The primary emphasis during 2015 was on millet, groundnut and cowpea, with secondary emphasis on upland rice, sorghum and maize.

Two trial designs were used in this project, both using a non-replicated split-plot factorial design. “Step 1” trials tested a single “new” certified variety of each crop alongside the participating farmer’s “local” seed stock and across a combination of two organic and two inorganic fertility treatments, resulting in 18 treatment plots per trial. Each treatment was 5m x 10m, for a total of 30m x 30m for each Step 1 trial. The organic treatments were millet husks, the waste of the threshing process and locally gathered cattle manure, which is often applied to fields through annual or seasonal livestock rotations. Both organic amendments were applied at 3000 kg/ha (1.34 US tons/acre), which was agreed upon by participating farmers as a rate that might reasonably be locally collected and applied by most farmers. Inorganic fertiliser was applied at the recommended level of 150 kg/ha ("high") and 50 kg/ha ("low") 15-15-15 NPK, with the same level of urea also added for non-legumes. These Step 1 trials were designed to target farmers who were producing primarily for personal consumption and had limited experience investing in their production. These are more likely to be relatively resource-poor households, who might be limited by insecure or insufficient access to land, labour and financial investments. Those farmers who might already be producing on a commercial level and experienced with investing in their production were targeted by “Step 2” trials, which compared the farmer-standard seed stock against four certified varieties that are currently available for purchase in Senegal. These trials ranged from 0.25 to 1 hectare in size depending on the crop, and both groundnut and millet were 1 hectare in total with each varietal plot 0.2 ha in size. All trial areas were demarcated by project field officers working alongside the participating farmers. The farmers were given the appropriate seeds for each trial and trained in the design and constraints of the trial, particularly the importance of managing each trial as a unit so that, for example, all plots are planted and weeded at the same time. The timing of the planting was determined by the farmer, but usually after the second or third significant rain in the region. Animal traction was used for all plantings, and hired locally as necessary. The organic amendments for Step 1 trials were collected by each participating farmer and applied under supervision just after the first rain. Inorganic fertiliser was applied by project field officers soon after emergence for the NPK and a few weeks later during rapid vegetative growth for the urea. Harvest was again supervised by field officers using local labour and consisted of all Step 1 treatment plots (5m X 10m each) and a representative 5m X 10m plot within each Step 2 varietal planting. Field measurements consisted of: i) number of productive plants or tillers; ii) fresh weight of harvest; and iii) dry plucked or threshed weight, all measured per plot.

Results are reported for millet and groundnut trials and presented here in three ways: i) as dry harvest per hectare; ii) as # productive plants/tillers per hectare; and iii) as dry harvest per plant. In the few cases where the fresh weight was available but the final dry weight was not, the latter was estimated using the mean percent weight loss with drying across all trials for that crop. The results are shown here primarily as the median percent change from the control plot, which is the “local/no organic/no inorganic” plot for Step 1 and “local” for Step 2. The Step 2 trials (varietal) are of a simpler design and the results thereby presented before the Step 1
trial (variety X organic X inorganic) results and also include the median, maximum and minimum of the harvest measurements.

**Preliminary Results**

Only a subset of the farmer field trials that were established were successfully measured during harvest (Table 2). When averaged across all Step 2 trials, the new groundnut varieties resulted in an increased yield per hectare and productivity per plant, while the new millet varieties showed the former for three out of the four varieties (Table 3). However, all three yield measurements varied by orders of magnitude for both crops. The only strong trend of the median effect size, calculated as the percent difference from the control within each trial, was an increase in yield per hectare of new groundnut varieties, and again there was dramatic variation among the trials for all measures (Table 4). The same analysis of the Step 1 trials appears to show all three management practices influencing yield in an additive fashion, such that the greatest median effect sizes come with the combination of all three (Table 5 and Table 6). This same trend is also apparent in the number of millet plants per plot, which is an indication of germination or maturation success, but is not clear in the other analyses. With only one exception (low inorganic, no inorganic, local groundnut), all treatments in the Step 1 trials on average resulted in a positive increase over the control, although without disaggregation and some assessment of variability, these trends are only suggestive.

**Discussion**

The official “best management practices” that are currently being recommended in Senegal and The Gambia regarding the use of inorganic fertilisers and certified seeds do not appear to be widely appropriate for farmers in this region. The common prescription that farmers should adopt certified “improved” seeds to increase their yield is particularly inappropriate, as the pairwise comparisons of the Step 2 trials found that new varieties of millet had, on the whole, a negligible influence on yield, while the new groundnut varieties were overall an improvement, but perhaps not at the dramatic level that is often stated or implied by the recommendation or worth the additional investment. This average effect is also no measure of reliability, and in both cases the new seeds were also sometime dramatically outperformed by the local variety.

The Step 1 trials that tested this adoption effect against alternative management options suggest that the effect of this single practice alone, which comes at a high cost for the certified seed, may often be outweighed by the potentially cheaper use of local organic amendments and locally available inorganic fertilisers. Similarly, the Step 1 trials found that while the recommended high inorganic fertility amendment on average drastically improved yield, the effect size was in fact far less than when integrated with local crop residue or animal manure. While many recommendations focus on new seed stocks and inorganic fertilisers, others focus exclusively on organic amendments, which where found in the Step 1 trials to be potentially valuable but not highly effective on their own, at least not at the rate that farmers identified as being pragmatically reasonable. Higher application rates of organic amendments are likely to have a greater effect, but would come with increased labour cost and may simply be unobtainable in some spatial and social circumstances.

This is not to say that using new seed stocks, inorganic fertilisers, and organic amendments are not potentially useful management practices, but rather that specific recommendations are not guaranteed and perhaps not even reliable. The original reductionist experiments that led
to these recommendations and the observed maximum effect sizes in these farmer field trials indicate that these alternative practices have the potential to dramatically increase yield. However, it is no more appropriate to assume from these maximums that the practices are broadly adapted and robustly effective than it would be to assume from the minimum effect sizes that they are reliably maladaptive and ineffective. The problem here is that with “best,” these alternatives are presented as simple and reliable prescriptions, whereas they are in fact something more like “optimal practices” or “sometimes best practices.” The failures of the current official recommendations to reflect the trends observed in these preliminary results should now lead to the question “well then, what IS the best practice?” In this region, as perhaps in most agricultural systems, the diversity of relevant factors might be such that there are simply no simple and broadly “best” recommendations. Strong evidence for this is the wide range of harvest measurements and effect sizes, which indicates that there are many other factors influencing the effectiveness of these practices.

An alternative strategy is to present farmers not with specific “best practices” prescriptions, but rather with alternative options, so that they can identify for themselves what might be most appropriate for their own circumstances. Such options are “adaptive” rather than assumed to be “adapted” or “best,” for this model encourages farmers to continue to adapt, alter and combine the identified practices rather than strive to adopt specific practices. For example, the recognition of the importance of high quality seed stocks can lead to multiple adaptive responses, such as stronger selection of personal seed stock, local sourcing of higher quality seed of existing varieties, or purchasing of nationally certified seed or new varieties. Similarly, the observed effectiveness of reasonable levels of locally available organic amendments and of lower than recommended levels of inorganic fertilizer suggests that these inputs have incremental value rather than a threshold for effectiveness, as might be assumed from the current recommendations.

The active role of farmers in the agricultural research can also help to identify alternative interpretations to what a scientist might conclude from the statistical results alone. For example, the failure of the millet trials in the Ziguinchor region was largely the result of birds destroying the early maturing varieties, leading the farmers to abandon the trials. However, follow up surveys found that these farmers were not overly concerned by this and were instead planning on delaying planting of early maturing varieties and/or planting larger fields where scaring tactics would be more efficient. Similarly, the higher rainfall and longer rainy season in this region has led agronomists to assume that short season crops are not needed or even not appropriate, yet many of the participating farmers recognised the potential of the new varieties to meet marketing niches, such as fresh early groundnut, and to allow for successive or relay cropping. While maximising yield or input efficiency are common targets of agronomic studies, they are only two of the many characteristics that a farmer must consider when adopting and adapting alternative management practices.

Embedded investigations are an effective stand-alone research method and particularly valuable in understudied systems, but they can also be integrated with other experimental and observational approaches. The rapid recent development of remote sensing data and spatial analysis offers powerful new observational tools, and to combine these with embedded experiments is to investigate complex agricultural systems from both within and from literally thousands of miles away. This potential integration can test the reliability of alternative practices while also identifying the variables that might be relevant, thereby providing a more
complete alternative to piecemeal and reductionistic interpretations of complexity. Soil conditions and precipitation patterns are two factors that are critical to production in the rainfed agricultural system of Senegal and The Gambia, but both are often treated in spatially simplistic ways. This region is mostly flat and formed primarily from weathered sandstone, resulting in uplands soils that are sandy and of low-organic matter by global standards and as a result considered relatively homogeneous. The latitudinal precipitation gradient is often assessed by annual mean only and classified as semi-arid or as a dichotomy between a drier Sahel ecotype in the north and a wetter Sudan-Savannah in the south. However, remote sensing data and spatially explicit estimates offer much higher resolution information of soil and precipitation, including soil characteristics at 250m resolution and decades of daily rainfall estimates at 10km (Love et al., 2004; Novella & Thiaw, 2013; Hengl et al., 2015). The resulting maps clearly show that simple spatiotemporal estimates of soil and precipitation are both inappropriate and unnecessary (Figures 1-3).

Conclusion
These preliminary results illustrate the risks associated with making general agricultural recommendations based largely on reductionistic studies of complex systems. The method presented here of using farmer field trials as a form of embedded investigation to assess alternative practices is particularly appropriate for diverse or understudied complex agricultural systems. This approach can be used to both estimate the robustness of a practice and test assumptions of how the system works. It is not, however, a replacement for other experimental and observational methods, but rather a practical compliment that can offer novel insights into complex interactions.

Acknowledgements
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References


Table 1. Organisations participating in the on-going project in Senegal and The Gambia. (The names of the Senegalese organisations are translated from French).

<table>
<thead>
<tr>
<th>Organisation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concern Universal (Senegal/The Gambia/Guinea Bissau office)</td>
<td>Non-government organisation (International, UK-based)</td>
</tr>
<tr>
<td>Senegalese Network of Farmer and Breeder Organisations (RESOPP).</td>
<td>Farmer cooperative and nationally certified seed producer (Senegal, multi-region)</td>
</tr>
<tr>
<td>The Rural Cooperative of Pambal</td>
<td>Farmer cooperative (Senegal, Thies region)</td>
</tr>
<tr>
<td>The Agricultural Cooperative of Malicounda</td>
<td>Farmer cooperative (Senegal, Thies region)</td>
</tr>
<tr>
<td>The Agricultural Cooperative of Kélle Guèye</td>
<td>Farmer cooperative (Senegal, Louga region)</td>
</tr>
<tr>
<td>The Rural Cooperative for the Inclusive Development of Missirah</td>
<td>Farmer cooperative (Senegal, Tambacounda region)</td>
</tr>
<tr>
<td>The Cooperative for Sibassor Local Development</td>
<td>Farmer cooperative (Senegal, Kaolack region)</td>
</tr>
<tr>
<td>Constructing the Peace</td>
<td>Non-government organisation (Senegal, Ziguinchor region)</td>
</tr>
<tr>
<td>Njawara Agricultural Training Center</td>
<td>Non-government organization (The Gambia, North Bank region)</td>
</tr>
<tr>
<td>Africa Geodata</td>
<td>Gambia-based spatial analysis consultancy</td>
</tr>
<tr>
<td>University of California, Santa Cruz</td>
<td>American University</td>
</tr>
</tbody>
</table>

Table 2. Number of trials included in the statistical analysis as per crop, region, and trial type, out of a maximum of eight trials per Location X Crop X Step. (Some farmer field trials were unsuccessful due to a combination of factors including insufficient training and support for some farmers, the complexity of the harvest protocol and local disturbances. All locations were grouped together for analysis but disaggregated by crop and step).

<table>
<thead>
<tr>
<th>Location</th>
<th>Millet</th>
<th>Groundnut</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Step 1</td>
<td>Step 2</td>
</tr>
<tr>
<td>Louga</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Matam</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Thies</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Kaolack</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>The Gambia</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Ziguinchor</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Tambacounda</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>23</strong></td>
<td><strong>39</strong></td>
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Table 3. Median, maximum and minimum plot-level harvest measurements for millet and groundnut Step 2 trials.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Threshed kg / ha</th>
<th># Plants or tillers / plot</th>
<th>Dry kg / 100 plants or tillers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Median</td>
<td>Max</td>
<td>Min</td>
</tr>
<tr>
<td><strong>Millet</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local</td>
<td>676</td>
<td>1690</td>
<td>281</td>
</tr>
<tr>
<td>Souna 3</td>
<td>754</td>
<td>1674</td>
<td>120</td>
</tr>
<tr>
<td>Sosat</td>
<td>640</td>
<td>2002</td>
<td>223</td>
</tr>
<tr>
<td>Gawane</td>
<td>736</td>
<td>1458</td>
<td>76</td>
</tr>
<tr>
<td>Thialack</td>
<td>816</td>
<td>1994</td>
<td>124</td>
</tr>
<tr>
<td><strong>Combined new</strong></td>
<td>740</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Groundnut</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local</td>
<td>1109</td>
<td>2292</td>
<td>42</td>
</tr>
<tr>
<td>Fleur 11</td>
<td>1300</td>
<td>2630</td>
<td>150</td>
</tr>
<tr>
<td>7333</td>
<td>1538</td>
<td>2493</td>
<td>152</td>
</tr>
<tr>
<td>55-437</td>
<td>1611</td>
<td>2840</td>
<td>200</td>
</tr>
<tr>
<td>GH 119/20</td>
<td>1392</td>
<td>2800</td>
<td>24</td>
</tr>
<tr>
<td><strong>Combined new</strong></td>
<td>1418</td>
<td></td>
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</table>
Table 4. Median, maximum and minimum treatment effect across all Step 2 trails, calculated as the % different of treatment plots from the adjacent control plot within each trial.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Threshed kg / ha</th>
<th># Plants or tillers / plot</th>
<th>Dry kg / 100 plants or tillers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Media Max Min</td>
<td>Media Max Min</td>
<td>Media Max Min</td>
</tr>
<tr>
<td>Millet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Souna 3</td>
<td>+ 2% + 300% - 59%</td>
<td>+ 3% + 140% - 62%</td>
<td>+ 1% + 69% - 70%</td>
</tr>
<tr>
<td>Sosat</td>
<td>- 14% + 99% - 75%</td>
<td>- 10% + 88% - 44%</td>
<td>- 3% + 147% - 63%</td>
</tr>
<tr>
<td>Gawane</td>
<td>- 12% + 150% - 71%</td>
<td>- 8% + 95% - 60%</td>
<td>0 + 527% - 74%</td>
</tr>
<tr>
<td>Thialack</td>
<td>+ 2% + 200% - 59%</td>
<td>+ 9% + 207% - 53%</td>
<td>+ 1% + 254% - 60%</td>
</tr>
<tr>
<td>Combined</td>
<td>- 3%</td>
<td>- 3%</td>
<td>0</td>
</tr>
<tr>
<td>Groundnut</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fleur 11</td>
<td>+ 18% + 338% - 59%</td>
<td>+ 2% + 97% - 37%</td>
<td>+ 4% + 539% - 59%</td>
</tr>
<tr>
<td>7333</td>
<td>+ 29% + 262% - 65%</td>
<td>0 + 169% - 52%</td>
<td>+ 1% + 521% - 55%</td>
</tr>
<tr>
<td>55-437</td>
<td>+ 27% + 638% - 44%</td>
<td>+ 17% + 201% - 30%</td>
<td>+ 7% + 692% - 57%</td>
</tr>
<tr>
<td>GH 119/20</td>
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<td>+ 3% + 168% - 67%</td>
<td>- 1% + 160% - 67%</td>
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<tr>
<td>Combined</td>
<td>+ 22%</td>
<td>+ 5%</td>
<td>+ 3%</td>
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Table 5. Median treatment effect across all Step 1 millet trials, calculated as the % different of treatment plots from the adjacent control plot within each trial.

<table>
<thead>
<tr>
<th>Millet</th>
<th>Threshed kg</th>
<th>No Organic</th>
<th>Millet Husk</th>
<th>Animal Manure</th>
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<tr>
<td></td>
<td></td>
<td>High Inorganic</td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>101%</td>
<td>105%</td>
<td>179%</td>
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<tr>
<td></td>
<td></td>
<td>Low Inorganic</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>53%</td>
<td>82%</td>
<td>103%</td>
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<td>No Inorganic</td>
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</tr>
<tr>
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<td>33%</td>
<td>28%</td>
<td>22%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Local Souna 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Local Souna 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Animal Manure</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>221%</td>
<td>182%</td>
<td>182%</td>
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<table>
<thead>
<tr>
<th>Millet</th>
<th># Plants</th>
<th>No Organic</th>
<th>Millet Husk</th>
<th>Animal Manure</th>
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<td></td>
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<td>58%</td>
<td>43%</td>
<td>83%</td>
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<tr>
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<tr>
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<td>21%</td>
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<td>50%</td>
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<td></td>
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<td></td>
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<td>8%</td>
<td>18%</td>
<td>23%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Local Souna 3</td>
<td></td>
<td></td>
</tr>
<tr>
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<td></td>
<td>Local Souna 3</td>
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<tr>
<td></td>
<td></td>
<td>Animal Manure</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>77%</td>
<td>102%</td>
<td>102%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Millet</th>
<th>Threshed kg / plant</th>
<th>No Organic</th>
<th>Millet Husk</th>
<th>Animal Manure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>High Inorganic</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>13%</td>
<td>25%</td>
<td>30%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low Inorganic</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>14%</td>
<td>29%</td>
<td>23%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No Inorganic</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>7%</td>
<td>1%</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Local Souna 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Local Souna 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Animal Manure</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>35%</td>
<td>33%</td>
<td>33%</td>
</tr>
</tbody>
</table>
Table 6. Median treatment effect across all step 1 groundnut trials, calculated as the % difference of treatment plots from the adjacent control plot within each trial.

<table>
<thead>
<tr>
<th>Groundnut</th>
<th>Dry plucked kg</th>
<th># Plants</th>
<th>Dry plucked kg / plant</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No Organic</td>
<td>Millet Husk</td>
<td>Animal Manure</td>
</tr>
<tr>
<td>High Inorganic</td>
<td>51%</td>
<td>108%</td>
<td>79%</td>
</tr>
<tr>
<td>Low Inorganic</td>
<td>17%</td>
<td>49%</td>
<td>65%</td>
</tr>
<tr>
<td>No Inorganic</td>
<td>29%</td>
<td>28%</td>
<td>52%</td>
</tr>
<tr>
<td>Local Fleur 11</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

# Plants

<table>
<thead>
<tr>
<th>High Inorganic</th>
<th>No Organic</th>
<th>Millet Husk</th>
<th>Animal Manure</th>
</tr>
</thead>
<tbody>
<tr>
<td>9%</td>
<td>11%</td>
<td>12%</td>
<td>11%</td>
</tr>
<tr>
<td>Low Inorganic</td>
<td>9%</td>
<td>9%</td>
<td>14%</td>
</tr>
<tr>
<td>No Inorganic</td>
<td>8%</td>
<td>7%</td>
<td>8%</td>
</tr>
<tr>
<td>Local Fleur 11</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Dry plucked kg / plant

<table>
<thead>
<tr>
<th>High Inorganic</th>
<th>No Organic</th>
<th>Millet Husk</th>
<th>Animal Manure</th>
</tr>
</thead>
<tbody>
<tr>
<td>39%</td>
<td>61%</td>
<td>51%</td>
<td>71%</td>
</tr>
<tr>
<td>Low Inorganic</td>
<td>-4%</td>
<td>34%</td>
<td>30%</td>
</tr>
<tr>
<td>No Inorganic</td>
<td>21%</td>
<td>15%</td>
<td>30%</td>
</tr>
<tr>
<td>Local Fleur 11</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Figure 1) Administrative boundaries of Senegal, The Gambia, and Guinea-Bissau and general trial locations, with each circle containing 60 farmer field trials in 2015. (The background image is the mean annual rainfall from 2001-2015 as calculated at 10km resolution from the daily estimates of the Rainfall Estimator Version 2 (RFE2), then smoothed at a higher resolution for presentation).
Figure 2. Spatial patterns of A) % sand and B) SOC organic carbon (g/kg soil) in the top 15 cm of the soil (as estimated by the Africa Soil Information Service (Hengl et al., 2015)).

Figure 3. Spatial comparison of the 2015 rainy season and the mean of 1983 to 2015 presented as: A) % difference in total precipitation and B) % difference in length of season, calculated as the number of days between the first and last day with greater than 10 mm of precipitation and correcting for outlier events. (The values are calculated at 10 km resolution using the Africa Rainfall Climatology v.2.0 (ARC2) dataset, then transformed to a higher resolution and smoothed for presentation (Novella & Thiaw, 2013). This dataset is less accurate than the RFE2, but with a longer timescale is more suitable for temporal comparisons).
Farmer experiments, agro-environmental policies and practice change

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Finnish Environment Institute, SYKE, Helsinki

Abstract: More sustainable farming practices need to be developed and adopted. Current agro-environmental policies struggle in efficiently promoting sustainable agriculture. On the other hand, many farmers experiment constantly in order to improve their practices, but the created knowledge is rarely acknowledged by formal agricultural research or extension, nor is it systematically collected to provide general lessons. Farmer experiments can be seen as a part of the creation of farmers’ local knowledge as opposed to more scientific and bureaucratic knowledge that forms the basis of policy formulation. This paper explores the role of farmer experiments in the building of their expertise and the relationships between experiments, agro-environmental policies and changing farming practices. Findings from thematic interviews with 31 Finnish farmers are provided. Farmer experiments were identified as important in translating innovative technologies and practices promoted by policies to the local circumstances. To encourage experimentation, policies need to leave sufficient room for local adaptation while encouraging practice change. If collected in a systematic manner, farmer experiments could be an important source for improving the policies as well as facilitating the spreading of environmentally friendly practices.

Keywords: Experimentation, farmer innovations, local knowledge, knowledge systems, agro-environmental policies, cultivation practices

Introduction

Farming is always site specific. It is performed at a unique setting regarding fields, crops, weather and farmer’s purposes. Generic rules or technologies developed in agricultural science are rarely directly applicable in the local context without being translated to the particular circumstances. Without translation and modification, they can easily be rejected as unfit for the current practices and purposes of the farming system (e.g. Noe et al., 2015). Similarly, the making of environmental policies and regulations often ignores the local specificities. This can result in failures in agro-environmental policies (e.g. Morris, 2006; Riley, 2008; Bartel, 2014).

Farmers have valuable knowledge built experientially over the years and previous generations (Millar & Curtis, 1999; Baars, 2011), but their knowledge is informal in comparison to more explicit scientific or bureaucratic knowledge. This local knowledge goes under many slightly differing terms such as tacit, implicit, vernacular, indigenous or traditional knowledge (Raymond et al., 2010; Bartel, 2014). The divisions between different knowledge types are somewhat arbitrary, since a person’s knowledge is always hybrid, combining different ways of knowing. The cross distinction between scientific knowledge constructed using scientific methods, bureaucratic knowledge constructed in policy making and implementation processes, and local knowledge production types is however useful in pointing out the varying ways of knowledge production and legitimisation (Morris, 2006; Raymond, et al., 2010). Scientific knowledge is based on scientific rules and processes, farmers’ knowledge is constructed via
their own knowledge systems and policies are based on the bureaucratic knowledge system (Morris, 2006). These discrepancies in the knowledge systems make policies seem distant and unreliable from the farmers’ perspective (and sometimes from the scientists’ perspective as well). Riley (2008) has suggested that understanding farmers’ ways of knowing and how these affect farmers’ perceptions of practices promoted by agro-environmental policies can facilitate policy design and implementation. One way of increasing this understanding is to focus on the experimental nature of farming.

A farmer’s experience with his/her fields is a result of ongoing experimenting and following learning in order to improve livelihood. Especially in the developing country context, it has been noted that many farmers experiment constantly to improve their farming practices (e.g. Bentley, 2006). Following Sumberg and Okali (1997), I argue that experimenting is a central process for the creation of local knowledge among farmers. By focusing on their experimentation process, it is possible to scrutinize knowledge creation and assess the knowledge discrepancies causing policy failures. The role of experiments in creating local knowledge and mediating policies has not been explored previously. Analysing Finnish farmers’ arable farming practices, the following research questions are asked: how do farmers build new knowledge via experimenting?; what is the role of policies in the experimentation processes?; and could building on farmer experiments be a way to improve the policies?

In line with Kummer et al. (2012) I define farmer experiments loosely as a process where something totally or partially new is introduced at the farm and the feasibility of this introduction is evaluated. In the analysis, experimentation refers to both planned and non-planned situations, where lessons are learned from observing the initial situation, making treatments and observing and monitoring the results (Hoffmann et al., 2007; Kummer et al., 2012).

Farmer experiments mediating knowledge asymmetries

Farmer experiments as livelihood experiments

Farmer experiments differ from more formal scientific or more applied innovation experiments which are focused on developing pre-determined solutions in an organised manner (Huttunen & Zavestoski, 2016). These so-called local livelihood experiments or folk experiments (Bentley, 2006), i.e. experiments that are performed in everyday life to improve one’s livelihood are (re)gaining attention in farming systems’ studies (Maat, 2011). Farmer experiments have been approached via the call for participatory research, acknowledgement of farmers’ local knowledge and the need to co-create innovations rather than disseminate information from science to farmers (e.g. Hoffman et al., 2007; Baars, 2011). Especially in the developing country context, farmer experiments have gained interest as a method of developing and spreading agricultural innovations (e.g. Bentley, 2006). In a more developed country context, farmer experiments are related to the development of unorthodox methods, which have initially not been promoted by the extension services. Typically, these include organic farming and no-till, which were developed via farmer experiments and exchange of knowledge via farmer networks, as no information was available apart from other practising farmers (Ingram, 2010; Goulet, 2013). In fact, all agricultural research has its roots in farmer experiments; only the increasing complexity and methodological organisation of agricultural science have distanced research from farmers working on their fields (Maat, 2010).

Farmers have different styles for experimenting and the degree of experimentation varies among them (e.g. Lyon, 1996; Bentley, 2006; Vogl et al., 2015). Livelihood improving
experiments need not be encouraged by advisors or scientists, but many farmers conduct them as a part of normal farming activities (Bentley, 2006; Munya and Stillwell, 2013). The experiments can be accurate, resembling scientific style in their design and management or they can be accidental implying that the experimenting farmer was not initially aware of conducting an experiment (Kummer et al., 2012). The experiments can be directed to solving a single, even incremental problem or towards wider transformative development of the farming system (Bentley, 2006). In the latter case, several consecutive experiments are conducted over a longer time-period to reach the development target via trial-and-error adjustment (Ingram, 2010).

Farmers evaluate the results of their experiments taking into account diverse observed factors and drawing from their local knowledge developed over the years of farming experience encompassing previous generations and neighbouring farmers (Lyon, 1996; Vogl et al., 2015; Baars, 2011). The results are discussed in farmer networks, leading to co-creation of new (local) knowledge (Goulet, 2013; Dolinska & d’Aquino, 2016) facilitated by farmers’ readiness to trust information obtained from other farmers (Hoffmann et al., 2007). The holistic evaluation style and implicit sharing of results suggest two major advantages in farmer experiments compared to top-down policy steering and extension: the knowledge created experimentally is adapted to the local circumstances; and it easily spreads in existing farmer networks facilitating its adoption.

**Experimentation and environmental policy**

Farmers perceive agro-environmental policies from the perspective of their local, practical knowledge (Riley, 2008). As new policy measures are introduced, farmers need to decide whether and how to implement them. The policies can appear far-fetched from the farmers’ perspective if the policies rely strongly on other knowledge systems. Farmers can find their knowledge superior to that of the government because it is more practical, evidence-based and effective (Bartel, 2014). They possess their own systems for the legitimation and production of knowledge (Morris, 2006; Goulet, 2013). In comparison, the knowledge systems used in making policies or science are unfamiliar to farmers making the knowledge produced seem non-transparent and invalid in the local context. This can lead to direct rejection of introduced policy measures and farming practices they promote.

The discrepancies between the different knowledge systems have been approached by bringing the scientific knowledge production closer to the production of local knowledge. Participatory and transdisciplinary research projects have managed to combine the different knowledge making processes and create new hybridised knowledge (e.g. Misiko, 2009; Nguyen, et al., 2014) and the ideas of co-creating knowledge and increasing dialogue and knowledge brokerage have been adopted in extension and innovation (e.g. Millar & Curtis, 1999; Klerkx & Leeuwis, 2008). From the policy perspective, the discrepancy has been approached by pleas to better incorporate farmers’ perspectives in the policy-making processes and to make the policies more fitting to farmers’ practices and purposes (Riley, 2008; Burton & Schwarz, 2013). In addition, attention has been paid to facilitate the internalisation of the policies by farmers via enhanced education and co-learning processes (Lobley et al., 2013; Stobbelaar et al., 2009), which connects the issue back to increasing participation in agricultural science (Nguyen et al., 2014). Experimentation provides a new angle to the debate by providing a broad arena in which the social learning can occur (c.f. Nguyen et al., 2014). Farmers mix the knowledge systems via experimentation drawing ideas and discussing results in their networks (Munya & Stillwell, 2013).
Thus, if the agro-environmental policies are mandatory or despite the far-fetchedness seem lucrative, due to monetary compensations for example, a process of implementation starts. This can be seen as an experimentation process. When farmers start experimentally implementing the policies by adopting the promoted farming practices, they incorporate the knowledge the policies provide to the creation of their own locally based knowledge. In this way experimentation functions as a process of knowledge integration, where farmers incorporate the knowledge implied in the agro-environmental measures into their own knowledge system finally resulting in modified or newly performed farming practices (Fig. 1).

![Figure 1. Framework for analysing the role of experimentation in the adoption of policies at the local level.](image)

I use this framework to analyse the role of experimentation in Finnish farmers’ farming practices and implementation of both voluntary and non-voluntary agro-environmental measures applied in the country via rural development programmes between 1995 and 2014.

**Data and analysis**

The analysis is based on 31 qualitative interviews of Finnish farmers, representing different locations, farm sizes and production lines. A detailed description of the data is available in the article by Huttunen and Oosterveer (2016), see also Table 1. The interviews were conducted during fall 2014 and they lasted from one to three hours. The thematic interviews focused on farmers’ arable farming practices, their changes during the past 20 years and the role of agro-environmental policies in these changes. Experimentation and learning emerged as an important category discussed with the farmers and the analysis derives mainly from this part of the interviews. In the analysis, the issues the farmers themselves identified as experiments were considered as experiments.

The analysis followed content analytical methodology (Mayring, 2004). The interviews were analysed qualitatively in two phases with a small quantitative element to describe the different experiments (Table 1). In the first phase, the transcribed interviews were read through while searching for specific experiments. These experiments were then scrutinized to identify their motivation, source of idea, design, innovativeness and results. These were classified under categories developed based on the identified issues and existing literature on farmer experiments (e.g. Vogl et al., 2015) (Table 2). In the second phase, the focus was reverted to the whole interviews to enable a deeper understanding of the farmer’s learning and
relationship between policies and experimentation. The following questions were posed at the interviews: how does the farmer build his or her knowledge?; and what is the relationship between experimenting, learning, practice change and policies? (Figure 1). The analysis was made with the help of an Excel spreadsheet, facilitating the collection of the relevant information from each of the interviews into shorter descriptions and enabling categorisation and comparison.

**Farmer experiments in Finland**

Experimenting was quite common: in total 18 out of the 31 interviewed farmers told about having experimented and 43 experiments were described at varying levels (Tables 1 and 2). The majority of the farmers told about one or two experiments, but up to six experiments were touched upon in an interview. The number of experiments discussed does not provide accurate number of the experiments actually performed at the farms as it was unlikely that the farmers remembered or found it necessary to describe all their experiments.

**Table 1. Experiments at different farms and (socio-economic) characteristics of the farms studied.**

<table>
<thead>
<tr>
<th></th>
<th>Experimenting farmers (18)</th>
<th>Total farmers (31)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of experiments in a farm</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Median</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Maximum</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td><strong>Farms by area</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uusimaa</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>Southwest Finland</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>Ostrobothnia</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>Cereal, ley or vegetable</td>
<td>7</td>
<td>16</td>
</tr>
<tr>
<td><strong>Farms by production line</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dairy</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Other animal husbandry</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td><strong>Farms by field area (ha)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>Median</td>
<td>70</td>
<td>70</td>
</tr>
<tr>
<td>Maximum</td>
<td>161</td>
<td>214</td>
</tr>
<tr>
<td><strong>Farmer's age (years)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>29</td>
<td>29</td>
</tr>
<tr>
<td>Median</td>
<td>47</td>
<td>49</td>
</tr>
<tr>
<td>Maximum</td>
<td>66</td>
<td>66</td>
</tr>
<tr>
<td><strong>Gender of the interviewee</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>11</td>
<td>21</td>
</tr>
<tr>
<td>Female</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Farmer couple</td>
<td>5</td>
<td>8</td>
</tr>
</tbody>
</table>
In general, the identified experiments were about improving the farming system by either searching for solutions to particular problems, or finding new ways to make agricultural production more efficient. This reflected in the motivations behind the experiments, which usually related to a desire to improve the economic result of the farm (Table 2). However, not all experiments aimed simply at economic benefit. Curiosity towards new issues was an important motivator, often connected to other motivations. In particular the farmers who experimented often regarded it as important to always try out new things and apply them at the farm level to see if they really work in practice. Other motivations also involved a desire to improve the environment, the soil or to help other farmers. Policy-measures had directly motivated the experimenting in five cases, but they had indirect effects on many other experiments (see below).

Table 2. Diversity of the 43 identified experiments summarised.

<table>
<thead>
<tr>
<th>What was the experiment about?</th>
<th>30% (13)</th>
</tr>
</thead>
<tbody>
<tr>
<td>New crop/ crop mix</td>
<td></td>
</tr>
<tr>
<td>Fertilisation</td>
<td>21% (9)</td>
</tr>
<tr>
<td>No-till/ reduced tilling</td>
<td>12% (5)</td>
</tr>
<tr>
<td>Green manure</td>
<td>9% (4)</td>
</tr>
<tr>
<td>Adding organic/inorganic matter to the soil</td>
<td>7% (3)</td>
</tr>
<tr>
<td>Plant protection</td>
<td>5% (2)</td>
</tr>
<tr>
<td>Other (e.g. separating manure, calculating nutrient balance, microbial additive to seeds)</td>
<td>16% (7)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Motivation (multiple reasons apply)</th>
<th>37% (16)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Directly improving the economic result:</td>
<td></td>
</tr>
<tr>
<td>Saving capital</td>
<td></td>
</tr>
<tr>
<td>Improving yield</td>
<td>26% (11)</td>
</tr>
<tr>
<td>Curiosity</td>
<td>33% (14)</td>
</tr>
<tr>
<td>Improve fields/ soil</td>
<td>21% (9)</td>
</tr>
<tr>
<td>Saving labour</td>
<td>16% (7)</td>
</tr>
<tr>
<td>Available subsidy</td>
<td>12% (5)</td>
</tr>
<tr>
<td>Other (environmental change, improve the environment/reduce emissions, help someone else)</td>
<td>7% (3)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Where did the idea come from? (multiple sources apply, in some cases no source was identified)</th>
<th>23% (10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Promoted/suggested by another farmer (incl. contractors)</td>
<td></td>
</tr>
<tr>
<td>Agricultural advisor, or project</td>
<td>19% (8)</td>
</tr>
<tr>
<td>Read about it from a magazine</td>
<td>16% (7)</td>
</tr>
<tr>
<td>Own idea</td>
<td>12% (5)</td>
</tr>
<tr>
<td>Policy recommendation/ option</td>
<td>12% (5)</td>
</tr>
<tr>
<td>Commercial agent</td>
<td>12% (5)</td>
</tr>
<tr>
<td>Agricultural Education</td>
<td>5% (2)</td>
</tr>
<tr>
<td>Other (visit abroad, previous work experience, suitable machinery)</td>
<td>7% (3)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Design</th>
<th>49% (21)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct application to a small area</td>
<td></td>
</tr>
<tr>
<td>Direct application to a large area</td>
<td>16% (7)</td>
</tr>
<tr>
<td>Serial experiments with modification</td>
<td>21% (9)</td>
</tr>
<tr>
<td>Comparison on parallel fields</td>
<td>7% (3)</td>
</tr>
<tr>
<td>Accidental</td>
<td>5% (2)</td>
</tr>
</tbody>
</table>
The experiments mainly involved adoption of existing technologies, crops or practices not previously used at the farm. The experimented issue could be quite common among other farmers, or it could be rare, such as applying a recently developed product or no- and reduced tillage in their early development phases. In these cases, the experimenting involved finding out whether the issue fits the conditions at the farm and making the required modifications to improve the compatibility. In three cases, farmers developed a new issue or made a new kind of application for an old method. These were about fertilisation and preventing water pollution.

Farmers designed their experiments to varying levels. The most common method was simply to try something out on a small parcel of land or in such a way that the potential failure would not mean significant financial loss or other problems severely hampering the functioning of the farm. In some cases, farmers directly employed a larger land area, but then they were quite certain of the success of the experiment beforehand based on the experiences of other farmers. Farmers could also design the experiments to resemble formal trials comparing parallel fields for example. If the first experiment provided successful results, the farmers often expanded the experiment and developed it further, potentially leading to full adoption of the new practice. In two cases the experiment was initiated by accident and resulted in a discovery of a suitable practice.

Farmers evaluated their experiments based on their own observations on the growth of the fields, soil structure, the level of yield and the amount of weeds, depending on the subject of the experiment. Many discussed and exchanged results with neighbouring farmers and recommended good practices to others. Hence, farmers did not experiment in isolation, but they benefitted from the knowledge of neighbouring farmers or other farmer-friends. Farmers also discussed the results with agricultural advisors and retailers, but their knowledge was perceived in relation to their practical experience as farmers (c.f. Hoffman et al., 2007). Experimentation was a co-learning process, where new knowledge was produced discursively comparing experiences and practices between different farms. It has been suggested that the discussions with other farmers create a space for the generation of new knowledge via the generation and reinforcement of new discourses (Dolinska & d’Aquino, 2016).

The described characteristics of the experiments are well in line with farmer experiments described elsewhere, including those in both developed and developing countries (e.g. Vogl et al., 2015). The particular role of policies as motivation and a source of ideas, however, is rarely scrutinized in previous literature.

**How experiments translate policies into practices?**
The interviewed farmers emphasised learning by doing. Knowledge was built over the years by observing fields under different weather conditions, while cultivating different plants and

<table>
<thead>
<tr>
<th>Innovative scale of experiment</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adopting new technology/crop/practice at the farm</td>
<td>56% (24)</td>
</tr>
<tr>
<td>Adopting new rare technology/crop/practice at their farm</td>
<td>37% (16)</td>
</tr>
<tr>
<td>Creating a completely new or significantly modifying a technology/crop/practice</td>
<td>7% (3)</td>
</tr>
<tr>
<td></td>
<td>New technology/changed way of doing</td>
</tr>
<tr>
<td></td>
<td>No clear result/ more experimenting required</td>
</tr>
<tr>
<td></td>
<td>Failure</td>
</tr>
</tbody>
</table>
using different farming techniques. This also made the created knowledge manifestly local and applicable only at the particular farm or in its proximity. The creation of experiential knowledge was slow and the farmers emphasised that one never stops learning. As described by Hoffman et al. (2007), farming is a life-long case study or a continuous experimenting process, where results are composed holistically in relation to time and space. Many farmers did not connect their experimenting directly to policies, but were highly motivated to develop their farming and saw policies more as hampering their endeavours than facilitating or promoting them. However, policies clearly had induced experimenting; they were translated into local practices and knowledge via experimentation in the various settings.

**Policies inducing experiments**
The interviewed farmers considered new issues in relation to their local knowledge. Introduced policy measures did not easily shift the understanding of proper and functioning ways of farming, hence there was reluctance and a feeling of misfit regarding the policy measures as reported in previous studies (Morris, 2006; Riley, 2008; Bartel, 2014). However, policies provided a motivation via subsidies and requirements, and induced experimentation to test the possible ways to implement the policy demands. The interviewed farmers described many areas where experimentation with new practices related to changes in policies. Common examples are no-till related to the requirement to increase plant cover during winter and reducing fertilisation. A young farmer explains how the plant cover demand induced them to experiment with winter crops:

“We started cultivating winter grain due to the environmental support, one reason was the high price of rye and the other was the requirement for plant cover in winter. And we wanted to experiment with them, because we had never tried them before, to see how they succeed”. (B1)

Usually the policy induced experimentation resulted in the adoption of the promoted farming practices, but also more ambitious development of new farming systems, like no-till. Not all the experiments were successful and some farmers rejected the new methods as unadoptable at their farms.

The policies could also support experimentation and development work in subjects not directly related to the particular policy measure. For example, one farmer was continuously experimenting related to different means to improve the structure of soil on his fields. He benefitted from the subsidies to establish a wetland and utilised the topsoil removed during the establishment of the wetland to improve his clay fields. In similar vein, farmers selected optional policy measures based on their predicted fit to their existing farming system. This limited the potential scope of policies to induce experimentation on new issues. As was evident from the evaluation of experiments, farmers consider their farm holistically, and the changes need to work well in relation to multiple interconnected farming practices. An older vegetable farmer describes his decision-making related to optional environmental measures:

“Largely we have taken the actions, which won’t require any radical modifications to our practices. That they wouldn’t make it impossible to do some important cultivation measure. This means that we have looked at what we can do and then tried to improve it and fit it to the environmental measures”. (A2)
The knowledge building initialised by policies can also be hampered, if the regulations are too tight and leave no room for experimentation, or if new technologies cannot be adopted in the first place because of the regulations.

“There were these requirements related to how deep you can till, it was something like 13 centimeters, nobody can measure it, and there is no machine that can do it precisely the way the requirements demanded. These kinds of ridiculous requirements should not exist". (B2)

The fear of new restrictions and the resulting change can also keep farmers from committing to the means, but they may still experiment on related issues.

**Policies mediating knowledge**

Experimentation provided the means to slowly build new knowledge via combining local and scientific knowledge. A farmer growing vegetables describes the development of his fertilisation activities with respect to the policy demands to reduce fertilisation:

“I have continuously questioned it (fertilisation reductions demanded by agro-environmental policy), that does it really work. We developed the system via fertilising the crops several times, which helps in getting the right nutrient to the right place at the right time. In this way the reduction of fertilisation begun. Then we used soil fertility analysis to monitor the remaining amount of phosphorous. The figures were wild; in principle we should not have needed to utilise phosphorous at all. Then we tried it on a couple of small fields, where we did not use phosphorous at all. But we had to revert to giving part of the plant’s phosphorous need at each fertilisation time to make the plant feel well, so that it could utilise the phosphorous in the soil”. (A2)

The farmer had high motivation for reducing the environmental impacts of his farming practices. He had internalised the need to reduce fertilisers, prevent pollution and connected these to his motivation to reduce cultivation costs. He tested the knowledge on the functioning of reduced fertilisation promoted by policy. In doing this, he used scientific knowledge provided by the soil fertility measurements and his own observations on plant growth and modified his practices accordingly. This resulted in a new fertilisation system, which demonstrated increased knowledge of the nutrient needs of the plant.

The farmer evaluated the fertilisation system mainly to produce healthy plants. Also, the success of the experimenting with different new systems (such as green manure, reduced tilling or manure injection) were evaluated and modified based on the improvement of the farm economics and overall improvement of the farming system, not in relation to the environmental benefits. Hence, successful experiments performed in order to accommodate policies do not necessarily mediate scientific knowledge related to the environmental impacts of farming, but they can simply translate the policy measures into local knowledge (c.f. Nguyen et al., 2014). This is the case especially if the reasons or scientific understanding behind the promoted measures are not made explicit to the farmers or if the farmers do not understand them. The search for (economic) farming system benefits resulted in some disappointments related to the policy measures and the questioning of their appropriateness. A cattle farmer explains his selection of the measure on specifying nitrogen fertilisation:

“Farmer: we have selected the measure on precise nitrogen fertilisation."
Interviewer: Do you remember why you selected it?

Farmer: the idea was to select everything, which even in theory can reduce fertilisation costs, but as we have the tools for the measurements and we have made the analyses, it feels a bit frustrating. We have not found any high values indicating that we should drop the fertilisation level”. (C3)

The farmer felt the measurement was useless, a waste of time, because it induced no further development with potential savings in fertilisation costs. The knowledge itself was not important to him.

Higher education helped some farmers to understand what lies behind the policies instead of mere mechanical implementation. Higher education provided farmers with tools to develop their farming: enhanced experimentation style; measurements to support their observations; and increased openness and boldness in testing and searching for new ideas. A cattle farmer with considerable crop production also emphasised that education was important in helping him to understand policy requirements:

“I think the university education has affected me in such a way that I don’t have any threshold to trying anything, not as high a threshold as my parents had. It has somehow widened my world view, given me the ability to experiment and ensured that the initial reaction is not rejection… It has probably given the so-called scientific world view, so that I believe research results and let them influence what I do. It also means that when there are all these instructions and regulations in the environmental support system, I have a better chance of understanding the background and reasons for their existence”. (B8)

The relationship between understanding and embracing the purposes of the policy measures and the experimental farming style appears crucial in improving environmental policies (see also Stobbelaar et al., 2009). Currently, the policies do not promote experimentation and innovation to better reach the policy aims, but merely to fit the policies to the farming systems. The potential learning effects to merge scientific knowledge with local knowledge via policy-induced experiments do occur, but policies could benefit much more widely from farmers’ experiential learning and innovation potential.

Policies to enable experimentation
The results suggest two improvements for the policies: i) focus on facilitating the understanding of the policy aims and their internalization; and ii) enable experimentation to reach the policy aims. A farmer couple discussed the role of motivation and understanding in implementing agro-environmental policies:

“Farmer 1: I believe that a better way is that the person who actually is taking the actions, that he has a motivation and a personal goal. And that it can be influenced. For example, if you think about the environmental issues, that we would want to care for the environment. It does not happen by handing out 10 orders saying that you need to do this and this and this. That only results in opposition, especially here in Finland.

Interviewer: You mean that you would need to understand why you are doing the things, and that there is a concrete purpose?

Farmer 1: Yes, exactly
Farmer 2: That would work better here, I’m sure of it.
Farmer 1: These are related to the fact that currently the understanding is not facilitated, orders are just delivered: draw a line to the wall at this date.
Farmer 2: You don’t need to know anything, just do these things. This is the attitude related to subsidies. It is none of your business, just carry out the actions. The spreading of information is second-rate”. (A4)

The importance of farmers’ understanding on why certain environmental measures are required and motivating farmers to take environmental actions are widely acknowledged (e.g. Stobbeelaar et al., 2009; Burton & Schwarz, 2013; Nguyen et al., 2014). Farmers’ experimental development of their farming systems brings about a new dimension for its importance. Experimentation is mainly done in order to improve the farming system, hence the motivation and understanding is crucial. Selecting the policy measures which were the most natural from the point of view of the farm, which would be done anyway, or which would imply the least harm, have not necessarily encouraged innovation or thoughtful implementation. However, the cases where the aims of the environmental support system were internalised demonstrated how new innovative systems can be developed going beyond the mere adoption of a required action.

The understanding and adoption of the policy aims is not sufficient, if the policy measures enable implementation only in a strictly defined manner. A cattle farmer explains:

“I think that we should create opportunities for action, so that the system would steer the opportunities in such a way that it would pay off to do certain things… so that a farmer could make supported choices to develop his farm holistically”. (C3)

There should be an incentive in the subsidies to actively develop farming instead of merely restrictions and punishments. The experiments related to policies were not very innovative, but often related to application of quite common methods. This is partially due to the small room for development available in the fixed policy measures.

To go beyond mere adaptation of the suggested technologies, the key issue is either the internalisation of the aims promoted by the policies or the openness of the policies themselves to allow for the development of the systems. Recent studies have pointed out how agro-environmental schemes can eventually lead to internalising at least some of the environmentally beneficial aims (e.g. Huttunen & Peltomaa, 2016). The development of the so-called result-oriented agro-environmental measures can provide a means for further opening space for experimentation within the policy measures. These measures subsidise farmers for the measured amount of environmental benefits they produce, not merely for performing a certain pre-defined action (Burton & Schwarz, 2013). Hence, they leave room for farmers to invent ways to produce the benefits, while also contributing to the internalisation of the understanding and motivations related to the environmental benefits. For experimentation to occur, an emphasis on enabling resources rather than strict guidelines is important.

Conclusions
Farmers learn by accumulating experience, and experimentation is a central process used for this learning. The interviewed Finnish farmers experimented in different ways and to a varying extent. Experimentation provides a means to accommodate new knowledge and practices promoted by policies and policies provide inspiration for experimentation. This efficiently
domesticates new practices and can result in the creation of new innovative practices. Experimentation provides a means to distribute innovations at the ground level and develop them further to meet the requirements of different kinds of farms. Thus, building on farmer experiments provides an interesting way to improve agri-environmental policies.

The results highlight the importance of farmers’ motivation to achieve the environmental improvements and understanding of the reasons and scientific mechanisms behind the policies, resulting in experimenting incorporating scientific knowledge and a better functioning of the policies. Without proper attention on the creation of understanding of the environmental aims and mechanisms behind the policies, the experimental implementation by farmers risks losing its potential to create new environmentally beneficial practices. Rather, the experimentation merely accommodates the policy measures (not the aims) to the local knowledge.

Experiments can also lead to new innovations which should be taken into account in policy-making. It is important to collect experiences from farmer experiments and applications of existing technologies at different kinds of farms. This could be combined with advisory services and development projects aiming at advising and changing farmers’ practices. The collection of experiments would be valuable especially as the resources for agricultural research are diminishing, but also because the translated knowledge can be more useful for farmers than results from scientific research. In the future agro-environmental policies would benefit from promoting experimentation for the implementation of policy aims and taking into account experimental innovations in policy design.

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References


Sparking small scale dairy farmers’ enthusiasm within a transdisciplinary project in Kenya

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Abstract: Small-scale dairy farming systems in Kenya are low-external input systems and therefore show a high context dependency. As most small-scale farmers have low capital endowment and have poor access to new information, they often do not see chances to improve their situation on their own. Fostering change in such systems requires methodologies that give farmers voice in the research process and that integrate and expand farmers’ knowledge and capacities, leading to improved action. As part of a transdisciplinary research project, two small-scale dairy farmer groups in Nakuru-County Kenya engaged in a collaborative learning process. This article seeks to analyse the processes that contribute to successful facilitation of farmers’ experimentation and innovation. We want to understand how enthusiasm was triggered, maintained, or suppressed. Enthusiasm is defined as a desire to engage with practices that draw on the energy, imagination and ideas of an individual or group (Russell & Ison, 2000). We found that enthusiasm played a role throughout the four collaborative learning phases, i.e. establishing the collaboration, dialogue, discovery and application. Democratised research relationships sparked enthusiasm during the steps of establishing the cooperation and dialogue, while a sense of progress and success maintained it during the steps of discovery and application of new knowledge. The article concludes by stressing the importance of new forms of research, such as transdisciplinary research, that include local actors, i.e. those that can change the system by changing their actions as partners in a knowledge creating dialogue.

Key words: Transdisciplinary research, enthusiasm, farmer-led experimentation, innovation system, Nakuru County, Kenya.

Introduction

Smallholder farmers in Kenya have limited physical and financial capital to improve production conditions. For this reason, smallholder farming systems are also referred to as low external input systems. Such highly context dependent systems are characterised by multiple human-environment interactions over space and time. Agriculture itself represents a co-evolution between society and environment (Bacon et al., 2012). Thus, any attempt to bring about sustainable change in agricultural systems requires a social-ecological analysis, i.e. an analysis that considers how agriculture produces landscapes that are social, cultural and ecological (Cronon, 1996). In agricultural systems, social-ecological analysis focuses on how farmers deal with variability and change and how this change occurs at the individual and the collective level (Coughenour, 1984). Hence, when analysing such coupled systems there is an emphasis on understanding agriculture as a human activity system, i.e. a system established and managed by farmers with their actions and knowledge (e.g. Bawden et al., 1984; Woodhill & Röling, 1998; Dillon, 1992; Valentine, 2005; Caporali, 2007; Halliday & Glaser, 2011; Kaufmann, 2011; Bacon et al., 2012; Blythe, 2012; Lescourret et al., 2015; Kaufmann & Hülsebusch, 2016; Moraine et al., 2016; Restrepo et al., 2016).
As most small-scale farmers generally have low capital endowment and are often isolated from networks of regional and global communities, i.e. have poor access to outside information, they often do not see chances to improve their situation on their own. Fostering change in such systems requires methodologies that integrate and expand farmers’ knowledge and capacities, leading to improved action. The contextuality of smallholder farmers’ systems calls for transdisciplinary research, i.e. open to real world actors. In transdisciplinary research approaches diverse knowledge systems bring multiple perspectives (from academic, practitioner and other societal actors) and enable a better understanding for finding applicable solutions to real world problems (Stokols, 2006; Lang et al., 2012). Consequently, contemporary approaches to generate practically relevant knowledge take into account the local context and address real world actors’ perspectives (including researchers) of the problematic situation through dialogue.

As part of a transdisciplinary research project, two small-scale dairy groups in Nakuru County, Kenya engaged in a collaborative learning process. Groups were invited to apply for farmer-managed innovation funds. The funds were directed at learning about, and experimenting on, key constraints in the farmers’ agricultural system, i.e. to stimulate farmer-led experimentation without individual farmers bearing the financial risk of experimentation. Hoffman et al. (2007) acknowledge the power of informal modes of farmers’ experimentation, while Wettasinha et al. (2014) stress the importance of experimentation that uses only local resources in innovation development with marginalised smallholder farmers. Farmer-led experimentation is defined as the process by which farmers conduct informal trials or tests that can result in new knowledge (Rajasekaram, 1999 cited in Leitgeb et al., 2014). We chose to work with a transdisciplinary approach in this research with farmers because: (i) one-size fits all solutions are not useful in context dependent systems; (ii) we acknowledge the importance of arriving at a common understanding of the problematic situation with all involved actors; and (iii) solutions identified and implemented with real world actors are more sustainable. This article seeks to analyse the processes that contribute to successfully facilitating farmers’ experimentation and innovation. Within a collaborative learning process, we want to understand how enthusiasm is triggered, maintained, or deterred in a collaborative learning process that promotes farmer-led experimentation. We pursued this line of inquiry with two dairy farmers’ groups in Nakuru County, Kenya. Enthusiasm is defined as a desire to engage with practices that draw on the energy, imagination and ideas of an individual or group (Russell & Ison, 2000).

**Materials and methods**

**Study site**

The study area is located in Nakuru County in the Rift Valley of Kenya. Nakuru County is classified as having a humid to sub-humid climate (Muriuki, 2011), and it is favourable for dairy and crop production (van de Steeg et al., 2010). Two areas were selected, Mukinduri (0°58´S, 35°98´E; 2687 masl) and Lare (0°44´S, 36°00´E; 2160 masl). The first study site is adjacent to the Mau Forest Complex, while the second is adjacent to Nakuru National Park. Mean annual precipitation in Mukinduri is 1400 mm, while in Lare it varies between 600 - 1000 mm (Figure 1).
Smallholder dairy farmers in the study area usually keep one crossbred cow, with a maximum of three. Cows are commonly fed with Napier grass, crop residues from the farm (i.e. maize stalks, bean and pea stubbles, as well as residues from carrots, cabbage and potatoes) and weeds. Lactation periods vary between 7 and 24 months, as cows may continue to be milked even when they did not conceive in time. The majority of the daily milk is marketed and milk is also used for family food needs.
**Data collection and analysis**

A collaborative learning process was established with the Mukinduri group in August 2013 and with the Lare group in June 2014. Farmers’ perspectives on the experimentation process were systematically documented from February to November 2015 using a combination of oral and visual methods. We conducted a series of complementary inquiry methods to assess what farmers have learned and how they evaluate the collaborative learning process. These included: 12 semi-structured interviews (SSI) including critical incident questions related to their own motivation and satisfaction (Brookfield, 1995); participatory scoring of benefits from the experimentation process with all group members (n=40) (Holland, 2013); 5 narrative interviews (NI) exploring farmers’ experiences during the collaborative learning process (Jovchelovitch & Bauer, 2000); and group sessions to share the stories of change from 33 farmers (October 2015) using the Most Significant Change technique (MSC). MSC is a form of participatory monitoring and evaluation that provides data on impact and outcomes from actors’ own perspectives (Davies & Dart, 2005).

The duration of the semi-structured (SSI) and narrative (NI) interviews was between 45 and 90 min. The stories of change (MSC) sessions lasted ca. 120 min. With farmers’ permission, each individual interview and group session was audio recorded and transcribed. For the semi-structured interviews guiding questions were used to maintain focus; however, the interviews did not follow a formal structure but were rather conversational for reciprocity of dialogue. This approach allowed interviewees to feel comfortable and to focus primarily on the topics that they were most familiar with.

A content analysis was conducted with the qualitative information obtained. It included inductive and deductive coding of the data to identify similarities and patterns. Codes used were related to learning topics, benefits from the collaborative learning approach and relational aspects of learning. Tables and diagrams were constructed based on this information.

**Context: steps of a collaborative learning process with two farmers’ groups**

Two small-scale dairy groups in Nakuru County, Kenya, engaged in a collaborative learning process as part of a transdisciplinary research project for reducing food losses and adding value. This project was conceptualised as four interconnected phases (for further information see Restrepo et al., 2014): (A) establish the collaboration; (B) process of dialogue; (C) process of discovery; and (D) applying the new knowledge (Figure 2).

During the process of establishing the collaboration a partnership was institutionalised between the two small-holder dairy farmer initiatives and the researchers. Farmers had the status of co-researchers, i.e. they had voice in the process of defining, designing, testing and implementing sustainable solutions for a jointly defined real-world problem.

The process of dialogue enabled: (i) development of a shared understanding of the complex problematic situation, i.e. problems related with milk quantity (seasonality and work load), quality (cleanliness and milk composition) and market (rejection and seasonality); and (ii) realisation of a joint strategy for achieving goals, that included different types of fodder and silage to improve milk quantity, and both on-farm milk quality testing and construction of a zero-grazing unit to improve milk hygiene.
Through the process of *discovery* farmers were able to fill knowledge gaps and to develop innovations for problematic activities. The process consisted of (i) farmer-to-farmer exchange sessions with peers having silage, different types of fodder or a zero-grazing unit; (ii) farmer-led experimentation in order to gain experience; (iii) collecting information using different instruments, e.g. keeping records of milk production and testing milk density and mastitis incidence; (iv) analysing new information and reflecting on what worked and what didn't during group meetings; and (v) evaluating the results and drawing conclusions regarding what might need to be done differently.

After testing the different options, applying the new knowledge is the basis leading to the consolidation of a new activity into a more broadly recognised social practice. This phase is on-going.

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**Establish the collaboration** (3 months) → **Dialogue** (4 months) → **Discovery** (12 months) → **Applying new knowledge** (on-going)

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<tr>
<td>Develop clear benefits and responsibilities</td>
<td>Maintain enthusiasm</td>
<td>Time</td>
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**Figure 2. Methodological sequence in a collaborative learning process with two farmer groups in Nakuru County, Kenya**

**Enthusiasm**

We found that enthusiasm played a role throughout the four collaborative learning phases, i.e. establishing the collaboration, dialogue, discovery and application (Figure 2 and Table 1). In the next section we will present different factors that triggered and maintained enthusiasm, both from farmers and researchers, during the different collaborative learning phases. Finally we discuss tensions that suppressed enthusiasm, for both farmers and researchers. Through this section, we illustrate our findings with representative examples using farmers’ own words.
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<th>Methodological sequence</th>
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*Theoretical items from the researcher’s perspective*
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<th>Self-monitoring activities</th>
<th>Short term results - feeling of progress Monitoring effects of own ideas for improvement: - Milk quantity with records - Milk quality with lactometer Learning from each other Friendship and trust</th>
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<td>(D) Applying new knowledge</td>
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Establish the collaboration: mutual selection process

In establishing the collaboration, a mutual selection process between farmers and researchers was a first step in fostering enthusiasm as it fomented hope, as stated by one of the farmers during the Most Significant Change session “I had one cow and ... I was contemplating selling it. But when we came together, I decided to keep it, because I saw some light” (female farmer, MSC) (see also social capital in Figure 4). In the selection process, researchers, guided by explicit and implicit selection criteria, chose two smallholder farmer initiatives to establish a partnership; Lare Livelihoods Improvement CBO and Mukinduri Dairy Self-Help Group. Importantly, the two farmer initiatives also chose the researchers to facilitate the process by proactively engaging with the researchers and expressing their desire for a collaboration contract. Both groups represent bottom-up initiatives, and are an example of farmers coming together because of their willingness to change, as can be seen with the following quote: “Let’s say the issue of joining the group was not in me. But the chairman told me ... that they are very much interested in learning more about dairy farming … in this area there has never been a group like this one” (male farmer, NI).

Once the collaboration was institutionalised, we worked on balancing power relations so that everyone’s knowledge and experience was recognised as important: “we are all learning and no one is ahead of others” (male farmer, NI). After clarifying roles and responsibilities, the size of the group in Mukinduri became smaller “when we formed the group we were 47 members, and that group just reduced in size because some had different aims where some had thought that the researcher had come with money” (male farmer, NI). Farmers with unrealistic expectations left, leaving only those willing to take the risk of embarking on a learning process into uncharted territory. As a young farmer stated, “we did not know that there is a way you can learn, even if the person (researcher) does not give you anything, she can teach you and you get that knowledge” (male farmer, SSI). This is an expression of the trust that was built during the first steps, but also of the desire to engage and change.

Dialogue: integrating knowledge

Using participatory photography, researchers facilitated the problem analysis from the farmers’ perspective, something that was later much appreciated by the farmers themselves. As one of the farmers in Mukinduri remarked, “it was good that we were capable of talking about our problems .... even if our government listened to our problems and we were assisted, it could be of great help. Perhaps this could be done using a video just like we did” (male farmer, SSI). Possible solutions emerged, after which the development of an action plan was facilitated. Farmers applied for an experimentation grant using a video proposal which served to jointly re-conceptualise their experimentation plan. The grant was intended to stimulate experimentation without farmers bearing the financial risk. In the dialogue phase, coming to a common understanding of the problematic situation triggered enthusiasm by promoting relevance, ownership and commitment (see social capital in Figure 4) as stated by one young farmer in Lare “everyone participated in planning even if they did not appear in the shoot (video proposal)... we were happy because we knew we are part and parcel of that. The video brought us all together because we had to discuss and agree upon what to do. It helped in decision making” (male farmer, SSI).

Discovery: constructing knowledge

In the discovery phase, farmer-to-farmer exchange sessions grounded farmers’ experiments and enhanced a collective sense of ‘we can do it’. As stated by one of the farmers, “When we
visited his (peer’s) place I was able to learn a lot about making silage practically. I saw that I can also make mine because he has already done his. So I was able to follow from step one to the last steps” (male farmer, SSI). Exchange sessions permitted farmers to see how peers are addressing the same problematic situation by making silage and planting different types of fodder for cows. It further increased farmers’ agency, as farmers had the space to test and evaluate how silage and different types of fodder could work and to remove doubts. Exchange sessions were also important in re-defining roles as teachers, as stated by one of the farmers that facilitated the exchange session, “when I was going to teach them I was happy that I was chosen ... although initially people were fearful to try silage, now they are doing it” (male farmer, SSI).

Subsequently, farmers developed their own trials to test sustainable practices to improve milk quality and to buffer seasonality based on different feeding strategies. Figure 3a) shows farmers’ participation in the farmer-led experimentation aiming to improve milk quality and quantity and to buffer seasonality. Farmers had in their hands the decision of what to test according to their current situation. For example, weather condition, land availability and labour; the experimental year was a dry year in Lare, and in Mukinduri farmers had already allocated most of the land for other crops. Enthusiasm was maintained during the experimentation process as can be seen by the high level of satisfaction (Figure 3b).

Figure 3. Farmer a) participation in, and b) perceived benefits (5 Excellent – 1 Bad) from farmer-led experimentation in a collaborative learning process in Nakuru County, Kenya (n=40; benefits only from those farmers that tested the innovation)

Farmers also tried different observation tools: keeping records, testing milk quality and early detection of mastitis using the California Mastitis Test (CMT). Using these tools, farmers implemented self-monitoring activities which maintained enthusiasm by highlighting the progress achieved. For example, as seen by a young farmer’s comments, “since we started recording the amount of kilos (of milk) the cow produces, someone can say from here to here, that my cow has made a difference” (male farmer, SSI). Farmers also used observation tools to further test the impact of the different feeding strategies, “I have used the lactometer. I wanted to know whether the density improved; it went from 26 to 29 and even 31. This was after feeding the cow with the new fodder” (female farmer, SSI). Self-monitoring activities
helped in maintaining enthusiasm. A young farmer stated that other areas of production activity were positively affected, “if your cow produces low-density milk, the milk density rises when you add Lucerne (alfalfa). When you deliver your milk, it will never be rejected and they (milk traders) gain trust in you…” (male farmer, SSI).

Figure 4. Perceived impact after sharing stories of change in a collaborative learning process in Nakuru County, Kenya (n=33; frequency of response; multiple answers per respondent)

Farmers emphasised the value of farmer-led experimentation, as can be seen by the following comments, "it's a lot of power to learn and to practice" (male farmer, NI) and “we were discussing according to how we have learned, the knowledge is more than money. Because if it was money we would have shared amongst us, spent and forgot" (male farmer, SSI). Experimentation was important for maintaining enthusiasm, as it provided short-term results,
"I planted the seeds that we received for investigation… it was excellent, because the cow produced enough milk for my family and I, and we were even able to sell" (female farmer, SSI).

The results from the individual experimentation were shared informally during casual meetings: "through the group I have many friends, so in case I have any problem when we meet, I share the problems and exchange ideas. That has helped me a lot" (Lare, MSC). Results were also shared formally during group meetings and through the Most Significant Change session. Here farmers commented on what had changed during the collaborative learning project. Results from sharing the stories were grouped into those related to a) milk production; b) Human capital: acquired knowledge and skills; and c) Social capital: relational aspects of learning (Figure 4). Sharing results maintains enthusiasm as farmers’ develop a sense of progress. Most importantly, farmers value the benefits from experimenting: "I have seen the benefits of trying new things. I will continue experimenting" (male farmer, SSI) and "the most important thing I have learnt is the passion for testing new things" (male farmer, SSI).

Applying new knowledge
In the application phase, group members implemented various innovations on a wider scale, which also expanded outside the groups. As an example, one young farmer in Lare has implemented silage and fodder on a larger scale, "I have done so much silage that during this dry period I was able to share with my father, as he did not have enough fodder to feed his cows" (male farmer, SSI). With the objective of selling the milk as a group, in Mukinduri, a small group of seven farmers pilot tested a local quality guarantee system, "we (with six other farmers) implemented a system for testing milk quality every 2nd week to avoid rejection" (male farmer, SSI). Finally, as stated by a farmer in Lare, “the group is gaining recognition, and we are spreading our roots …” (male farmer, SSI).

Tensions: factors that reduce or suppress enthusiasm
In our concrete experiences, time is an important factor that could suppress researchers’ and farmers’ enthusiasm. When working with farmer-managed innovation funds one needs to bear in mind that there are trade-offs between facilitating the initial phases so that the partnership is solid (i.e. balancing power relations; clarifying benefits, roles and responsibilities; preventing the occurrence of self-serving positions; improving decision-making among group members). All require a lot of time to set up. In such partnerships, researchers need results while farmers want action. Inconsistent participation from farmers during the dialogue phase not only reduced enthusiasm, but also increased the time needed to arrive at a joint understanding of the problematic situation and an agreement on strategies to achieve goals. The time use in the sessions (i.e. participatory photography, video proposal, peer-to-peer exchanges or Most Significant Change) also affected enthusiasm when the sessions did not start at the agreed time, or took longer than had been agreed upon by the group. The issue of time was contentious. A participant explained that, “the challenge… for me is especially concerning transport… the journey is not short, but I sacrifice a lot because it is for my own good and also for the society in my area. So I make sure I arrive at the right time” (Lare, MSC)

A situation analysis at the beginning of the project is seen as offering important initial information for the researchers, but farmers did not see the need for it. Moreover, they felt it was extractive and resulted from a hidden agenda. Both farmers and researchers also discovered that some members of one of the farmer groups had a hidden agenda related to local politics, which created confusion and slightly reduced commitment among other members.
During the *discovery* phase, unsuccessful past experience explained why the percentage of farmers that tested Lucerne (alfalfa) in Lare was low, as the dry season was strong and farmers knew the crop was not easy to establish. The percentage of farmers that tested silage in Mukinduri was low due to the perceived risks of failure (the innovation funds covered all materials except the crops from each individual farmer), and greater in Lare due to the imminent drought. Monopolisation of tools to test for milk quality and mastitis not only reduced the number of farmers that tested them, but also had an impact on enthusiasm.

Finally, when working in a situation where not all actors (particularly the researcher) speak the same language, there is a need for an interpreter. Communication dynamics can reduce enthusiasm when: (a) the researcher and/or interpreter use overly technical or paternalistic language, in some cases pejorative terms; and (b) the message does not reach all members of the partnership in a timely manner (not all farmers obtained accurate information about dates, objectives and duration of sessions).

**Discussion**

This paper presents different factors that triggered, maintained and suppressed enthusiasm during a collaborative learning process that promoted farmer-led experimentation in Nakuru County, Kenya. The reported findings demonstrate that it is possible to actively trigger and maintain enthusiasm through inclusive methods: participatory photography and video; farmer-led experimentation; self-monitoring activities; and sharing results. By analysing farmers’ perspectives on the experimentation process, we highlight the importance of: (i) democratised research relations that included farmer-managed innovation funds to co-construct knowledge; (ii) building trusting relations; (iii) peer-to-peer exchange sessions; and (iv) sharing short-term results to accentuate a sense of progress.

For sparking farmers’ own enthusiasm in a collaborative learning process that included farmer-led experimentation, one important issue is to give farmers an active voice in the research process, i.e. they can decide what they want to experiment on, how and why. Building the foundations of the research with the farmers implies having an open-story for farmers to re-write (Dolinska & d’Aquino, 2016). Hence, the emphasis is on shifting the project towards co-construction rather than transfer of knowledge or, as Sewell et al. (2014) expressed it, “sharing power with farmers”. This also means that farmers have the freedom to decide how they prefer to implement their experiments and what they prefer to observe according to their interest, curiosity or knowledge needs. Facilitating the use of different tools to observe and monitor (e.g. keeping records, on-farm testing for mastitis and milk quality), was also perceived by farmers as motivating. These observation tools were further used according to different needs and interests to self-monitor the outcomes from experiments. As Saad (2002) and Bentley (2006) argue, it is not necessary that farmers employ scientific methods (e.g. formal treatments, random trials or control groups) to experiment and learn.

Because of smallholder farmers’ low financial capital endowment, working with farmer-led innovation funds is a good idea as farmers can experiment without bearing the financial risk. As stated by Ton et al. (2015), grants targeting smallholder farmers are a promising agricultural policy instrument. Farmer-governed funds have been widely implemented by PROLINNOVA (Wongtschowski et al., 2010). For these funds to succeed, it is important to work with group dynamics to facilitate a partnership in a collaborative process. Faure et al. (2011) describe such partnerships in action research as the commitment of different actors who maintain their autonomy and bring together different human and material resources to achieve a shared
objective. As stated by Rist et al. (2006), the willingness to collaborate in a partnership comes along with trust building, and the development of trustful relationships is related to less hierarchical patterns of communication.

The peer-to-peer exchange sessions helped farmers on one side to change their perception towards a determined technology and on the other side to become more aware of their own knowledge. For example, silage was perceived as something that only rich farmers can do, but after meeting peers that have adapted and adopted silage successfully, their own agency increased. Besides, peers who were visited became aware of their own knowledge when performing their new roles as teachers, also reported as a key factor in a social learning process by Rist et al. (2006). Finally, when farmers are experimenting individually or collectively they are also observing the results from their experiments. When they meet and share these observations, enthusiasm grows as they can see the progress.

**Conclusion**

The article concludes by stressing that democratised research relationships spark enthusiasm during the steps of establishing the cooperation and dialogue, while a sense of progress and success maintained it during the steps of discovery and application of new knowledge. The collaborative learning process supported farmers in: (i) constructing knowledge that answered contextual problems, therefore improving the management systems; and (ii) strengthening their own agency. This example from two groups in Nakuru County, Kenya can serve to provide guidance on how to initiate, maintain and support enthusiasm through different stages of participatory research that hinges on empowered farmer-led actions.

**Acknowledgements**

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References


Integration of knowledge for sustainable agriculture: why local farmer knowledge matters

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Abstract: Previous research has revealed that transition to sustainable agriculture requires a new knowledge base - new content and forms of knowledge and learning. In this paper, we explore farmers' knowledge and learning practices with a focus on the role of informal knowledge and learning in strengthening agricultural sustainability and resilience. It is based on 11 case studies from the international RETHINK research programme, which discover diverse pathways of farm modernisation and related knowledge and learning processes. We outline the diversity of knowledge sources and learning forms that farmers use and the particular role of local farmer knowledge. We argue that the potential of farmer knowledge is not being optimally used, and we identify several ways in which different kinds of knowledge can be integrated: by the individual farmer by synthesising knowledge from different sources; through farmer networking – whether or not facilitated by formal agricultural knowledge institutions; through collaboration between farmers and researchers as knowledge co-generator; and through multi-actor knowledge networks that bring together participants from various fields. We conclude that the dynamic contexts, complexity and the local specificity of the current challenges facing agriculture and the many roles it is being asked to fulfil require more inclusive, flexible modes of the generation, integration and sharing of knowledge. All stakeholders and all kinds of knowledge need be brought together on an equal basis in innovation processes. For these purposes, policy frameworks and initiatives that promote an interactive multi-actor approach to agricultural development can play a considerable role.

Keywords: Farmer knowledge, learning, sustainable agriculture, knowledge networks, knowledge integration

Introduction
During agricultural industrialisation the role of farmer knowledge has been largely deteriorating; a lot of this knowledge has even been lost all together with the spread of productivist logic and standardised solutions, and declining farmers’ community (Fonte, 2008). However, in the face of the many contemporary challenges - climate change, food security, resource depletion, to name a few - a growing number of development specialists admit that farmer and local knowledge is a valuable resource to reorient modern agriculture towards more sustainable and resilient paths of development.
In this paper, we explore farmers’ knowledge and learning practices with a particular focus on the role of informal knowledge and learning in constructing sustainable and resilient agriculture. We use the distinction between formal and informal knowledge to better illuminate the diverse forms of knowledge which exist outside the formal agricultural knowledge system and are generated by practitioners from their experience, without externally imposed criteria and agenda (Livingston, 1999).

It is recognised that sustainable agriculture, due to its holistic, diverse and distinctive nature - explicitly interlinking environmental, social and economic dimensions - requires new content and forms of knowledge and learning (Curry & Kirwan, 2014; Kloppenburg, 1991). As formal agricultural knowledge and innovation system (AKIS) is still strongly focused on the production-oriented model of agriculture, farmers who choose more sustainable paths rely often on alternative learning networks and knowledge sources. Therefore better recognition of local farmer knowledge, and the combination of local and scientific knowledge are needed in order to meet sustainability goals in agriculture (IAASTD, 2009; Pretty, 2008). In recent years agricultural sustainability is linked with the concept of resilience, which evokes the capacities of an agricultural system to adapt and transform in order to persist over the long term. Learning to live with change and uncertainty, and combining different types of knowledge, including farmer, appear as critical for building resilience (Folke et al., 2003; Darnhofer et al., 2016).

This paper advances the stream of research that points to the potential of informal knowledge, and local farmer knowledge more specifically, in strengthening agricultural sustainability and resilience. The rest of the paper is organised as follows. The next section details the concept of informal knowledge, and learning networking for sustainable and resilient agriculture. The subsequent chapter presents our multi-case methodological approach. Next, we analyse farmers’ knowledge sources and learning practices and how these are related in various networks. We explain why informal knowledge and learning matter for sustainable and resilient agriculture. Finally, we identify several action points to enhance (informal) learning.

**Theoretical framework: knowledge and learning networks for sustainable and resilient agriculture**

Research literature brings up several overlapping concepts to delineate informal knowledge (local, practice-based, traditional, lay, farmer, tacit, endogenous, indigenous etc.) and informal learning modes (self-education, learning by doing, experimenting, observing, from own or other's experiences, in social interactions etc.) in agriculture. We focus on two core interrelated kinds of informal knowledge - local and farmer. Local knowledge involves dynamic and complex bodies of know-how, practices and skills, developed and sustained over time on the basis of local people’s experiences in their environmental and socio-economic realities (Beckford & Barker, 2007). Farmer knowledge is a subset of local knowledge, enabling farming in specific local conditions. As agriculture is highly dependent on the local environment, local farmer knowledge is of particular importance as it contains an intimate understanding of the particular set of local cultural and natural resources.

The holistic and adaptive character of local knowledge - considering local systems as a whole, integrating their social, environmental and economic aspects, empirical and spiritual dimensions (ICSU, 2002) - makes it especially relevant to agricultural sustainability and resilience. This is illustrated by the development of agriculture within its environmental and social settings through accumulation and application of local knowledge in many regions of the world, over generations (IAASTD, 2009). For example, traditional farmers integrate their
farming methods with natural ecological processes and reproduce biodiversity (Altieri, 1999); local farming practices address local community needs - food security, social activities related to food, local economic conditions and sustainable soil management (Briggs & Moyo, 2012). This points to the links between local farmer knowledge and specific ethical, environmental and social values. This issue is of particular pertinence when discussing sustainable agriculture which is driven by different values to conventional agriculture and new ways of thinking.

Informal knowledge is often regarded in relation to formal knowledge (Table 1) and perceived as being pushed into a subordinate position. The science driven conventional agriculture with its technological and organisational changes has resulted in farmers being increasingly dependent on external inputs, and loose tacit knowledge due to alienation from production processes, and reduction and standardisation of skills (Timmermann & Felix, 2015).

**Table 1. Differences and commonalities between informal and formal knowledge**
(Source: Authors’ compilation)

<table>
<thead>
<tr>
<th>Informal knowledge</th>
<th>Formal knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Source</strong></td>
<td><strong>Academia</strong></td>
</tr>
<tr>
<td>Own experimentations and practical experience</td>
<td>Research stations</td>
</tr>
<tr>
<td><strong>Ownership and certification</strong></td>
<td><strong>Scientists</strong></td>
</tr>
<tr>
<td>Practitioners, farmers, local community</td>
<td></td>
</tr>
<tr>
<td><strong>Approach</strong></td>
<td><strong>Holistic</strong></td>
</tr>
<tr>
<td><strong>Transferability</strong></td>
<td><strong>Locally specific solutions</strong></td>
</tr>
<tr>
<td><strong>Transmission and access</strong></td>
<td><strong>Exchange with peers, passed through generations</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Standardised decontextualised solutions</strong></td>
</tr>
</tbody>
</table>

A juxtaposition of informal and formal knowledge is helpful to illuminate their different characteristics. However, it does not reflect well the farming reality where farmers integrate and use all kinds of relevant knowledge they have access to (Figure 1). Moreover, the domination of formal knowledge is not straightforward; farmers do not accept it uncritically, rather they negotiate various expert and local information against their own experience-based knowledge (Kaup, 2008). They even tend to value more practice-based knowledge (Wood, et al., 2014; Fonte, 2008) and are able to mobilise their local knowledge to resist the scientific one (Wynne, 1998).

Still, beyond the farm gates, scientific knowledge is more prominent. Together with increasing standardisation and certification of knowledge, farmers’ knowledge and skills are devalued and their application is restricted by legal means via laws and regulations. In other cases
farmer knowledge is appropriated and codified by scientists and industry, excluding producers and local communities from the benefits of the valorisation of the product (Fonte, 2008). Poor links and interchanges between scientific and practitioners’ life-worlds and knowledge, their asymmetrical powers and interests, complicate the applicability and implementation of scientific knowledge in practice and integration of farmer’s perspectives into scientific research (Noe et al., 2015).

However, there is an increasing body of research showing the complementarity of informal and formal knowledge, and expansion of multi-stakeholder and participatory approaches where joint trans-disciplinary knowledge production is enabled (Scoones & Thompson, 2009). This research confirms that contemporary sustainable agriculture is advanced by multi-actor knowledge networks where various kinds of knowledge are exchanged, and new meanings and practices of farming are negotiated and institutionalised (Moschitz et al., 2015; Tisenkopfs, et al., 2015; Wood, et al., 2014; Knickel et al., 2009). It is also noted that knowledge creation and dissemination for sustainable agriculture often happen through informal mechanisms (like networks, personal and local daily relational structures, co-learning, mutual support) rather than formal ones (Curry & Kirwan, 2014; Wood, et al., 2014).

As multi-actor knowledge networks bring together different stakeholders, negotiation of the meanings and practices of sustainable agriculture is a part of their interactions and contestations. Such a “social” process brings more sustainable outcomes than purely rational top-down planning, especially in situations when decisions have to be taken on complex issues (Bodin & Crona 2009). In order to reach different stakeholders’ mutual understanding and enhance transition towards sustainable agriculture, knowledge mediators or brokers play a key role through facilitation of interactions, joint reflection and integration of various knowledge cultures (Moschitz et al., 2015; Tisenkopfs et al., 2015).

**Methodology and case studies**

We base our paper on 11 case studies carried out in the international RETHINK research programme. The cases were selected to illustrate diverse pathways of farm modernisation, their connections to rural development and resilience, and the role of knowledge and learning (Table 2). The case studies utilised common conceptual and analytical frameworks and methodology (Darnhofer, et al., 2013; Darnhofer, et al., 2014). Information was gathered through a range of methods involving semi-structured interviews and group discussions with farmers and other key stakeholders from market, public, administrative and civil society sectors. Also relevant secondary data from surveys, statistics and previous research were integrated into the original research. Empirical material was gathered, analysed and structured according to several predefined themes: farmers’ needs for knowledge; how they source it; learning modes; networks and outcomes. These themes were also used as the basis for comparative analysis.
<table>
<thead>
<tr>
<th>Case</th>
<th>Key knowledge and learning issues</th>
</tr>
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<tbody>
<tr>
<td>Organic farming and resilience, Austria</td>
<td>The case demonstrates the role of farmer-led networks, informal knowledge building and knowledge transfer and the way they are supported (or not) by formal institutions such as vocational agricultural schools or institutions of life-long learning.</td>
</tr>
<tr>
<td>Landscape strategy making and agriculture, Denmark</td>
<td>The case presents how farmers gain knowledge on local landscape management in Odderbaek watershed, and depicts learning as both individual and collaborative, a social capital-building process.</td>
</tr>
<tr>
<td>Transitions towards ecological production, France</td>
<td>The case focuses on the types of technical knowledge built during the transition towards ecological production in the French Drôme department fruit and vegetable sector, and the role of on-farm experimentation in the learning processes.</td>
</tr>
<tr>
<td>Opportunities for creating an eco-economy: lessons learned from the Regional Action and Bio-energy Regions schemes, Germany</td>
<td>The case explores links and interactions between key stakeholders who build competence for the bio-energy regions and their cross-sectoral and multidisciplinary exchange of information in a transition towards a low-carbon resource-efficient economy.</td>
</tr>
<tr>
<td>Farmer adoption of a new nutrient management technology, Ireland</td>
<td>The case highlights farmer learning and the adoption of a new nutrient management method and decision support tool in study groups across the Teagasc Agricultural Catchments Programme. It characterises the role of farmers as intermediaries in innovation dissemination in livestock manure application.</td>
</tr>
<tr>
<td>Rural innovation in global fluctuation: the Arava region case study, Israel</td>
<td>The case explores the variety of learning tools available to a farmers’ cooperative in the Arava desert area, and their gaps regarding the need for new skills and knowledge, such as marketing, self-organisation and product development.</td>
</tr>
<tr>
<td>Extensive pig production systems, Italy</td>
<td>The case reveals the role of collaboration / competition and knowledge exchanges between the food-chain actors, research organisations and regional development agencies in the development of a PDO certified supply chain.</td>
</tr>
<tr>
<td>Smallholder farm development strategies, Latvia</td>
<td>The case explores small-holder farmers’ knowledge and learning practices and networks and highlights the importance of informal knowledge and learning in this farming segment.</td>
</tr>
<tr>
<td>Title</td>
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<tr>
<td>Resilient farming systems and market differentiation: challenges and opportunities in farmers' markets, Lithuania</td>
<td>The case study focuses on the role of the agricultural knowledge system in Lithuania, particularly formal education and advisory, in stimulating farm innovations at local level both in traditional and alternative food chains.</td>
</tr>
<tr>
<td>Innovation and social learning in organic vegetable production in the Region of Murcia, Camposeven, Spain</td>
<td>The case study explores how the cooperative’s internal governance structure and relational networks promote integration of experiential and expert knowledge, and connecting knowledge and learning to action.</td>
</tr>
<tr>
<td>Sub-urban food production systems in a Swiss agglomeration: the example of the milk supply chain in Bern, Switzerland</td>
<td>The case explores knowledge and learning processes across five milk delivery channels with a focus on the role of formal knowledge institutions and informal networks. It points to farmers' strong respect for local farmer knowledge, as well as illuminating learning from consumers in direct sales and CSA systems.</td>
</tr>
</tbody>
</table>
Analysis: learning for sustainable and resilient agriculture

Farmers’ knowledge needs and motivations to learn

We discovered a complex of personal and societal drivers behind farmers’ learning decisions and activities. The evolving character of agriculture and new societal demands towards it require new knowledge and skills from farmers. Also farmers’ motivations and values guide them in selecting knowledge subjects, sources and learning forms. We group these motivations around two axes: business; and ethical and social.

“Business” is of central importance when farmers learn to improve their market performance, increase income, and gain economic stability and growth. In all cases one of the key knowledge needs is marketing, in particular for small-scale farmers and those building new marketing channels (e.g. direct selling, processing or a PDO market chain). Another is technical knowledge that manifested the most in the cases which depended on advanced technologies, like bioenergy production or farming in severe conditions in the desert. Competition, quality demands and opportunities created by scientific advancements push towards constant updating of technical knowledge. To carry out the “business” side successfully, farmers also need bureaucratic, administrative and legal knowledge. The motivation to do better business also involves building certain social and personal skills, like networking, conflict management, creativity and time management.

While a strict division cannot be made between business and non-business, we examine “ethical and social” motivations and corresponding knowledge needs separately. “I love what I’m doing” was a common phrase that farmers used when describing their work. This passion is also urging them to discover, learn and experiment in fields of interest to them. Pride in and responsibility for working on the farm that has belonged to the family for generations was another common learning framework, prioritising some solutions over others. This can establish a certain path-dependency, an unwillingness to break with family traditions. But the long-term involvement fosters creativity as farmers learn and develop solutions to stay on their farm even in high-pressure situations. Responsibility for the farm also involves caring for its natural environments – soil, landscape, old trees, wildlife etc. Farmers tend to preserve these resources and learn ways to do so, sometimes even at the expense of production efficiency. Another “ethical and social” motivation is consideration for the interests and resources of the community: neighbouring farmers; a cooperative; a local village; or a broader region. Finally, striving for certain autonomy was guiding knowledge acquisition as farmers are seeking to maintain some independence from market, financial and public forces, and wishing to keep control over their farming decisions and operation.

Knowledge sources

The cases demonstrate that farmers use and integrate knowledge from various sources in order to meet their diverse knowledge needs. In many cases farmer knowledge was the most prominent and trusted knowledge basis due to its local relevance and meaningfulness. In their daily operations farmers rely primarily on their own knowledge accumulated over extended periods of time from practical experience by doing, experimenting and observing.
Traditionally, farm families have been a core platform for learning and knowledge decisions, and in countries like Latvia and Lithuania this is still very common. Another cornerstone source of knowledge featured in the cases is other farmers. Farmers consider their successful colleagues as reputable experts and particularly trustworthy due to their practical experience in similar conditions. Traditional farmer knowledge serves as a solid production resource and a source of inspiration. For example, production of the reputable ancient Cinta Senese pig meat in the Italian case (De Roest & Ferrari, 2015) or retro-innovation projects combining traditional knowledge, handcraft and regional resources with new technologies and creative marketing ideas in Austria (Darnhofer & Strauss, 2015).

In all the cases farmers use also knowledge from formal agricultural institutions (provided in the form of training courses, advice, field days, etc.), but not on a daily basis. The involvement of formal AKIS institutions in local knowledge and learning processes varies and is higher in the cases of advanced technologies. Sometimes farmers choose formal courses over informal learning due to the high profile of the AKIS, its clear production-oriented knowledge content, higher public appreciation and approved certificates (Darnhofer & Strauss, 2015).

Public administrative and controlling institutions are critical knowledge sources for farmers to receive public support. As food production and distribution are strictly regulated and the agricultural regulative framework and support measures are regularly changing, farmers need to frequently update their knowledge. Farmers often perceived this as a burden that demands financial investment, practical adaptations on the farm and considerable bureaucratic work.

Market actors, in particular consumers, are another important source of knowledge and innovation for farmers. In the Austrian and Swiss cases, the direct link to consumers stimulates farmers to rethink their habits of working, and to design new products and services (Darnhofer & Strauss, 2015; Bourdin et al., 2015). For part-time farmers, their off-farm jobs and exposure to other sectors provide additional soft skills, new ideas and experience to integrate into their farms.

The variety of knowledge sources brings us back to the issue of integration, which happens (or fails) in interactions in networks.

**Relations between formal and informal knowledge bases**

*Mediating and transmitting knowledge in networks*

In line with previous research, our study demonstrates that farmers operate in multi-actor knowledge networks consisting of overlapping formal and informal sub-networks.

Formal knowledge networks contain various formal institutions: research institutes; advisory services; farmers’ organisations; etc. They have a strong historical and institutional ‘back-up’, have a more structured agenda, operate at a larger scale and receive some public funding. Formal knowledge is often inscribed in printed and digital artefacts circulating in these networks and connecting actors.

Conversely, informal knowledge and learning operate in fuzzier networks, relying on farmers’ private interests, community ties, family and personal relations,
neighbourhood associations, peer groups, territorial communication structures and tradition. They are often a part of farmers’ daily routines and the first channels for exchanging and disseminating ideas and practices. These networks are more local, but not exclusively so, as thanks to mobility and modern ICT tools the connections may be to more distant partners (Šūmane, et al., 2015).

In several cases a central node in farmers’ learning networks are farmers’ organisations. As Austrian organic farmers and Latvian niche farmers show, farmer groups are particularly important in the pioneer phase of new agricultural approaches when formal knowledge, advice or manuals are limited and farmers look for both knowledge and moral support. Farmer organisations retain an essential role also in well-established sectors and businesses as sites for sharing information, knowledge and experiences, and assisting farmers to manage both farming and non-farming related issues. Farmer organisations also connect farmers to other knowledge sources assuming mediation with wider AKIS.

**Complementarity and creative synergy**

Informal and formal knowledge are often complementary. We identify several ways of integrating different kinds of knowledge.

At an individual level, farmers use and integrate the many knowledge sources that are available to them, from scientific to their own experiential knowledge. The Irish case demonstrates how a scientifically based support tool (hydrometer) aids farmers’ decision making on nutrient management. Its application ameliorated farmers’ awareness of the nutrient value of organic manures, improved resource use efficiency and planning, led to savings on chemical fertilisers and reassured farmers about their own estimations (Buckley & Shortle, 2015).

Another level of knowledge integration and dissemination occurs through farmers’ networking both in their formal organisations and informal structures. Farmers adopt more easily external ideas and practices which are already accepted and successfully applied by other farmers. An example of the key role of informal knowledge networks in supporting scientific knowledge is the eradication of fruit-fly pest in the Arava region, where the informal social networks and parallel interaction on agricultural and social levels contributed to a region-wide, successful eradication that was unsuccessful elsewhere (Hurwitz et al., 2015).

Formal AKIS institutions, particularly advisory services, can provide another way of facilitating knowledge transfer and exchange between farmers. They organise knowledge exchange between farmers through site visits, study trips, farmer discussion and training groups, formal forums and the like. In some countries, like Ireland, farmer discussion groups are facilitated by approved agricultural advisors, and monetary incentives are given to farmers for participating.

A variation on the above is co-creation of knowledge between farmers and researchers as equal partners, with mutual benefits. Teagasc, the Irish research, education and extension institution, maintains information feedback loops between researchers and advisors and the farmers, whose experience and opinions are used to evaluate the
new technology and its likely success or failure if introduced to the wider farming population (Buckley & Shortle, 2015).

Finally, mixed actor groups, involving participants from both agricultural and non-agricultural fields, can lead to completely new, unforeseen insights and developments. In the Odderbæk river valley (Denmark), the cooperation between farmers, local administration and academics has raised awareness about the diversity of local environmental and cultural resources and resulted in a shared vision and strategy for landscape management in the watershed of the Odderbæk. The initiative integrates agriculture into a broader rural development context and has launched a more complex approach to local development (Pears et al., 2015).

Each site and level of integration of different knowledge sources has its role in farm development and modernisation. Better outcomes in terms of agricultural sustainability and resilience are achieved when various kinds of knowledge – formal and informal, local and external – are incorporated into networks, and all actors are reflexive and sensitive to potential synergies.

Conflict and contest
Diverse knowledge sources may also provide conflicting knowledge. Such knowledge clashes were clearly identified between farmers’ practical knowledge rooted in their experience and the knowledge of agricultural practices presented in regulations of food production and distribution. The increasing standardisation of agricultural knowledge and practice can be restrictive given farmers’ diverse knowledge and skills, lack credibility, and demand cognitive, financial and practical efforts to adopt. Latvian small-scale farmers testify that often agricultural knowledge is locked into certified expertise, and they cannot perform some exercises they might otherwise do themselves (e.g. vaccination) because of regulations (Šūmane et al., 2015). Austrian farmers complain that the dates for distributing manure on grassland are fixed by regulations which ignore the regional conditions of weather, soil patterns etc. (Darnhofer & Strauss, 2015). In these cases farmers are not appreciated as experts, and their experience-based knowledge and skills are ignored, hence undermining the sustainability of their agricultural practices.

So, formal and informal knowledge and their respective networks may be competing. Where informal knowledge networks are strong, formal advisory services have a weaker role as the informal networks dispense with their technical advice (Lamine et al., 2015). On the other hand, there is a trend towards formalisation of knowledge structures and the increasing need for formal knowledge, reducing informal networking and learning (Darnhofer & Strauss, 2015; De Roest & Ferrari, 2015).

The existence of conflicting knowledge can close down or open up the space for innovation and novelties; it demands flexibility from farmers to assume and work it out for their use. For instance, the regulation regarding approved slaughterhouses and processing areas demands intensive investment and prohibits farmers from simple on-farm processing. But these restrictions urge them to look for new market and organisational solutions, like expanding processing, cooperation among farmers or creating a joint commercial enterprise. Nevertheless, this creative energy and the efforts of farmers would be more effective if AKIS and other formal agricultural
institutions would acknowledge farmers not only as recipients of information, but also as knowledge generators. In the context of modernisation their expertise is often neglected, although it is a considerable resource to increase resilience and sustainability.

**Contributions of informal knowledge and learning to sustainable and resilient farming**

Our study confirms that informal knowledge generated in local contexts tends to be holistic - it considers the complexity of the reality in which farms operate integrating the many or at least several of the environmental, economic, social, financial, technical and other dimensions into a single whole. The diverse and dynamic Latvian small-holder farms' strategies illustrate how farmers develop and adapt their farms on the basis of their personal interests, family situation, knowledge of the farm's agro-environmental conditions, regional traditions, market opportunities, available technical and financial resources, labour, public support etc. (Tisenkopfs et al., 2015).

Practical, experiential knowledge adds to farmers’ confidence, professional satisfaction and autonomy. Farmers admit to the difficulties of their profession, but in general they express pride and pleasure in applying their creativity and knowledge and seeing them bring results both for their family and community. Their knowledge accumulated over a long time through personal experience in local settings forms a reliable basis for farming and improves their adaptive capacity – to select solutions that best fit their unique conditions.

Similarly, farmer confidence and capacity to act is increased through informal knowledge networking with other farmers. Informal learning networks ease innovation diffusion as farmers adopt more easily practices accepted by their peers. Importantly, knowledge obtained from family or neighbouring farmers is often the initial motivator and guide into agriculture for young and new farmers. Local farmer knowledge also continues to serve as a valuable support and source of inspiration and innovation for experienced farmers.

Informal knowledge sources diversify farmers’ knowledge and in this way they also strengthen resilience. They compensate for knowledge gaps in the formal knowledge system, in particular with regard to novel, niche, alternative farming practices as well as non-technical knowledge and skills to which formal knowledge institutes pay less attention. Informal knowledge is even more important when you take into account the weak or weakening state and accessibility of public formal agricultural knowledge systems in some regions or countries.

Direct knowledge exchange not only helps to develop and disseminate sustainable practices, but also strengthens the social structures through which these practices are disseminated: ties of friendship or solidarity; community; and identity building. This is even more pertinent when collective benefits result from joint learning e.g. improved local settings, an eradicated pest, a boosted local economy or an empowered farmers’ community.

In addition, we also identified environmental benefits linked to informal local knowledge. For instance, many of the small-scale farmers studied practice less intensive farming
techniques linked to specific local knowledge, rooted in natural processes and creating less environmental pressures. In the Danish case, the experiential local knowledge has been a key to developing a shared integrated vision and projects of agricultural landscape management. The Israeli Arava farmers’ unique local knowledge on farming in extreme climatic conditions is relevant when considering climate-smart agriculture.

Thus informal knowledge and the social mechanisms through which it is acquired and disseminated can compensate for the shortcomings of formal knowledge systems, demonstrating a range of contributions to resilient and sustainable agriculture, including those to farmers’ identities, communities and environments.

**Conclusion**

We have examined the multiplicity of knowledge sources and learning structures in agriculture, the integrative links between informal knowledge and formal knowledge, and demonstrated the prominent role of farmers’ informal knowledge for sustainable and resilient agriculture.

Integration of various knowledge sources and learning forms appears as a key aspect in order to survive, adapt and prosper in modern agriculture, in particular if one innovates and wishes to depart from the well-trodden paths. It requires of individuals and systems both sturdiness and flexibility. Personal curiosity and willingness to learn, together with social networking and supportive formal knowledge and governance structures appeared as central elements for successful learning, knowledge integration and innovation. Both formal and informal knowledge sources have their strengths, yet it is networking and knowledge exchange which make knowledge flexible and sustainability-enhancing. The particular role of informal knowledge lies in the fact that adaptation and transfer of knowledge are mediated by farmers’ own and local knowledge.

While joint knowledge activities among various stakeholders are expanding, additional targeted consideration still needs to be given to farmer knowledge and innovation, other informal knowledge sources and learning forms, and the ways to better integrate this knowledge. Such recognition and use of farmer knowledge would also support the goals of an inclusive knowledge-based society, which builds on the respect of knowledge diversity, broad knowledge access and everyone’s participation with his/her knowledge. The more recent engagement of AKIS in multi-actor knowledge networks and the closer collaboration with farmers point to the development towards more participatory, inclusive and comprehensive knowledge and learning processes.

Our research suggests some areas of engagement for formal knowledge institutes and agricultural policy makers:

- Facilitating connections and knowledge exchange among various stakeholders for joint learning such as: joint events with experts from all the relevant fields; collaboration between farmers and formal research institutes in field tests or when developing new products; and consulting farmers to integrate their knowledge into regulations;
- Supporting local-level initiatives such as networking, cooperation, mentoring, exchange of experiences, young farmers’ projects etc. Advisory could become
involved in such knowledge exchanges acting as a professional knowledge mediator and facilitator;

- Training in the social skills of networking, collaboration and joint learning could help to strengthen both networks by avoiding over-reliance on the few skilful leaders and the outcome of learning;
- Financial support for organisational expenditure (e.g. printing materials, postal delivery and travel costs) of the learning networking together with simple and transparent guidelines to apply for such funds would be helpful, in particular to reduce financial and time constraints of dedicated and trusted farmers who are often overburdened.

The changing nature of agriculture, its links to other rural sectors, as well as the current challenges facing agriculture and the many roles it is being asked, require development of mixed knowledge and learning networks with a broader inclusion of both agricultural and non-agricultural stakeholders. All stakeholders, including farmers, need to be recognised as equal co-authors of knowledge, and all kinds of knowledge, both formal and informal, need be enhanced and brought together in innovation processes.

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How “fundamental knowledge” supports the cropping system re-design by farmers?

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Abstract: Re-designing cropping systems to move towards agroecology leads farmers to implement practices which involve biological processes, sometimes qualified as “knowledge-intensive”, as they involve the renewal of agronomic principles and numerous interactions between the systems’ components and their regulations. Agronomists have developed an abundance of models, which encapsulate partial knowledge on systems’ functioning, but these appear to be seldom used by farmers. In contrast, several studies recognise the value of exchanging specific and fundamental knowledge with farmers in relation to technical change processes. This paper discusses how fundamental and generic knowledge acquires an agronomic sense and is reinvested in the action of farmers through their technical changes. We performed an inductive case study of step-by-step cropping system re-design situations. We combined individual interviews with farmers re-designing their cropping system, and facilitated farmers meeting about a shared technical problem. From full transcripts, we identified each new element of knowledge and its reformulation, its relation to action mentioned by farmers. The focus of our analysis concerns the knowledge which made it possible to develop action strategies when farmers were facing hindrances to continuing their technical changes. Our findings concern the specific fundamental knowledge actually mobilised, and the processes of its linkage with action through contextualisation. We conclude by suggesting that farmers alternate between systematic and systemic thinking about the biological processes at play in their own situation. This has practical implications for agronomists wishing to support such re-design processes, and provides an insight on how farmers’ experiments might be combined with fundamental scientific knowledge on agroecosystems components to enhance cropping system redesign.

Key Words: Cropping system re-design, agroecology, inductive case study, knowledge.

Introduction

Re-designing cropping systems to move towards agroecology leads farmers to rely increasingly on biological processes and endogenous resources and far less on external inputs (Altieri 1999; Biggs et al., 2012; Duru et al., 2015). This has several implications for the application of agricultural practices. First, farmers might have to implement practices corresponding to new agronomic approaches (such as, for instance, maintaining a canopy for most of the year to cover the soil, trying to control weeds, limiting leaching and possibly increasing nitrogen fixation in the case of legumes). Thus, they may face situations in which they have little experience to guide their decisions about appropriate action. Second, managing such biological processes is made harder by the variability of their functioning according to environment-specific pedo-climatic conditions, and by the numerous and largely under-explored interactions (for example, maintaining a cover crop may lead to an increase in
the slug population). This increases the uncertainty of the targeted effects or leads to unintended impacts. In view of these specificities, some authors have described the related practices as “knowledge-intensive practices” (Röling & Jiggins 1994; Ingram 2008). This stresses the acute need for new knowledge to apply these, particularly because they involve “the adoption of technology that requires a high level of management skills, with an emphasis on observation, monitoring and judgement” (Ingram 2008).

Agronomists have developed three main strategies to fulfil this need. First, some have made more intensive use of the knowledge developed by farmers, either to broaden agronomic knowledge, or to design and assess agro-ecological cropping systems (Walker et al., 1999; Altieri & Toledo, 2005; Doré et al., 2011; Malézieux, 2012). In particular, there is an emphasis on the tacit knowledge that farmers acquire through acting in their own situation, called “experiential knowledge” (Fazey et al., 2006; Baars, 2011), largely based on know-how. Second, some agronomists have carried out experiments with innovative crop systems to quantify the effects of new combinations of practices enhancing biological processes, emphasising the scope for learning (Deytieux et al., 2012; Coquil et al., 2014). Third, and this is probably the predominant strategy, many agronomists have developed integrated and complex models to describe the numerous interactions within a cropping system (e.g. McCown et al., 1996; Rossing et al., 1997; Constantin et al., 2015). By gathering the scientific knowledge available on soil-crop-atmosphere mechanisms the value of these models is thus argued to lie in their capacity to: extensively take into account feedback loops and the unintended consequences of actions (such as the quantification of water and nitrogen needs of wheat at spring when sown densely and early, which have consequences on fertilisation and potential water stress induced); and to predict long-term trends in the system, such as soil nitrogen and carbon content dynamics under various management practices (Constantin et al., 2012). The use of such quantitative and integrative models has been argued to provide helpful support to change practices (e.g. Hochman et al., 2000; Sterk et al., 2009). However, many authors have shown that models were of little help for the very design process of renewed practices by farmers (Prost et al., 2012). Moreover, the interactions between crops and practices that models simulate mostly concern the amounts of abiotic growing factors (e.g. water and nitrogen) and rarely biotic processes, while these strongly impact low-input systems (e.g. those linked to diseases, pests and soil biological activity). As a result, these integrated models may lack contextualisation variables to be used successfully by farmers or advisors to design locally-adapted crop systems.

These limitations of models underline the issues about direct use of scientific knowledge in redesign situations: how can farmers mobilise general scientific knowledge in a situated action process contending with systemic interactions between biological processes? The effectiveness of knowledge-sharing between agronomists and farmers has been shown to vary, based on agronomists’ behaviour and social skills (Ingram, 2008; Fazey et al., 2014; Reed et al., 2014). Yet, as these studies focus on social dynamics and actors’ behaviours, they provide little information on the actual content of the exchanges. Furthermore, the hybridization of scientific and local knowledge is sometimes considered difficult because of their differing aims regarding agrosystems: it has been argued elsewhere that the farmers’ objective is to manage ecosystems (for a crop or practice to yield satisfying results in a farmer’s situation), and scientists’ aim is to understand them (i.e. they need to know why and how something works) (e.g. Farrington & Martin, 1988; Ingram et al., 2010). Based on these distinct aims, scientists have developed numerous decision support systems as a means to
transfer their knowledge to farmers, with the aim of helping farmers make the right choices based on their constraints. In so doing, scientists consider that farmers do not need to understand the functioning of their agrosystem to manage it and they encapsulate scientific knowledge in a usable tool. However, re-designing a cropping system in the context of agroecological transition does not just mean managing it: farmers do not work with a given stable system whose management is to be learnt; they actually gradually transform an agroecosystem while acting on productive resources - removing, adding or modifying some of its components.

Consequently, when the re-design of a cropping system involves biological processes, this requires a combination of scientific general knowledge of the corresponding system, the situated knowledge farmers acquire or develop, and an integrated approach to the cropping systems. Although such a category as “scientific knowledge” is commonly used, it inherently refers to an indefinite variety of knowledge forms regarding, for instance, their relevance for farmers’ actions. What is referred to as “scientific general knowledge” in this article corresponds more specifically to knowledge produced by scientists by means of experimentation, measures and analysis (that may not be available to farmers), and that concerns generalisable processes or laws about the agroecosystems and natural objects. We focus on knowledge that seems a priori not directly operational for farmers, namely produced through fundamental research. The core focus of this article relates to this combination: how do farmers re-designing their cropping system mobilise general scientific knowledge in their particular situation?; how is this knowledge contextualized?; and what do such processes tell agronomists seeking to provide relevant resources for re-designing cropping systems? In the next section, we briefly present the methods we used in the different cases for data collection. In the results section, we present four crosscutting findings.

Methods
We selected in this paper two examples (out of a larger set) of technical change in step-by-step re-design processes, as characterised by Meynard et al. (2012). These case-studies concerned the implementation of new “agroecological” practices (Wezel et al., 2014), following various goals: diversifying the cultural strategies to reduce weed pressure along the crop sequence (Case 1); and changing soil tillage to improve the soil structure and fertility (Case 2). For each case study Table 1 states the timescales that the data we collected concerned, the location, and the number and professions of actors involved. On the one hand (Case 1), we observed a group of farmers in a one-day design workshop. On the other hand (Case 2), we carried out an individual semi-structured interview with a farmer, focusing on the implementation of one specific technical change, and asked the farmer about the information sources mobilised, the successive actions he implemented and the observations he made.

Table 1. Presentation of the case studies.

<table>
<thead>
<tr>
<th>Case studies</th>
<th>Number of farmers and advisors</th>
<th>Location</th>
<th>Farming systems: main productions</th>
<th>Situation</th>
<th>Time scale of the story</th>
</tr>
</thead>
</table>

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We made an instrumental use of the cases (David, 2003): in each case, we particularly observed the moments when new knowledge was mobilised by focusing on the agronomic objects or processes mentioned (e.g. a new crop, a soil management tool, a specific interaction mechanism between crops and weeds). Based on the identification of this knowledge, we tracked its transformation and its use until the implementation or design of a new practice, that is, how it is rephrased and connected to previous knowledge or thoughts. We used full transcripts of the interview or meeting which were fully recorded. We identified key elements in the chronology, and focused on some sticking points and steps or events through which these were overcome. Namely, we distinguished periods of the meeting during which either each participant’s own experience was shared or a common understanding was built and discussed. In the interview, we resituated as precisely as possible each particular knowledge mentioned along the technical change process. We then identified what was specific in this knowledge, shared and used by farmers in each of these steps, with a particular focus on the knowledge that made it possible to continue with the different technical changes and therefore unlock the re-design processes. The main questions we used to obtain this information concerned: how specific knowledge is asserted and discussed; how generic knowledge is used in a specific context or, conversely, how localised experiences are discussed and shared in general terms; and how it allows the farmers to choose new practices or strategies they intend to implement.

Case studies

An organic farmers’ meeting for the design of perennial weed control strategies
The meeting focused on the management of perennial weeds, particularly thistle, identified as a common problematic species on the group’s farms. It started with a presentation by a facilitator on biological and physiological aspects of thistle, drawing on scientific papers, agronomic press and expert knowledge from experimenters (Table 2, line 2). During this presentation, although the techniques were not mentioned on the slides, farmers’ comments directly linked the information given with possible changes in their actions. The same facilitator then presented two curative strategies: exhaustion and extraction (Table 2, line 2). The size of root fragments to support each strategy differs (long for extraction, and short for exhaustion)
based on the soil management tools used. The results from different experiments comparing various soil tillage tools quickly prompted discussions about organisational feasibility (workload, equipment, energy use), but did not lead to the emergence of new management strategies. After this first part of the meeting farmers discussed their own experiences but without reaching a shared conclusion, mostly underlining the specificities of situations (e.g. the possibility of having long dry periods for an efficient extraction strategy; density and age of thistle’s spots). In the afternoon, the farmers were asked to each make propositions for a specific case. They started with opposing points of view, without consensus on the results of the techniques proposed (competitive effect of alfalfa or a lentil-triticale mixture; the use of specific machines adapted from other farmers’ experiences, e.g. the “Wenz method”). A real strategy began to emerge only when the discussion returned to the key aspect of the dynamics of thistle’s “reserves”. The effect of practices (mowing, false seed bed) on this dynamic was discussed, which involved re-specifying the key moments of the dynamics and the detailed processes of the constitution of reserves (e.g. are they at minimum at harvest or at the end of summer? Are they increasing when the plant grows?). Participants identified a specific indicator of plant development stages which was directly linked to the reserves’ dynamics: the 6-8 leaves stage. Prior to this, the plant’s reserves decrease, whereas after they increase. Only then were two practice strategies to test proposed (Table 2, line 5).

Table 2. Case study specificities according to the knowledge and experiences exchanged, the agronomic problems and the technical strategies built.

<table>
<thead>
<tr>
<th>Organic farmers’ meeting about perennial weeds control</th>
<th>A farmer’s implementation of stubble ploughing, cover crops, in a minimum-tillage system</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 The initial problem</td>
<td>Implementing non-ploughing strategies consistently with other practices on the farm: stubble ploughing was introduced to prevent deep tillage while reducing pesticides use, but not well managed</td>
</tr>
<tr>
<td>Controlling perennial weeds without herbicide</td>
<td></td>
</tr>
<tr>
<td>The knowledge claimed, discussed, proposed for debate</td>
<td>Carabid species and basic biological elements: depth at which they live and reproduce, populations they impact on.</td>
</tr>
<tr>
<td>The redefinition of perennial weeds (“possess specific organs that allow self-multiplication and store reserves”); the description of vegetative propagation mechanisms (“thistle buds are on a root that is horizontal and it produces shoots called suckers”); the rooting depths and suckers’ dormancy (broken down when the root is cut into pieces); the soil factors favouring thistle;</td>
<td>Cover crop species characteristics (which is still in progress): 200 species described in terms of nutrient uptake and release, growth dynamic and competitive capacities.</td>
</tr>
</tbody>
</table>
the life cycle and rates of reproduction by seeds and particularly the dynamic of thistle's reserves during the year and according to plant development stages and climate.

Two curative strategies: exhaustion ("repeated destruction of aerial parts forcing the thistle to regrow or by a fragmentation of roots that bring out dormant buds and generates new shoots"); and extraction ("fragment the rhizomes, pull them out of the ground and then export them or let them dry").

3 The people at the origin of knowledge
An animator presented knowledge gathered from scientific papers, agronomic press and expert knowledge from experimenters
A carabids specialist technical institute for crop techniques confirmation

4 The personal experiences brought to the discussion
The different applications of stubble ploughing within the group were compared (depth, results in terms of weeds germination)

5 The action strategies finally proposed
i) with a cover crop mixture sown just after the harvest and without ploughing, and a ploughing destruction at dawn, when thistle would have reached the 6-8 leaves stage; ii) with alfalfa introduction, either undersown in the cereal or sown after harvest, adapting the cutting frequency to the thistle regrowth, identified according to the 6-8 leaves stage indicator.

The farmer eventually built his soil tillage strategy under the constraint of a 10cm depth limit. He adapted and reinterpreted the stubble ploughing action from this basis.

A farmer's interview in a minimum-tillage system
This farmer participated in an eight-year project with a R&D organisation to develop integrated crop management using less pesticide. At the same time, he changed his cropping system by removing all ploughing practices. At first, his knowledge about the techniques associated with no-ploughing strategies was restricted to the types of machines one can use, and the problems
encountered which lead to removing ploughing (e.g. the energy cost of ploughing, hydromorphic soils). Rapidly he had to use more pesticides. In order to continue not to plough while decreasing herbicide use, he tried to adapt the techniques used for soil preparation and covering between crops. He implemented stubble ploughing after crop harvests to bury crop residues and manage weeds. However this had varying effects and the following wheat crop showed a weaker growth dynamic. He obtained various references by comparing the number and date of applications with colleagues, but this still did not give him guidance for the specific adjustment of the practice. He began to resolve this issue when a scientist studying carabid species presented basic elements on carabids’ biology, and in particular the depth of soil at which they reproduce. He deduced that soil tilling deeper than 10 cm prevented the development of a carabid population by disrupting its habitat, thus favouring the growth of slug populations. With the help of an expert from a technical institute, he then confirmed that 10cm was a sufficient depth to grow beetroots: he considered other possible actions in his own situation, handling interactions with other practices (i.e. the presence of beetroot crops in the succession). He analysed and reinterpreted the results concerning the false seed bed action of the machine with colleagues, comparing their respective experiences to confirm some of the technique’s effects.

Crosscutting analysis: mobilisation and contextualisation of “fundamental knowledge”

The mobilised knowledge is focused, partial and often qualitative

The comparison of our case studies shows that the knowledge which appeared useful for unlocking processes of change was very specific, rather than involving the whole system in an integrated way. In fact, whereas the problems the farmers faced were highly systemic (Table 2, line 1), the knowledge that allowed them to move forward in the technical changes was very fragmentary and selective: it concerned only some components of a system and mainly the biology and dynamics of biological objects (particular species such as thistle in Case 1; cover-crop species and groups of species such as carabids in Case 2). These biological objects are generally not directly and intentionally manipulated by the farmers, but they are always involved in natural processes that might interact with cash crops’ growth and productivity. Also, they can be influenced by the farmers via cultural practices. Furthermore, the knowledge used was fundamental, describing a biological or physiological process (such as the dynamics of thistle reserves’ accumulation and depletion throughout the year, or the cycle of development of a plant disease, Table 2, line 2). This fundamental knowledge is opposed to more operational knowledge, for example the effectiveness of different soil tillage tools to decrease the thistle population. It concerned neither systemic interactions nor regulation. The analytical fundamental knowledge we identified was thus mostly qualitative.

This particular knowledge was proposed by a specialist in our case studies. This was expressly mentioned in Case 2 concerning the carabid species’ biology (an entomologist specialised in carabid species). These specialists belonged either to research institutes or to national technical institutes, but their legitimacy in the eyes of the farmers lay in their ability to bring together a host of bits and pieces of knowledge that may also be available from other sources (websites they visit for example) but were never organised in a synthetic form. We stress the fact that this focus on specific aspects of the knowledge mobilised, which is fragmented and concerns biological objects, highlighted differences compared to what most crop simulation models show. The prevalence of partial knowledge on a limited part of the system components might seem contradictory with the need to anticipate the systemic
feedback effects and unintended consequences of actions. However, in the following sections we show how such knowledge may gradually be related to a particular cropping system.

**Farmers use the knowledge they can link to their own action**

The knowledge mobilised was that which farmers could use to steer their own actions. In fact, among all the functional aspects of the biological objects that farmers might manipulate, they considered as useful those for which they could establish a relationship between their actions (already implemented or potential) and the response of the objects. We identified four different types of relationships or patterns as described below.

First pattern: knowledge about a biological object can relate to an action that farmers already performed and manage, the effect of which is also partly known by the farmer. To understand the effects on the new object of an action already performed, further knowledge on this object is required (Figure 1, Pattern 1). For instance, in Case 1, farmers asked for specific details about the depth at which root regrowth mechanisms occur, to be able to relate this to the depth of their soil ploughing. This gave them a better understanding of the various effects of actions on roots’ biology and physiology. This pattern can be considered as a first step towards situating knowledge: farmers try to identify the conditions of action in which the effects targeted will be obtained or not, depending on the knowledge acquired on the biological object.

Second pattern: farmers can use fundamental knowledge on biological objects when it allows them to anticipate the effect of a new action that they have never performed (Figure 1, Pattern 2). In Case 1, they asked for knowledge on thistle roots’ biology in connection with the different tools used for soil tillage. In fact, since only specific parts of the roots can regrow after being cut, they tried to select the appropriate tool for soil tillage based on the depth and width of scalping. In Case 2, the farmer built a new complete soil management strategy starting with the constraint of a 5 to 10 cm depth limit for soil tillage, so as to keep the disruption of carabids to a minimum and thus reduce the occurrence of slug attacks. Third pattern: fundamental knowledge can be used to reinterpret previously observed effects or consequences of an action (Figure 1, Pattern 3). In Case 1, the 5% spread of thistle through seeds explained the low effectiveness of topping. Farmers also associated repeated cutting and mechanical

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![Figure 1. The different ways knowledge was linked to action.](image)

*Figure 1. The different ways knowledge was linked to action. (The numbers in grey circles correspond to the four patterns described in the text).*
weeding with the thistle pressure increase, based on the regrowth mechanism of suckers: these cultural practices cut roots into short pieces, stimulating re-growth.

Fourth pattern: fundamental knowledge can guide action by enabling farmers to identify an indicator to monitor their action (Figure 1, Pattern 4). In Case 1, farmers identified the thistle’s development stage of 6-8 leaves as an indicator for triggering the cutting because it is the stage at which the plant’s reserves are at their lowest and the cutting the most efficient.

These patterns suggest particularities in the mobilisation of knowledge to design new actions in a cropping system. They highlight the fact that farmers gradually organise knowledge on the functioning of limited parts of the system and do not embrace the whole system at once. This contrasts with the assumption that, in order to take into account all systemic interactions, one should formalise the functioning of the whole system (i.e. draw connections between numerous actions with combined but inseparable effects), which is at the core of the modelling strategy (e.g. McCown et al., 1996). Considering the functioning of a limited part of the system makes it possible to relate it to specific actions, while the assessment of a global functioning would relate to integrated actions (e.g. a complete crop management itinerary), involving a whole set of causal relations that one may not be able to grasp. In that sense, our findings converge with those of previous ergonomic studies (Amalberti, 1992; Cerf, 1996), which suggest that actors tackle anticipated events and plans based on a known set of actions, that is, that knowledge on the systems’ processes is organised according to known action. Nevertheless, these studies considered situations where usual actions were to be applied. In our case, the design of a technical change may explain why we observed such organisation of knowledge in both directions: new knowledge also led to the organisation of new actions. Building an understanding of the functioning of parts of the system results from iterative loops between knowledge on the biological components and the farmer’s own action.

**Fundamental knowledge supports the reformulation of individual experiences and makes them useful to others**

Farmers readily shared their own experiences. In our case studies we observed that simple experience sharing could rapidly lead to various explanations depending on the situation. Most of the time, local specificities were invoked as the sole cause of these differences, preventing further extrapolation, and more particularly interpretation and learning from others’ experiences. Conversely, when a specific bio-physical phenomenon was used to reinterpret the various experiences, the results were not just used to deduce whether or not a technique “worked”, but mostly to validate the farmer’s existing knowledge specific to his situation. Personal experiences, when related to a specific bio-physical phenomenon, also provide an illustration of fundamental knowledge on this phenomenon, even if the variability of the results they show is not fully explained. In that sense, there is both a reinterpretation of these experiences taking into account the new understanding afforded by the fundamental knowledge, and a reformulation of this knowledge through existing experiences. Cross-comparing the different experiences allowed farmers to gradually confirm a particular aspect of the functioning of the system, based on fundamental knowledge. Moreover, when fundamental knowledge is confirmed, the slight differences in results or observations in various experiences may call for further specification. In Case 1, the farmers successively shared their own experiences with different thistle management strategies, discussing the results, but struggling to find a common conclusion on the effects of different techniques because of the variability in soil structure and management practices, weed pressure intensity, crop sequences and the climate. However, when one of them related each practice and result
to the dynamics of thistle reserves, they found consistency in these results and deduced the possible management techniques to be applied to the situation discussed. They eventually reconsidered the significance of their observations (thistle regrowth becomes a positive process because it signals a decrease in its reserves), but also highlighted the need to be more accurate in the description of reserve dynamics during the discussion. Furthermore, future actions planned to compare mowing and scalping effects in an exhaustion strategy were also geared towards specifying the exact type and intensity of cutting that induces the greatest regrowth.

The reformulation of individual experiences we described in this section relates to Pattern 3 presented earlier. Also, whereas this pattern related to individual action (and was described as a process that each farmer may apply individually), this analysis of experience sharing introduces a collective dimension. The collective reformulation of individual experiences therefore corresponds to the growth of Pattern 3. Furthermore, it is worth emphasising here the distinction we make between experience and action. Whereas action is mentally delimited in Pattern 3, experience tacitly encompasses the unintended effects and consequences of the conceptualised action. In that sense, it includes the share of unknown surrounding the implementation of action in a particular situation.

Sharing previous observations and results allows a collective to perform “narrative sensemaking” (McCown et al., 2012), which produces a combination of “if …then” rules of action, as well as an understanding of the partial system functioning underpinning these rules. This finding from our case studies is also in line with what Pålshaugen (2004) called “practical discourses” containing “public interpretations of personal experiences”.

“Fundamental knowledge” and farmers’ own cropping system are linked through three main processes.

We now propose an analysis of the way fundamental knowledge is mobilised in the particular situation faced by the farmer. We identified three different processes participating in the reformulation of new knowledge, which the farmers applied in order to gradually form an understanding of a part of their cropping system. These processes can be summed up as (Figure 2): 1) non-situated knowledge on generic aspects of the biological objects is tailored in order to situate a biological process/phenomenon in a given environment; 2) the situated biological phenomenon is related to the effects of actions which impact it; and 3) other practices that can have the same effects on the phenomenon are considered. Although continuity between these processes may appear, they were rarely observed in the corresponding full sequence in our case studies.

First, the non-situated knowledge concerns the biological objects, and is thus independent from the environment in which such objects are or would be manipulated (Table 2, line 2). These may concern stable features of the objects, which can vary in intensity or accurate values in different environments, but of which the trend of interest for the farmer’s interpretation remains (e.g. the thistle increases root reserves in summer, which is true in various environments, although the rate of accumulation and quantities may vary according to the climate and soil nutrient contents). Hence, farmers try to complement this knowledge with the influence of the environment (climatic and biotic context), so as to situate the phenomenon involving the biological objects.

Second, farmers related the situated biological process to the effects of their own actions. This allowed them to validate, confirm or specify the direct and indirect results of specific practices,
and involved the various patterns presented above. Sensemaking in this process appeared to focus on the distinction between the description of a biological process in the environment occurring without direct human intervention and the part of the process induced by human intervention. In Case 1, a farmer asked “you say that there is only 3 to 5% of thistle plants which come from seeds, but is it because we avoid flowering or is this the case even in a wild system?” This second process also materialised in Case 1 when farmers tried to re-draw the curve representing the amount of thistle root reserves throughout the year when different cuttings were performed. Interestingly, Walker and Sinclair (1998), who proposed a method to elicit and formalise local qualitative knowledge, emphasised the relevance of distinguishing the objects, processes and actions in order to establish the causal links between them.

Third, the specified influence of human action on the biological phenomenon was used as a base to broaden the range of practices that may have the same effect. This led to identifying other actions impacting the same situated phenomenon, or to specifying the quality or intensity of the relationship between an action and a situated mechanism, or to identifying other mechanisms of interest (Case 1: the cover-crops preventing soil tillage led to considering whether repeated topping would also deplete thistle reserves, and to tackling another mechanism – the effect of competition for light between thistle and cover-crop species on the accumulation of roots’ reserves).

We have previously shown how particular and situated experiences were used to bring out decontextualised causal relations within the cropping systems but the description of these three processes addresses the way farmers contextualise generic knowledge on non-situated biological objects. The contextualisation we analysed does not amount to simply validating the knowledge discussed in a particular situation based on various contextual elements. Rather, it involves a gradual reformulation of this knowledge, in order to build situated meaning for action, that is, to construct its meaning for a particular cropping system. By distinguishing between these different elementary processes, we were able to unravel how specific fundamental knowledge may give farmers a “hold on reality” (Mormont, 2007).
A systemic understanding built gradually

Findings from our case studies suggest that, in order to think about action within a system, farmers successively and consistently compile different aspects of the functioning of limited parts of the system. This involves decontextualisation and contextualisation processes, combined with gradually linking new fundamental knowledge to their particular cropping systems.

The four patterns followed to link knowledge on biological objects to farmers’ action showed that farmers develop knowledge, in a joint and iterative way, on the biological objects involved in their cropping system, and on the actions which are part of this system (Figure 1). This leads to the situated development of an understanding of the functioning of a part of the cropping system which includes action. In that sense, the contextualisation of fundamental knowledge on biological objects that impact crop growth or the state of production resources corresponds to systemic thinking. Ison (2008) has defined “systematic thinking” as “thinking which is connected with parts of a whole but in a linear, step-by-step manner”, and “systemic thinking” as “the understanding of a phenomenon within the context of a larger whole; to understand things systemically literally means to put them into a context, to establish the nature of their relationships”. The findings from our case studies suggest that farmers alternate between both systematic and systemic thinking: it is systematic through the mobilisation of knowledge on isolated biological objects and the natural processes they relate to, but the comparison with action and previous experiences gradually leads to addressing emerging effects and interactions between various practices which may cause unintended effects. The move from systematic to systemic thinking is operated by action (Figure 3). This is worth noting as it mitigates the claim that “the primary prerequisites for the sound design of managed ecosystems are a profound and comprehensive understanding of their components and the relationships between them, and of the ecological processes that occur within natural and managed ecosystems.” (Hill, 2014). In fact, we suggest that while such a comprehensive approach is required, design occurs throughout the process of understanding, which contrasts with the hypothesis that a preliminary understanding of the whole system’s components and interactions is a prerequisite for action.
Conclusion
This article focused on cropping system re-design and addressed the link farmers make between generic and fundamental knowledge, their situated action on particular systems and the systemic approach it entails. This led us to discuss how farmers take into account the immanent systemic aspects related to the re-design of cropping systems. One major finding is that farmers can choose, adapt and implement new practices based on an understanding of the functioning of a limited part of their own system, and not necessarily taking the modelling of the system, as complete and integrative as possible, as a prerequisite for choosing best practices. We propose that farmers build a situated understanding of the functioning of their cropping system in order to design new practices, but this requires continuous comparison with the results of action, known or imagined, and with past experiences reformulated in light of new fundamental knowledge. Knowledge of the system increases in a joint dynamic, along with knowledge of action that farmers implement. Our conclusion is therefore not simply that it is necessary to further extend knowledge on biological system components in any way possible, but that scientists wishing to support these re-design processes should produce knowledge which might be articulated in farmers’ action. It is worth remembering that these findings relate to re-design situations geared towards a greater mobilisation of biological processes. This might explain the specific focus on fundamental knowledge about biological components of the system. Furthermore, the processes we described suggest that R&D agronomists should play a particularly significant role in identifying the possible links farmers operate between generic knowledge and their situated actions for re-design (Cerf et al., 2010; Delbos et al., 2014). Rather than supplying sets of operational procedures, they should contribute to farmers’ identification and observation of the situated biological phenomenon and the way they are affected by the various actions, and to the reformulation of individual experiences regarding this phenomenon. In return, agronomists’ involvement in such processes might shed light on the directions which the production of scientific knowledge should follow.
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Farmers' experiments and innovations: a debate on the role of creativity for fostering an innovative environment in farming systems

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Abstract: Innovation has become the promising concept to overcome problems and enhance agricultural performance in agricultural research and policies. In the past, innovation was mainly seen as being developed by science or enterprises, and only recently the focus has shifted from a linear to a systemic perception, acknowledging that innovation is a dynamic process that implies the participation of a diversity of stakeholders. Consequently the role of multiple stakeholders, including farmers, in the innovation process receives more attention. Farmers' experimentation is the process by which farmers informally conduct trials or tests that can result in innovations suitable for their specific conditions. Although the role of farmers experiments in the innovative process is increasingly acknowledged, literature on the creative process that leads to farmers' experiments and innovations is missing in farming systems research. The aim of our contribution is discussing this missing link, focusing on how motivations, learning processes and specificities of the workplace farm may influence the creativity of farmers.

Keywords: Farmers’ experiments, innovation, creativity, agricultural knowledge and innovation systems (AKIS), organic farming

Introduction: farmers’ experiments and innovations

The historical development of locally adapted farming systems worldwide can be ascribed to continuous experimentation activities of farmers (Hoffmann et al., 2007). Farmers’ experimentation is the process by which farmers informally conduct trials or tests that can result in new knowledge and innovative management systems suitable for their specific agro-ecological, socio-cultural and economic conditions (Rajasekaran, 1999). Experimenting enables farmers to adapt to constantly changing conditions (Bentley, 2006; Darnhofer et al., 2010), is a means to generate local knowledge (Sumberg & Okali, 1997), and builds the base for countless agricultural innovations (Vogl et al., 2015). For a long time the term ‘innovating’ was mainly associated with science or enterprises and only recently the focus has shifted from a linear to a systemic perception on innovation, acknowledging that innovation is a dynamic social multi-stakeholder process that implies the participation of a diversity of stakeholders and institutions (Klerkx et al., 2012b), including farmers. Consequently the role of farmers as innovators and the value of local knowledge receives more attention (Brunori et al., 2013). Also, with the increasing interest in novel approaches to rural development including the concepts of participation and empowerment in sustainable rural development, the topic of farmers’ experiments and innovations began to attract more attention (Bentley et al., 2010).

Innovation research has become a field of science covering a remarkable diversity of topics with a high complexity of theoretical and applied debates. One of the areas of research in innovation studies is agriculture where e.g. agricultural knowledge and innovation systems (Knierim et al., 2015) provide details on the process of innovating in the agriculture sector. In a claim for fundamental reorientation, systems redesign and radical innovations, Klerkx et al. (2012a) show the importance of visions - visual and tangible representations of novel
agricultural system concepts in innovation and learning processes. Heterogeneous multi-actor environments with a variety of actors, sources, types and processes of active social learning are state of the art in learning and innovation networks for sustainable agriculture (Tisenkopfs et al., 2015). These environments enable co-learning and link grassroots experimentation of farmers with agricultural research and extension. These environments create a ‘dialogue of wisdoms’ (Tittonell et al., 2016).

Nevertheless, the creative process that leads to farmers’ innovations is rarely studied nor described precisely in agricultural sciences and not yet taken fully into account in organic farming systems research (Vogl et al., 2015). As an example, in the organic farming literature, terms currently used for describing what leads to farmers innovations are e.g. ‘problem solving’, ‘innovating’ or ‘self help’ (TP-Organics, 2014). These terms are however used ambiguously and imprecisely, which might easily lead to ignoring the complexity of the processes involved. Both the organic farming and agroecology movement feature innovations (e.g. Herren et al., 2016) but miss carefully addressing the origins of innovations.

A lack of knowledge of this genuine creative process of ‘innovating’ might lead to ignoring the intervening factors, misplacing the key incentives and thus not sufficiently taking into account the opportunities for encouraging farmers’ experiments and innovations. To our knowledge specific literature on the genuine process of creativity that leads to farmers’ experiments and innovations is missing in agricultural sciences and farming systems research. Therefore, the aim of our contribution is discussing the link between creativity related research and farming systems research. We start by summarising and defining relevant selected literature on creativity, motivation, learning and workplace influence, with specific focus on the potential relevance for farming systems research, farmers’ experiments and innovations. After outlining and defining these concepts, we discuss options for creativity research in (organic) farming systems, with an additional focus on the specificity of the workplace ‘farm’.

**Creativity**

Creativity is defined as the "development of a novel product, idea, or problem solution that is of value to the individual and/or the larger social group" (Hennessey & Amabile, 2010). Creativity can be found behind all innovations. Creativity is an attitude towards life that responds to problems in a fresh and novel way (Sternberg, 2012).

Creativity is being conceptualised in various models. We choose the Four-C Model, which distinguishes four levels of creative magnitude and development (Kaufman & Beghetto, 2009) in a way that will later allow us to link these levels with examples from farming systems:

- mini-C creativity consisting of the creativity inherent in learning processes;
- little-C creativity consisting of amateur, everyday creative activities;
- pro-C creativity consisting of professional-level creativity;
- big-C creativity consisting of eminent creativity.

The investigation of creativity can be separated into the study of creativity of products and the creativity of persons. When creativity is perceived in terms of products achieved, creativity is understood as largely situation-dependent and spontaneous. Contrary to this, creativity of persons rather perceives creativity as a stable and enduring trait of individuals (Hennessey & Amabile, 2010). Creative people habitually: a) look for ways to see problems that other people don’t; b) take risks that other people are afraid to take; c) have courage to defy the crowd and
stand up for their novel beliefs; and d) seek to overcome obstacles and challenges (Sternberg, 2012).

Methodologically, the creativity of products can be evaluated by self-assessments (mini-C), consensual assessments from experts in the corresponding field (little-C, Pro-C) or major prizes or honours (Big-C) (Kaufman & Beghetto, 2009). The type of creative products achieved can be conceptualised as “contributions that accept current paradigms, contributions that reject current paradigms, and contributions that attempt to integrate multiple current paradigms” (Sternberg, 2006).

The study of creativity of persons on the other hand relies on experimental, case study or questionnaire-based research designs (Hennessey & Amabile, 2010). Creativity of persons depends on six distinct but interrelated resources: intellectual abilities (including seeing problems in new ways); knowledge (know enough about a field); a thinking style that gives preference to think in new ways; personality (including willingness to take sensible risks and overcome obstacles); environment (supportive and rewarding for creative ideas) and motivation (intrinsic, task-focused) (Sternberg, 2012).

Historically, the term creativity was approached by scholars from a variety of disciplines – including education, arts, economics, neurosciences, anthropology and diverse sub-disciplines of psychology such as cognitive, developmental, social and organisational – all concentrating on very specific aspects of creativity. This resulted in a wide range of knowledge about creativity but also in fragmented and isolated groups of researchers losing sight of each other. Also, across all disciplines, creativity research has long concentrated on the creative individual or products obtained but largely neglected the creative environment in which creativity may or may not flourish (Hennessey & Amabile, 2010). Systems models were created to improve the understanding of creativity, and aimed at connecting (sub-) disciplines and increasing interdisciplinary investigation on creativity and at broadening the level of analysis to include the social and cultural environments in which creativity grows (Csikszentmihalyi, 2014; Hennessey, 2015).

Although systems views of creativity help to generate new insights and research questions, they may not adequately foster the application of these insights in real world settings (Hennessey & Watson, 2016). Since the ultimate goal of creativity research needs to be the promotion of creativity, a further focus of creativity research should lie on the application of findings in real world settings (Hennessey & Watson, 2016), such as schools, organisations, arts and, as our main concern, farming systems. For promoting creativity, e.g. in farming systems, a close look at motivation or motives is essential.

**Motivation**

Motivation is a frequently researched influential trait for creativity. To be motivated was defined as ‘to be moved to do something’ (Ryan & Deci, 2000). The types of motivation can be distinguished as intrinsic and extrinsic. Intrinsic motivation means behaviour that is inherently interesting and satisfying and thus results in positive feelings. Intrinsic motivation is enhanced by autonomy or self-determination, feelings of competence and a sense of connectedness or relatedness to individuals, groups or societies (Ryan & Deci, 2000). Extrinsic motivation means to be moved to do something because a separable outcome is strived for, whereas the activity itself is not as satisfying (Deci & Ryan, 2008). Examples of extrinsic motivation include reward, expected evaluation, surveillance, competition or restricted choice. Intrinsic motivation
was found to enhance creativity (de Jesus et al., 2013; Hennessey & Amabile, 2010), whereas extrinsic motivators can reduce intrinsic motivation and creativity when self-determination is undermined. However, extrinsic motivation was also found to enhance creativity in some cases, such as rewards when people are already intrinsically motivated or when they confirm competence (Hennessey & Amabile, 2010).

Creativity may also, under certain conditions, be enhanced by prosocial motivation (Forgeard & Mecklenburg, 2013). Mood states (Baas et al., 2008) and stressors (Byron et al., 2010) have also been linked with creativity. The links between motivation and creativity are thus pronounced but complex. Autonomy, competence and connectedness are key for enhancing intrinsic motivation, which again is important for enhanced creativity.

Both creativity and motivation are key concepts used in research related to learning environments.

**Learning**

There are two premises regarding creativity in education: first, creativity can be developed; and second, all individuals have potential to be creative (Lin, 2011). Enhancing creativity has become a global-wide interest reflecting the demand to raise competitiveness, and so there is a trend to reform educational systems to equip young people with innovative and creative capacities. Consequently, creativity is regarded as a life capacity for future success (Lin, 2011).

Sternberg (2008) defines success in his “Theory of Successful Intelligence” as “the use of people’s abilities, recognising their strengths and correcting or compensating for their weaknesses, adapting to or shaping environments, and finding a balance in their use of analytical, creative and practical abilities” (Sternberg, 2008).

Three interrelated elements are distinguished in creative pedagogy: creative teaching (focusing on teacher practices); teaching for creativity (highlighting the learner agency); and creative learning (Lin, 2011). Torrance (1963) contrasted learning creatively with learning by authority: children learn by authority when they are told what they should learn and accept ideas from authorities (e.g. teachers, books), whereas when learning creatively children learn by means such as questioning, searching, manipulating, experimenting and playing (Torrance, 1963 in Lin 2011).

There exists a synergistic cycle among self-actualisation, learning and creativity, but the fact that in the current educational systems we do not achieve excellence on a broad level indicates that there are significant challenges to entering and sustaining this cycle (Burleson, 2005). A way to enhance learning experiences is to let learners use their imagination and multiple points of view, by asking their own questions and seeking answers in diverse ways, in a process of developing and exchanging perspectives. Several important scientific discoveries were developed by imagination and the use of analogies, such as Einstein’s Theory of Relativity or the discovery of the benzene-ring structure (Burleson, 2005).

One important barrier to learning is the fear of failure, although failures are critical to learning, and experts can be regarded as people who have failed many times. To overcome this barrier, the consequences of failure and humiliation should be minimal, motivation should outweigh failure, and learners should strengthen abilities to persevere through failure, such as motivation, will and effort. It can also be helpful when learners can reflect on their failures with
experts and learn from the experts’ experiences and strategies to deal with failures (Burleson, 2005).

Despite the abundance of research on creativity and learning, little achievements have been made to apply these research findings to the classroom or other real-world settings, except in the area of corporate creativity and innovation, with the aim of helping companies boost profits (Hennessey & Watson, 2015).

There is a multitude of academic references on the importance of learning within agricultural systems and in natural resource management in general, including literature on social-ecological resilience. But when searching for concrete relationships between learning and innovation with creativity, there is not much to be found. Most academic discussions circle around the question of how to facilitate and enhance social learning (e.g. Blackmore, 2007; Hubert et al., 2012), how to enable learning and innovation networks (e.g. Moschitz et al., 2015), and adaptive (farm) management (e.g. Armitage et al., 2008; Darnhofer et al., 2010).

Structural conditions hindering or facilitating innovation systems described in literature (Hermans et al., 2015) focus on (knowledge) infrastructure, laws and regulations, norms, values and culture, interactions, market structures, and finally capabilities of the involved actors – a point where creativity could be relevant.

**Workplace**

Much attention in scientific literature on innovation and creativity is given to topics related to characteristics of workplaces, performance of employees, behaviour of employers, architecture or interior design of office space and office buildings. The interest guiding research and development in these domains is often efficiency and effectiveness of the performance of staff, the enabling environment for innovation but also how certain characteristics support or inhibit the creativity of the working process or products. Constraints and pressure in the work environment are detrimental to creativity. Speaking up about concerns, reporting mistakes, proposing new ideas, autonomy in the workplace, or a degree of empowerment can be important for organisational creativity. Also important are team leader support, the behaviour of managers, time pressure or psychological safety (e.g. Hennessey & Amabile, 2010).

Compared to the vast, diverse and detailed literature on industrial or so called white collar workplaces, or on the workplace ‘classroom’ at schools or universities, the literature on the workplace ‘agriculture’ is relatively sparse. Conflicts based upon social processes between generations at farm level (Jaunecker et al., 2011; Larcher & Vogel, 2009), the ergonomics or safety of work in agriculture or forestry (Kogler et al., 2016) are just two examples of topics that are discussed. The debate on creativity in agriculture, forestry, gardening or other related professions that manage natural resources is seemingly non-existent.

**Options for creativity research in (organic) farming systems**

When we look into farming systems, innovation has become the promising concept to overcome problems and enhance agricultural performance. In the European Union Common Agricultural Policy there is a clear shift from innovations originating from state and corporate Research and Development activities towards participatory innovations, which depend on individuals’ or rural societies’ own creativity. Innovations should consequently be developed in collective and creative learning processes (EU-SCAR, 2012).
Trying, testing or experimenting at farm level is one of the inherent processes of farming that contributes to explaining how the process of innovation is approached by farmers (Vogl et al., 2015), but the research on farmers’ experiments has so far not explained sufficiently how and why individuals become experimenters. The scientific debate on creativity may help as it has not yet been extended to farming systems research.

Farmers and gardeners are immersed in a workplace that can be analysed related to creativity of products and/or creativity of processes. Interpreting Kaufman and Beghetto (2009) we see:

- mini-C creativity consisting of the creativity inherent in learning processes at farm level for the farmer and the farming family, e.g. in continuous contacts with consumers, other farmers, as a participant in training courses or when watching TV documentaries on farming practices;
- little-C creativity consisting of everyday creative activities such as finding spontaneous solutions when confronting problems, and simple trial-and-error experiments (repairing, adapting, substituting resources…);
- pro-C creativity (professional level creativity), i.e. the constant adaptation of farming practices to seasonality, trends in the market, available labour at the farm, etc.;
- big-C creativity consisting of eminent creativity, that could be attributed to personalities such as Lady Eve Belfour, Hans Müller, Hans Rusch or Rudolph Steiner, who are seen as key persons to the development of organic farming.

At all these levels of creativity various and differing factors influence creativity, including motivation, learning and the workplace, and thus the innovative capacity of farmers. And for all these influencing factors a range of discussion points and questions emerge about their interaction with creativity. In the case of intrinsic motivation (consisting of autonomy, competence and connectedness) such questions include:

- How do current agricultural politics and market forces influence farmers’ autonomy and self-determination?
- How do farmers’ basic and advanced education, peer group interactions, product vending, consumer interaction, local community etc. promote or weaken feelings of competence?
- How can farmers’ evaluation, such as in environmental or quality control systems, be shaped to confirm competence and increase intrinsic motivation rather than induce a sense of surveillance and thereby contribute to the opposite?
- How do family members, neighbours, peer farmers and the larger society value farmers’ innovations and thus create a sense of connectedness?

One possible strategy to promote new, creative ideas and social learning for innovation is to integrate ‘outsiders’ into the existing agricultural innovation systems (Hermans et al., 2015), but for this to happen it needs brokerage and dialogue between members at the periphery (Ingram et al., 2014). Another entry point to enhance creative learning within agricultural systems is in the agricultural education system, be it at university level (Francis et al., 2012; Salomonsson et al., 2008) or at the level of agricultural schools and extension (Francis &
Carter, 2001). This leads us to the question of how different learning environments and workplaces influence creativity.

If we aim at studying e.g. motivation and its impact on creativity at farm level, the concept of ‘the workplace farm’ might be too general. Work at farms often includes (as for example at diverse organic family farms):

- a series of different tasks with complex job descriptions, different from one task to another, like managing the farm forest, arable crops, horticulture crops, farm animals for commercial purposes or for subsistence, maintenance and repair of machinery, household, administrative tasks or social networks, etc.;
- a diversity of actors involved, like family members of different age and sex, neighbours and friends that support the farm to a varying degree of intensity with a variety of complementary skills, hired labour, etc.;
- a managed mosaic of buildings, plots, and other units of the farming operation;
- an environment of seasonality, shocks and trends.

The impact of intrinsic or extrinsic motivation on creativity might be easily tested at the agricultural workplace and support a better understanding of the factors that support creativity, experiments and innovations at farm level. But these factors might depend heavily on the various multifaceted sub-workplaces and actors involved. There is not ‘a (proto-) typical workplace farm’ but e.g. the son’s work in the forest or the mother’s work in the greenhouse or the father’s work on any other task that might have totally different enabling or inhibiting environments for creativity and thus the innovation capacity of the farm.

Farmers and their workplaces are embedded in what e.g. Hennessey (2015) calls the “myriad of environmental factors” or the creative milieu with a strong impact on the intrinsic or extrinsic motivation. “For each of us, when prompted by just the right amount of novelty, feelings of competence, and sense of control, the inner state of intrinsic motivation sets the stage for prolonged periods of concentration, deep learning and the possibility of creative performance” (Hennessey, 2015, p. 196). Contrary to this, a variety of environmental constraints imposed by (or on) work place managers can have especially damaging effects on an individual’s intrinsic task motivation and subsequent creativity performance. The environmental constraints may be cultural values, expectations, and associated practices by entire nations, regions or groups, as well as the culture of specific institutions and environments (Hennessey, 2015).

More detailed research is needed on these topics in the context of farming systems. Especially in the context of formal and informal institutions, like for example the tight regulations for organic farming at European level (and in many countries also at national or provincial level), paired with private schemes for organic farming might have an impact on creativity and innovation not yet explored sufficiently. Agricultural policy may have neglected the impact of its instruments, like rules and regulations, on risk taking, experimentation and collaboration, i.e., the motivation and creativity of farmers, and therefore on the capacity of the so much appreciated innovation partnerships.

The evaluation of work, including how this evaluation is delivered, has a strong impact on creativity (Hennessey & Amabile, 2010). This evaluation of the farmers’ work expressed in e.g.
inspections or controls of a variety of institutions is a frequent phenomenon at farms (Vogl & Axmann, 2016). As one example (organic farming inspection) we conclude that the social and technical skills of the inspector as well the way in which the inspection and certification are delivered by the inspector and the certification body may have, together with the communication of the goals of the regulatory framework, an intense impact on creativity at farm level and the innovative capacity of actors along the supply chain.

It will be important to pick up the insights on the relation between creativity and learning, e.g. for answering the question on how to facilitate creative learning processes that lead to creativity, farmers experimenting and relevant innovations for a sustainable future of farming.

We invite the audience to an open access assessment and debate on this paper, for contributing complementary insights and adding related references at www.researchgate.org, where this paper will be online at the authors’ pages.
References


Workshop 1.6: Merits and limits of innovation platforms to promote sustainable intensification in farming systems
Convenors: Bernard Triomphe, Helena Posthumus, Mariana Wongtschowski and Jens Andersson.

Farmers operate in an increasingly complex and uncertain socio-economic and agro-ecological environment, which requires continuous adaptation and innovation. The agricultural innovation systems theory maintains that innovation in agriculture often requires a combination of changes in technology and infrastructure (hardware), knowledge, skills and information (software) and organisation of agricultural systems (orgware). Agricultural intensification for its part requires different types of innovations and associated innovation processes: breakthrough innovations, diffusion of proven agricultural techniques, support to endogenous innovation, etc. They are complementary to each other and may involve different sets of stakeholders, levels of organisation and timeframes depending on the specific context. Research and development initiatives increasingly use multi-stakeholder approaches in order to promote innovation in general, and sustainable agricultural intensification in particular. Innovation platforms are one instrument that is increasingly used and promoted to operationalise a multi-stakeholder approach to innovation fostering and diffusion. By bringing different stakeholders together to work towards a common vision or goal, innovation platforms provide a specific space and resources which can be used to foster information exchange, negotiation, planning, action and reflection. However, recent experiences in sub-Saharan Africa (e.g. Africa-Rising, ABACO, DONATA, SIMLESA) suggest that innovation platforms tend to be implemented in a rather mechanical and narrow way. Furthermore, IP leadership tends to devote (too) much energy and resources to the technological aspects of sustainable intensification and not enough to tackling the underlying learning, institutional and organisational issues which affect sustainable intensification. It also struggles to tackle the non-linear, multi-dimensional, multi-scale and unpredictable nature of any innovation process. Furthermore, focusing too much on the IP tool itself, as is often the case, tends to overlook the fact that there may be other means and avenues for fostering participatory, multi-stakeholder innovation design, delivery or adaptation (such as policy, subsidies, taxes, market regulation, etc.). This half-day workshop was an opportunity to share experiences on the use of innovation platforms and similar multi-stakeholders endeavors for sustainable intensification and to develop generic lessons and recommendations for the AR4D community. Researchers and practitioners were invited to present empirical cases, describing candidly the successes and failures, the opportunities and limitations of using an AIS approach for sustainable intensification of farming systems. We were also interested in papers focusing on conceptual or analytical frameworks which are being used or could be used to design, monitor and strengthen the approaches to innovation in general. The intention was to use the workshop to produce a subsequent joint review or comparative paper.
Agricultural innovation platform dynamics: a conceptual framework to analyse knowledge production

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Abstract: Innovation platforms (IPs) appear to be one of the most appropriate tools to operationalise research for development. Increasingly, agricultural research initiatives for development set up innovation platforms to facilitate the management and support of innovation processes; yet the mechanisms by which they operate are not well understood. This paper seeks to open the 'black-box' and proposes a framework to analyse processes that occur in innovation platforms from inception to maturity. Firstly, we use a New Institutional Economics (NIE) based analytical framework for the monitoring and evaluation (M&E) of IP performance. Secondly, from a review of the literature, we identify three ways through which research could be done within IPs: 1) soft transfer, when research has readily available results that could help solve jointly identified problems; 2) co-creation, when researchers and IP members develop research objectives and protocols together; and 3) community-based research, when IP members set up experiments on their own. We propose that both frameworks should be used to improve the monitoring of IP dynamics.

Keywords: Demand-driven research, innovation platform, innovation processes

Introduction
An increasing number of agricultural research initiatives for development use innovation platforms (IPs) to facilitate the management and support of innovation processes. Innovation platforms are increasingly seen as a promising vehicle to operationalise research for development. The innovation platform is an arena where various categories of stakeholders related to a specific crop or crop system can meet to exchange and discuss problems and constraints, and collectively propose solutions. Essentially they are spaces for learning, to implement change and to support the scaling-out and scaling-up of solutions. In the field of
agricultural research for development (AR4D), IPs are an important element in working towards more structural and long-term collaboration and engagement between stakeholders in the agricultural sector, and essential to achieving development impacts. Ideally, through innovation platforms, researchers and other stakeholders rely on each other to achieve impact at scale but unfortunately collaboration for AR4D has been insufficient so far. Understanding what affects IP performance and by what processes IPs achieve impact is therefore important to be able to improve the success of this potentially valuable development tool. IP short term performance is mainly measured through its capacity to support the implementation of activities. The complex processes leading to the identification of R4D activities in IPs are poorly understood and not well documented, but are crucial to assessing mid- and long-term performance of IPs. Structural data such as the type of actors, the level of their participation, their attendance at meetings, have to be complemented with observations and monitoring of details such as who raises issues, makes complaints and contributions, and particularly who takes the decisions and what type of decisions they are. This allows for the identification of processes not working as desired within an IP, which structural information alone would not reveal. For example, when powers are unbalanced within an IP, decisions could be taken by a small group of actors, and yet the same number of people may be recorded present at the meeting.

In this paper, we provide a framework to analyse and assess the level of maturity of IPs, particularly those established within research and development projects. We hypothesise that IPs function as a governance body (Mathé, 2009) and that the management and support of innovation processes have a strong influence on IP performance. Accordingly, we develop a New Institutional Economics (NIE) based analytical framework for the M&E of IP performance which goes beyond identifying categories of stakeholders and their interactions. We detail this framework and identify three processes within IPs: 1) soft transfer, when research has readily-available results that could help solve joint-identified problems; 2) co-creation, when researchers develop research objectives and protocols together with all platform members; and 3) community-based research, when communities set up their own experimentation. These three processes can co-exist within the same platform but at different levels, depending on the maturity of the platform, and we identify the main characteristics and drivers that lead to the transition from one process to another. We investigate whether IP functioning influences the type of processes that lead to activities carried out by the IPs (demonstration plots, trainings, participatory trials). A key assumption is that IP platforms often face difficulties in reaching maturity before the end of the project due to the forms of institutional arrangements between researchers and other IP members. Reaching maturity is not directly related to longevity or the number of activities implemented. In fact, maturity has various dimensions, and can be assessed through the multiplicity of embedded commodities, the capacity to address system trade-offs and policy impact and scaling as a long term vision of innovation platform performance (Schut et al., 2015). Humidtropics, a CGIAR research program on integrated systems for the humid tropics, has built on innovation platform initiatives and successes to pilot two multi-stakeholder platforms (MSP) to develop joint action and science-based solutions through an integrated agricultural systems research.

We take a case study of three innovation platforms and one AR4D platform in Cameroon, and analyse them in the context of the developed framework. This paper is structured as follows. The first section describes the analytical framework and the three processes we want to study.
The second section presents the methodology we used to identify the nature of processes occurring during the establishment of mother and baby trials (Snapp, 2002) with IPs in the Cameroon field sites of Humidtropics. In the third section, we discuss how this framework could be used to evaluate platform maturity and, more generally, long term performance. From there we make some recommendations for future research in this field. We conclude that the benefits of focusing on actor interactions within a system approach, and also on the IP governance mode, help to assure their performance in achieving development goals in the long term.

Conceptual framework

**IP functioning conceptual framework**

There is no universally accepted evaluation tool for innovation platforms within Research and Development (R&D) projects. Some practitioners have proposed grids and parameters to monitor and analyse innovation platform performance (Damtew & Duncan, 2015). These manuals propose to monitor IP in a structural manner, focusing on the number of meetings and the number and categories of participants. However, these elements don’t provide enough information to monitor the processes occurring within the IP. Instead, we propose to analyse IP dynamics by looking at processes rather than simply structures, using an analytical framework that builds on New Institutional Economics (NIE) approaches (North, 1990; Ostrom, 1990). This approach focuses on the extent to which the performance of a governance body is linked to its functioning. It identifies two elements: (i) the institutional environment (policies, laws, regulations), i.e. ‘the rules of the game’ and (ii) the institutional arrangements, i.e. how actors ‘play the game’. The former is related to a set of institutions and the latter to a set of organisations, both of which could be formal or informal (North, 1990).

In this study, we take IPs as governance bodies and identify the mechanisms through which they function. Some interactions occur outside of the IP boundary, but can have a strong influence on its functioning. We identify three core mechanisms through which IPs work: (i) decision-making mechanisms; (ii) operational mechanisms; and (iii) knowledge and information systems. In addition, we distinguish two secondary components that impact IP function: (i) the institutional framework, policy and financing; and (ii) the social network that are potentially pressure groups outside of the platform boundary (Figure 1). We describe in detail each of these three core mechanisms of IPs.

**Decision-making mechanisms**

Decision-making theory describes two elements to making decisions: (i) how problems and constraints are analysed and articulated; and (ii) the rationale and criteria used to make the decision.

The former, how situations are analysed and articulated, is similar to the process of sense-making described by Weick et al. (2005): “*Sense-making involves turning circumstances into a situation that is comprehended explicitly in words and that serves as a springboard into action*”. Identifying problems or constraints through a sense-making process is a central step and facilitates collective decision. In IPs, this is linked primarily to the capacity of the platform members to collectively analyse problems and constraints. Through the presence of multiple
stakeholders, IPs facilitate the capacity to analyse problems in a holistic way through to the sharing of information.

Secondly, the set of rationales and criteria used to make choices within an IP is influenced by institutional arrangements that outline the range of actions and potential solutions. Each stakeholder has their own rationale and criteria to solve problems based on information available to them, the way risks are evaluated and behaviours related to these risks. These elements represent potential transaction costs (Williamson, 1985) which could slow down the process. It is in the interests of the platform to access, produce and make available to members all information in order to identify best-bet solutions. The decision then consists of identifying a range of solutions available and choosing the most adapted solutions. In other words, IP decisions are larger than whether or not to adopt a technology. Decisions within the platform are taken collectively through institutional arrangements, but the degree of collectiveness depends on the distribution of power within the platform.

Knowledge and information systems
The lack of information and knowledge, often associated with power imbalances, can be a main source of high transaction costs which can slow down institutional arrangements within the platform. In an IP, information and knowledge generally comes from various stakeholders of the platform but new knowledge can also emerge from the dynamics of interactions between stakeholders through learning-by-searching and learning-by-doing. Knowledge management involves knowledge provisioning and also hybridisation (Callon et al., 2001; Mathé & Rey-Valette, 2015; Lyet, 2016) or conversion (Nonaka et al., 2000) of the knowledge. In fact, two types of knowledge are identified. The most obvious is the scientific knowledge, which contrary to the model of innovation based on technology pull, is no longer dominating the knowledge domain. The second type is the tacit knowledge that is non-codified and is generated through exchange of experience, observation and imitation (Nonaka et al., 2000). Tacit knowledge is crucial in demand-driven innovation processes because it is the invisible reservoir of experiences. The main issues are how to reveal and activate this tacit knowledge and how to facilitate hybridisation between tacit knowledge and scientific knowledge, especially given that information sharing is not obvious. Issues around appropriation of scientific knowledge by communities, and recognising community needs and know-how within research activities, remain insufficiently understood. Analysis of the information–sharing component of IPs therefore permits a measure of the level to which knowledge is capitalised within the platform. It also allows us to understand the extent to which researchers and community members share a common set of knowledge to build on. In the different innovation processes, the size of this component could vary.

Operational mechanisms
Operational mechanisms result from the convergence between decision mechanisms and the information and knowledge systems. This component describes the activities implemented within the platform through institutional arrangements (market or non-market based) between actors. Most activities are not directly related to marketing, such as the implementation of demonstration plots or training sessions. Some marketing activities may be implemented, such as developing trade contracts between producers and traders, or between nursery operators and producers. In essence, this component measures the capacity of the platform to implement concrete activities and develop formal or informal market contracts.
Institutional framework, policies and financing

The institutional framework depicts the context in which platforms evolve and is a part of the institutional environment (North, 1990). The institutional environment is defined as the social, political, financial and legal rules that support interactions in a society. It is related to institutional arrangements that represent the way individuals coordinate when they interact - i.e. the intermediary level between the institutional environment and individuals. Innovation processes occur within an institutional environment and emerge through the construction of a multitude of institutional arrangements. There are different levels of institutional environment: the general one that covers all activities in a society, and more specific levels linked to specific activities, in this case R&D. According to Hall et al. (2003), the institutional context for R&D concerns the rules and norms that govern it as a social process of learning. The institutional framework contains the institutional environment and arrangements. For Edquist (1997), it refers to routines, norms, shared expectations, and morals that pattern behavior. This institutional framework contains the modality of research financing that influences directly decision-making mechanisms within the platform due to the high power this financing can give to researchers.

Social network

The influence of the social network outside of the IP should be considered. Each IP member represents a group of actors who have their own interests and can influence their representatives. These social networks are also the channels through which the knowledge built within the platform can be disseminated (Bandiera & Rasul 2006). Indeed, these networks are an important means of scaling out new knowledge.

The NIE analytical framework

In this New Institutional Economics (NIE) based analytical framework, understanding the interactions between components is crucial to explain processes that occur with the platform. For example, decision-making mechanisms are influenced by the information and knowledge available and produced, feedback from the activities implemented, the institutional framework and the social networks which may influence the platform members' decisions. Figure 1 shows a diagram of the system. The platform facilitator and other free actors (Wielinga & Vrolijk 2009) can influence the intensity and direction of the efficacy and success of interactions between the components (the arrows in Figure 1) in order to enhance IP performance. The following analytical framework should lead to a better understanding of IP members' involvement in the different components, and allow the identification of disturbing and unbalanced situations within the platform that could reduce its performance. Each component and the influence it wields (the size of the arrow) can change depending on the context, the phase of the IP and the function emphasised.
Figure 1. Analytical framework to study innovation platform functioning (Source: Adapted from Mathé (2009))

Innovation processes within IPs

We describe a typology of processes which can occur within an innovation platform, particularly within an agricultural context (Figure 2), namely: (i) soft transfer; (ii) co-creation and (iii) community-based research. These three processes have been described in various ways in the literature. Soft transfer is where research has readily-available results that could help solve jointly identified problems or could also occur when research tries to enforce its own interests using its powerful position (financial or social). This model aligns with the Transfer-of-Technology (ToT) model (Nagel, 1997) and diffusion theory (Rogers, 2003). Soft transfer in innovation systems requires that we bring the linear logic of innovation into systems thinking. This model can be appropriate when the relations between research and its intended beneficiaries are quite new and both need to better know each other through interactions. In
addition, soft transfer can gradually reduce resistance from researchers to move away from a traditional ToT model to a new way of interacting with the final users of their research (Paulré, 2004). These resistances can be unlocked thanks to learning processes and the way researchers embed their work in the platform activities. Soft transfer processes are more present at the inception stage of the platform.

**Co-creation** processes occur when researchers develop objectives and protocols jointly with platform members (Wielinga & Vrolijk, 2009; Nederlof et al., 2011; Kilelu et al., 2013; Schut et al., 2015), resulting in the integration of scientific and tacit knowledge to create new knowledge. Co-creation requires some time after IP inception to allow researchers to develop a good understanding of the context and the demand, but also to gain the trust of stakeholders. It is based on the capacity of researchers and other IP members to build sense-making of problems and find solutions together. The presence of this type of process in a platform comes from the investment of both researchers and other IP members. When it occurs, it can have self-reinforcing effects, which means that co-creation processes can generate other ones. The existence of an IP facilitator playing the role of intermediary or broker is critical to support this type of process.

**Community-based research** occurs when platform members are empowered to carry out their own research and experiments. They can call upon researchers’ expertise to endorse or improve their experiments. These processes are well described in literature using various concepts, such as positive deviant (Pant & Hambly Odame, 2009), farmer-lead research (Waters-Bayer et al., 2015), endogenous innovation and social innovation (Bock & Fieldsend, 2012). All these concepts emphasise the primary role of communities within innovation processes.

The platform is an arena that promotes knowledge exchange and learning among members. From the community point of view, the three processes correspond respectively to knowledge transfer or internalisation, knowledge hybridisation and knowledge externalisation.

![Figure 2. Three ways to undertake demand-driven research with innovation platforms (Source: authors)](image-url)

The three processes can occur simultaneously within platforms and depend on the type of activities that are implemented.
Methods

Characterisation of the three processes

From the previous analytical framework described, we developed a matrix-type table crossing the three processes and the three primary components of an IP. This matrix aims at characterising what happens in the different components of the IP functioning relative to the three processes that we identified (Table 1).

Table 1. Description of the three processes through the analytical framework

<table>
<thead>
<tr>
<th>Decision-making mechanisms</th>
<th>Soft transfer</th>
<th>Co-creation</th>
<th>Community-based research</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Strong presence and influence of research in the decision-making</td>
<td>Co-decision between research and IP members</td>
<td>Community-based decision. Research could play the role of advisor</td>
</tr>
<tr>
<td>Operational mechanisms</td>
<td>Community applies research recommendations</td>
<td>Implementation of activities in an interactive way</td>
<td>Community implements its own research activities / experiments</td>
</tr>
<tr>
<td>Knowledge and information systems</td>
<td>Little conversion of scientific knowledge into shared information and knowledge</td>
<td>Strong hybridisation of tacit and scientific knowledge</td>
<td>Tacit knowledge is used and valued.</td>
</tr>
</tbody>
</table>

The passage from one to another comes through moments of bifurcation or transitions that change the nature of the relation between members of the platform including researchers. This does not mean that the passage from one process to another is irreversible. However, the probability of a switch from co-construction to soft transfer processes becomes lower with time.

Description of the case study

Using the grid in Table 1, we observed and analysed the processes occurring as platforms within the Humidtropics programme were set up and established. Humidtropics is a research programme on integrated systems to improve the livelihood of rural poor. This programme uses a system-based approach to put people at the centre of research interventions. We describe the platforms established by HumidTropics in Cameroon. This includes a national platform, ‘R4D platform’ and three regional IPs in the North-West (Batibo), the South-West (Kumba) and the Centre (Mbalmayo) (Figure 3). These three sites were selected by the R4D platform during its first meeting in February 2014. The R4D platform is composed of national representatives from farmer organisations, private sector, government, research and academic institutions and civil society. Its roles are: (i) to identify the constraints and main
challenges for the development in the region; (ii) to identify the entry points for R4D interventions; (iii) to conceptualise and develop research protocols; and (iv) to organise and implement R4D interventions. IPs are established at the lowest level such as district or communal level and are composed of the same categories of R4D stakeholders but acting at this lower level. They aim to support and co-implement activities on the ground.

Figure 3. Field sites within Cameroon

IPs in Cameroon
A R4D meeting in May 2014 identified the main entry themes for the Cameroon Action Site through the use of Rapid Appraisal of Agricultural Innovation Systems (RAAIS) (Schut et al., 2015). They were: (i) improving the input supply system (improved planting materials, seed in quality and quantity, fertilisers and pesticides); (ii) soil degradation and fertility management; (iii) pests and disease management; (iv) improving access to land and property rights; (v) farmer access to financial and agricultural product markets; and (vi) develop partnerships among agricultural sector stakeholders. These entry points were decided upon at the IP level during the first IP meetings in each of the three field sites. Main tree crops and food crops related to their constraints were specified.

The three IPs in Cameroon have followed the same sequence during the inception steps. The meetings gathered representatives from farmer organisations, researchers, government, private sector (marketeers, processors, transporters...), NGOs and civil society, etc. In the first meeting organised (from June to July 2014), after presentation of the programme, participants were asked to rank the main crops grown in their farming system. In the Centre IP, the main crops, in order of importance, were cassava, cocoa and maize but participants emphasised the short term profitability of maize, tomatoes, chilli and okra. The main constraints were low
access to seeds, conservation for maize, price and market issues for maize and cocoa, and pests and diseases for cocoa. The same exercise was repeated for the other two platforms. In addition, at each platform, a steering committee was elected with a representative from each of the stakeholder categories present at that meeting. These committees were set up to serve as a link between the IPs and the Humidtropics’ management team. A facilitator was also designated to each IP.

After this initial meeting, a long period of platform inactivity followed. During this time, R4D members, and particularly researchers, were able to evaluate their capacity to respond to the platforms needs, i.e. (i) by providing ready-formed solutions that had already been developed, (ii) by formulating research questions able to respond to the IPs’ demands and (iii) by raising funds to make these platforms work. During this period of latency, some ad-hoc meetings were organised at the field side level, but all activities were concentrated within the R4D platform. Funds to develop activities at the field level eventually came through a mechanism called cluster 4. These funds, from a Humidtropics programme, were dedicated to implementing activities involving IP members.

The funds now being available, a meeting was organised at each platform to reorient the focus towards what researchers could offer to address the priorities raised by IP members one year previously. For example, in the North-West IP, researchers proposed working on maize constraints instead of yam, as there was no expertise or proven technology on yam cultivation and conservation available within the R4D platform. After the reorientation, researchers proposed the establishment of mother and baby trials with selected crops from their portfolio of proven technologies, and cropping practices specific to each IP were developed. In addition, they proposed capacity building activities to strengthen the IPs. In the North-West, IP members accepted the proposed interventions and the trial design raised enthusiasm among participants, who promptly proposed sites where the trial plots could be established. In the Centre, there were more discussions around the proposed crops and trial design. Participants argued for inclusion of more local varieties, particularly of cassava, in the proposed trials. They insisted on local varieties that seem to be more suitable for processing into ‘baton’ (the main commercial product from cassava in the area), compared to the improved varieties. The experience of the Centre shows the importance of a strong facilitation of this step in co-creation where participants should be encouraged to express themselves and amend propositions from researchers. We clearly identify the strong role of research at this stage and the difficulty of hybridising tacit and expert knowledge in the processes. Activities, such as the establishment of mother and baby trials, were implemented in each field site soon after these meetings with the IPs (Table 2).
### Table 2. Establishment of mother and baby trials in Cameroon action site

<table>
<thead>
<tr>
<th>Principal crops selected for the plots</th>
<th>Centre (Mbalmayo)</th>
<th>South-West (Kumba)</th>
<th>North-West (Batibo)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize, cocoa, plantain, vegetables and cassava</td>
<td>Maize, cocoa, plantain, vegetables and cassava</td>
<td>Maize, beans and cassava associated with calliandra and thitonia for soil enrichment</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of mother trials established (place)</th>
<th>South-West (Kumba)</th>
<th>North-West (Batibo)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 (Nkolget and Bilik)</td>
<td>2 (Kumba and Konye)</td>
<td>5 (Batibo, Bali, Bafut, Nsongwa and Tubah)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of farmers who established baby trials (origin of seeds*)</th>
<th>South-West (Kumba)</th>
<th>North-West (Batibo)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 (IRAD, AVRDC, IITA)</td>
<td>30 (IRAD, AVRDC, IITA)</td>
<td>60 (IRAD, IITA)</td>
</tr>
</tbody>
</table>

*IRAD: Institut de recherche agricole pour le développement, AVRDC: The World Vegetable Centre, IITA: International Institute of Tropical Agriculture

Since then, we have seen some evolution in the three platforms. They have become increasingly autonomous, particularly in terms of organising meetings and the identification of new topics they want to work on. For example, the South-West platform wrote a proposal, with the support of the AVRDC (The World Vegetable Centre), to raise funds from the Forum for Agricultural Research in Africa (FARA) to finance cassava processing. In the Centre, there is a real interest among the platform members for the activities set up, people are increasingly, openly expressing their needs and what type of activities they are interested in. For example, they are strongly interested in vegetable cropping even though it is quite a marginal crop in the area. There are some arrangements between researchers and farmers for training on seed multiplication. In the North-West platform, they are also interested in testing new vegetables and they asked for support from research to better understand how they could have a better use of their local market information system. We observe a tendency of the platform to be more able to discuss with the researcher through co-creation processes and also to be more autonomous and envisaging testing new ideas themselves and asking for research support.

**Discussion**

**Supporting platform maturity**

From Table 2 we can see that more activities were implemented in the North-West platform than in the Centre, in terms of the number of farmers who established baby trials. However, this is a view of the end-point, and does not show anything about the processes that lead to IP activities or why those differences might exist. In order to achieve more co-creation and
community-led research in IPs through a R4D project, three main challenges need to be tackled; all of which require time and trial-and-error experiences to help researchers and other platform members to work together.

The first challenge, from the researchers’ perspective, is the need to learn to work with IP members to formulate research questions related to demand and to avoid the pitfall of proposing existing technologies without adapting them to the local situation. The researcher’s capacity to make this adaptation sometimes requires a change in research posture or practice, which may imply the need for simple and double-loop learning processes (Argyris & Schön, 2002). Simple loop learning is guided by a new way of doing research and double-loop learning is related to changes in terms or values. For the present case study, it is about how researchers change their vision of research and adopt or reinforce the system dimension in their work.

The second challenge, for IP members, is the need to formulate their constraints more clearly, and also to build sense-making for these constraints to be able to formulate a well-defined demand to the R4D platform.

The third challenge, for all IP members and researchers, is taking the time to build trust, particularly if they have never worked together within a system approach before. Inter-personal trust is a key element of innovation processes (Torre, 2008). This trust is built through interactions between stakeholders and also building the capacity of both researchers and IP members to share and reconcile their respective scientific and tacit knowledge.

One of the first aims of the IP is to build a common base of knowledge and information. In this process, the role of the facilitator is crucial in order to break down scientific knowledge so that it can be understood and to explore the tacit knowledge of members. To this effect, a training session was organised for West African Flagship facilitators. It aimed at strengthening facilitators' capacity to analyse tricky situations and support processes within the platform. The facilitator has to help with the implementation of shared internal rules and the organisation of the continuity of information and knowledge exchange. The facilitator also helps to balance the power between actors within the platform.

The advantage of the system approach and the use of platforms within this lies in its potential to facilitate the development of ’mature’ platforms. Yet often platforms are set up within R4D projects with the sole goal being the ‘transfer of technologies’ (ToT). The ToT approach, however, underestimates the various functions innovation platforms could play in the long term (Hekkert et al., 2007). Platforms can in fact support various functions if their path to maturation is supported. These functions include entrepreneurial activities, knowledge development, knowledge diffusion through networks, guiding the search of knowledge, market formation, the creation of legitimacy and counteracting resistance to change. These functions all support the generation of sustainable outcomes.

**Indicators to monitor processes within IPs**

Based on Dror et al. (2016), we propose a model showing the distribution of the processes occurring in IPs from their inception to maturity (Figure 4). In most cases of platforms that are set up by R4D projects, the soft transfer of technologies seems to dominate in the initial stages
as researchers try to find solutions to constraints expressed by the platforms by going through their portfolio of research results. This situation can be accentuated by pressure from donors to show evidence of dissemination and adoption of research results. The trajectory to co-creation and then community-based research occurs when the three main challenges highlighted above, start to be addressed. This is a common trajectory in group dynamics, namely starting from divergent thinking and eventually reaching convergent thinking (Leonard & Sensiper 1998). These convergences can be explained by the multiplication of institutional arrangements between researchers and other stakeholders within the various processes. At the inception of platforms co-creation could exist if researchers and IP members were already used to working together. Similarly, community-based research can occur when platforms are built on existing groups that are already dynamic. The trajectory from soft transfer or co-creation to community-based research could be driven by strengthening IP members’ capacity to innovate (Leeuwis et al., 2014).

![Figure 4. Dynamics from inception to maturity of innovation platform in R&D projects](Source: authors)

The framework we propose to monitor the types of processes leading to activities within platforms is useful to guide a long-term vision of platforms. Mature platforms are more able to support and promote sustainable intensification in farming systems and its scaling out and up. These monitoring indicators help to assess whether an IP is on the right track to achieve maturity through empowerment of IP members. It could also highlight tension between researchers’ needs and other IP members’ needs.

**Conclusion**

The operationalisation of IPs for integrated agricultural systems research and interventions does not follow a linear process. The soft transfer process tends to dominate in the initial stages when researchers and other platform members are learning to work together, and in the absence of a facilitator or any type of skilled facilitation. Interactions between researchers and other platform members and the roles they play co-evolve with IP maturity, as processes of co-creation and community-based research develop. How demand-driven research is implemented depends on the maturity of the platform and particularly on the capacity of
researchers, facilitators and platform members to create genuine interactions and learning processes based on trust, decision-making and the capacity of researchers and IP members to integrate various sources of knowledge to build new ones.
References


Innovation platforms beyond projects and commodities: a case study of Lundazi, Zambia

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Abstract: Innovation Platforms (IPs) are undoubtedly the most common manifestation of the growing popularity of Agricultural Innovation System (AIS) thinking in Agricultural Research for Development (AR4D) in Africa. Born out of the realisation that constraints to agricultural development are not merely technical in nature, and often located beyond the farm-level, AR4D projects increasingly initiate such multi-stakeholder platforms from a utilitarian perspective. The formation of IPs is often driven by donor demands for stakeholder participation and impact at scale - may be merely to act as a communication tool serving projects’ dissemination strategy. This utilitarian approach towards IP formation is also evident in a common disregard for existing multi-stakeholder fora, which may result in a plethora of project-based IP’s. The focus of AR4D projects usually determines the organisational modus of such IP’s; platforms may bring together actors along a particular value chain or stakeholders involved in the extension of particular agricultural technologies such as Conservation Agriculture (CA). Project focus and organisation usually also shapes at what level IP’s are organised – locally or at higher levels. Project-initiated IP’s also raise the issue of sustainability; they run the risk of disappearing when a project ends. This case study analyses the institutional development, embedding and integration of different multi-stakeholder fora in eastern Zambia. It describes how different project-based IP’s developed alongside one another undermine one of the key functions of IP’s – network brokering and coordination. The paper makes a case for linking IP initiatives to existing (government) structures, not merely for coordination, but to improve agricultural sector governance. In the absence of a government policy framework for agricultural system innovation, the Lundazi district government in eastern Zambia now chairs an integrated multi-stakeholder platform. Such local embedding does not mean, however, that the platform has the capacity to innovate or that its sustainability is secured. Platforms are, by definition, dynamic and somewhat fragile. After all, they depend on an enduring capacity to bring together and broker interactions between stakeholders with only partially overlapping interests.

Keywords: Innovation platforms, agricultural innovation system, multi-stakeholder, agricultural research for development, project-based.

Introduction

Innovation Platforms (IPs) are undoubtedly the most common manifestation of the growing popularity of Agricultural Innovation System (AIS) thinking in Agricultural Research for Development (AR4D). Born out of the realisation that constraints to agricultural development are not merely technical but often located beyond the farm level and of organisational and institutional nature, AR4D projects increasingly initiate such multi-stakeholder fora. IPs are a
well-documented ‘phenomenon’ (see, for example, Nederlof et al., 2011; Nederlog & Pyburn 2012; Sanyang et al., 2016; Dror et al., 2016). They are conceptualised as a group of individuals or organisations, often interdependent, that come together to exchange knowledge and tackle problems (Nederlof et al., 2011; Homann-Kee Tui et al., 2013; ILRI, 2012; Schut et al., 2016).

This case study documents and analyses the institutional development of one such multi-stakeholder forum in Lundazi, eastern Zambia. It describes how two different project-based initiatives were integrated in order to strengthen project activities and coordination within the district; a major function of IPs. This case study makes a case for linking IP initiatives to existing coordinating institutional structures, not merely for coordination - which is key to scaling-up - but also for improved agricultural sector governance and learning (Nederlof & Pyburn, 2012; Mur & Wongtschowski, 2013; Pyburn & Woodhill, 2014).

Methodological approach
The authors supported the IP in Lundazi from 2013 until 2015, in the context of a collaboration between the Consultative Group on International Agricultural Research’s (CGIAR) research programme on maize (referred to as MAIZE) and the Royal Tropical Institute (KIT). The authors used a participant observation approach by actively engaging with platform members and local stakeholders in Lundazi. The authors have been present at, and documented the results of, five IP meetings in the above-mentioned period. In addition, semi-structured interviews were carried out with representatives of the District Administration, the Sustainable Intensification of Maize Legume Systems for the Eastern Province of Zambia project (SIMLEZA) and the Conservation Farming Unit (CFU) of the Zambian National Farmers’ Union (ZNFU).

Results
The formation of the Lundazi agriculture stakeholders’ platform
To understand the emergence of agricultural innovation platforms in eastern Zambia, it is first necessary to elaborate on how agricultural governance is organised, and how government organisations coordinate the activities of different stakeholders.

Lundazi District1, on which this case study focuses, is a relatively remote district, two hours’ drive to the north of the provincial capital, Chipata, which is located on the main road and trade route connecting Lusaka and Lilongwe in Malawi (Figure 1). Population densities in Lundazi are substantially lower than in Chipata District (23 persons/km² vs 68 persons/km²) (CSO, 2014). Both input markets and agricultural produce markets for Lundazi farmers depend to a large degree on the connection with Chipata. Important crops grown in Lundazi include maize, cotton, tobacco, sunflower, soya bean and common bean. There is a guaranteed market for maize as the Zambian government buys maize through its Food Reserve Agency (FRA). There is a good presence of private sector input suppliers and produce traders in the district. There is also considerable NGO presence. The NGO with the highest coverage is CFU. CFU’s focus is on disseminating conservation farming: a set of soil and water conserving practices that aim to sustainably intensify agriculture. Many other NGOs and projects work on conservation farming/agriculture (CA) in the area.

1 Lundazi District borders Malawi, covers 14,068 km² and has a population of approximately 324,000 people (CSO, 2014).
Local governance bodies are operational at different levels in Lundazi (and overall in Zambia) (Figure 2). Of particular importance is the Camp Agricultural Committee (CAC), the camp level governance body and the Office of the District Coordinator Agriculture and Livestock (DCAL). The DCAL plays a pivotal role in providing marketing information both to input suppliers and to buyers.

The District Development Coordinating Committee (DDCC), is a high-level meeting bringing together government officers from different sectors at district level. All projects and organisations are expected to report to the DDCC on a quarterly basis, indicating both activities carried out and plans for the following quarter.

The extension workers at camp level (CEO – Camp Extension Officers) work under the leadership of the DCAL, and act as secretariat to the CAC. The level of their real presence at the camp varies greatly, due to staff shortages. Not all camps have a resident CEO. Sometimes a CEO has to cover up to three camps which are relatively far from each other. Where functional, the CEO operates as a link between the District Agricultural Office and the camps, bringing and taking news and linking farmers to other initiatives and actors. The DCAL in turn acts as a bridge between projects and the agricultural camps. The DCAL’s office is supposed to be informed of all activities taking place in the district, and has to make sure these activities are well coordinated. The DCAL meets with the CEOs and is supposed to bring key challenges and issues to the DDCC.
The Conservation Agriculture Committee
Conservation Agriculture is a common focus in agricultural interventions in rural Zambia. International agencies (such as FAO and NORAD), NGOs and research organisations promote CA in the country. Lundazi is no exception.

There are, nevertheless, considerably different definitions of CA (see: Andersson & D’Souza, 2014). Whereas FAO defines Conservation Agriculture as a combination of three principles (minimal soil disturbance, crop residue retention and crop rotation/diversification), the CFU uses the term Conservation Farming (CF) for this, and speaks of CA for a situation in which farms’ dependency on external inputs is reduced. CA then, is CF with the integration of nitrogen fixing *Faidherbia albida* trees and fruit trees (Andersson & D’Souza, 2014). In the CF the use of chemical fertilisers and herbicides is strongly supported. CFU recommends farmers to dig small basins for planting or to use animal draw rippers. COMACO (Community Markets for Conservation), another NGO working in the area, discourages the use of agro-chemicals. It promotes zero-tillage, retaining crop residues and the application of home-made fertiliser - the latter element is seen as an important component of “their” approach to CA. Although they also work with planting basins, they promote much larger ones.

In 2010 the CFU set up its first office in Lundazi, headed by Clement Mwankotami. Clement had just been transferred from Chipata, where he was the chairman of a district-level IP on CA, supported by the DFID-funded project Research Into Use (RIU).
When arriving in Lundazi, Clement realised that projects working in the area had very different approaches to Conservation Agriculture. These differences posed challenges to those promoting CA at camp level. When CFU started working in the district farmers with whom it worked refused to follow its recommendations, sticking to what they had been taught earlier.

CFU approached the DCAL and shared the problem, suggesting (building on the experience with the IP in Chipata) that all stakeholders should be called to a meeting to discuss the definition(s) of CA. The first meeting of what was later to be known as the “Conservation Farming Committee” was held in June 2010 and brought together all organisations working with CA in the district. The objective of the meeting was to ensure that organisations would ‘make space’ for each other, recognising each other’s approaches to CA. As it evolved, the committee started to support the alignment of different CA projects, for example by agreeing that projects should not use the same lead farmers.

For the DCAL the Conservation Farming Committee turned out to be an effective way to gather the necessary data for their own reporting, such as to the DDCC and the provincial government. In 2013, the committee formally became a sub-committee to the DDCC. The DCAL acted as its chair, and the CFU as secretariat of the meeting. Originally started as a committee trying to harmonise CA promotional messages of different agricultural development projects, the committee’s main activity thus became to gather and share reports on all the projects working in the district.

Organisations and projects active in the district would attend the meetings, covering their own transportation costs, while lunch and drinks were provided by the different projects on a rotational basis. This was an important change Clement had made in comparison to the organisation of the Research-Into-Use IP in Chipata, where the project had paid allowances to participants. After the project ended, the Research-Into-Use IP in Chipata became defunct as no other organisation took on the task of paying allowances. Participants from both the public and private sectors became discouraged. As well as the unsustainable allowances the collapse of the IP was also due to some key persons being transferred to other districts.

**The SIMLEZA project: linking on-farm experiments to a wider set of stakeholders**

Launched in 2011 by CIMMYT (the International Maize and Wheat Improvement Centre) and IITA (International Institute for Tropical Agriculture), SIMLEZA combines on-farm research on new maize and legume varieties, CA and soya agronomy, with the targeting of such new technologies and household-level training in soya processing. The project aims to increase maize and legume yields by 25% in project communities over four years and directly benefit at least 30,000 farm households. It works in three districts in Eastern Province: Chipata, Katete and Lundazi.

SIMLEZA set-up project-based IPs in these three districts as an out-scaling mechanism - for communicating project findings to a wider audience. IITA staff organised the first IP meeting in Lundazi in April 2012. This first innovation platform meeting brought together 22 people from private, public and non-governmental organisations. The concepts of agricultural innovation systems (AIS) and Innovation Platforms (IP), as well as participatory research and extension approaches were introduced. Participants went to an initial farming system analysis
and problem inventory and ranking meeting, together with farmers. A list of follow-up actions was developed. Despite this initial attempt at involving stakeholders in identifying technological, organisational and institutional constraints, the focus on stakeholder participation was limited and mostly focused on the on-farm experiments.

The approach had several weaknesses. No institutional landscaping exercise was done. Consequently limited knowledge existed about other stakeholders and projects (not present), other multi-stakeholder initiatives and potential partners needed to create the enabling environment for scaling the project’s technologies and practices. Second, the action plans that were formulated during IP meetings did not allocate responsibilities to specific persons/stakeholders; activities were therefore largely not implemented.

Due to reduced funding and institutional capacity, the project’s innovation platform work was scaled-down late 2012. What continued though were the local level project activities linked to the implementation of on-farm experiments. Researchers and farmers continued to implement and evaluate ongoing on-farm experiments, yet without much of an idea of what the implications would be of large-scale technology adoption. One consequence of this was that farmers stimulated to grow more legumes or produce legume seeds, experienced difficulties in selling the grain and seeds that the project had enticed them to produce.

**Lundazi agricultural stakeholder platform: the result of a merger**

In late 2013, with external support from the CRP MAIZE programme, SIMLEZA set out to revive its Lundazi Innovation Platform. Individual stakeholder visits were used to increase attendance at the meetings in which a wider set of stakeholders participated. At one of these new IP meetings participants realised that other multi-stakeholder fora existed in the district, whose mandate (partly) overlapped with that of the SIMLEZA IP. CFU – the secretariat to the CF committee – was approached and SIMLEZA was invited to a committee meeting. The suggestion to merge the Conservation Farming Committee and the SIMLEZA IP led to their integration; the Lundazi Agricultural Stakeholder Platform (LUASP) was formed in April 2014.

The objective of LUASP changed to coordinating different stakeholders’ actions and the joint identification of organisational and institutional constraints in agricultural development in the district. LUASP (in the same way as the CF committee) is a sub-committee of the DDCC. Nevertheless, since LUASP was formed, reports are no longer read and presented at length during the meetings (which resulted in low attendance), but rather the focus is on discussing common challenges faced by agricultural sector stakeholders.

With a larger membership and one that spans beyond CA projects (see Box 1), the meetings are geared towards identifying constraints to agricultural development and the development of action plans which are implemented by sub-sets of interested stakeholders. In addition, SIMLEZA’s research outputs are no longer the main focus. Instead the platform provides SIMLEZA and other projects with a better understanding of the context they work in, enabling the project to better understand the constraints to technology adoption that farmers face. In addition, the different projects get better informed about the issues that research needs to address as well as new opportunities for collaboration with other stakeholders; some of those are well-positioned to scale-out SIMLEZA’s research outputs, such as new seed varieties or farmer-produced seed.
Box 1. LUASP membership

*Government:* Ministry of Agriculture (District administration, camp extension officers), USAID local coordinator.

*Non-governmental:* ASNAPP, CFU, COMACO, Community Development, MAWA, Mthilakubili, Profit+, Relief and Development CCAP, TLC, World Vision, WVZ, farmers’ union (ZNFU).


*Research:* CIMMYT, IITA, ZARI

Farmers are not directly present or represented in the platform.

As in the CF committee, organisations cover their own expenses for participating in the meetings and meetings are chaired by the district administration. Recently, it has been decided that the secretariat of the Lundazi Agricultural Stakeholders Platform will function on a rotational basis.

**LUASP’s results so far**

Since the ‘merger’ meetings have been well attended with particularly strong interest from the private sector. According to those interviewed, this is a result of more efficient (i.e. shorter) and action-oriented meetings. An excerpt of an action plan from a platform meeting can be found in Table 1. The central role of the district government’s agricultural office, inviting projects and organisations as well as chairing the meetings, may also contribute as many stakeholders depend on the DCAL’s office for field work activities.
Table 1. Excerpt of LUANAR action plan April 2014.

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Organisation who participated in discussion at the meeting</th>
<th>Description</th>
<th>What can be done about it</th>
<th>By whom? Responsible organisations</th>
<th>When?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marketing of certified legume seed (cowpeas, soybeans, beans, G/nuts)</td>
<td>MAWA, SIMLEZA, Mthilakubili, MAL</td>
<td>• Pricing: farmers do not know how much it costs them to produce the seeds so they bargain (often too hard) and so miss reasonable market opportunities. Market then fluctuates quickly and farmers end up losing money.</td>
<td>• Farmers training on gross margin analysis (seed growers from Vuu, Kapichira, Mthilakubili.)</td>
<td>MAL (Dept. of agribusiness and marketing – Mr. Thembo and Mr. Holmes), Muthilakubili, SIMLEZA</td>
<td>End of May</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Attitude of farmers who do not trust each other (and therefore do not bulk) not buying from fellow farmers</td>
<td>• Exchange visit on bulking to Kapichira and Mthilakubili</td>
<td>MAL</td>
<td>End of June</td>
</tr>
</tbody>
</table>
| Organisation of and attendance at field days                             | CFU, SIMLEZA, MAWA, World Vision, Manjeet, Cargill, Community Development | • Coordination/poor attendance at field days by stakeholders.  
• Coordination needed for field days within camps (so that one field day covers different projects, now stakeholders working in isolation) | • Jointly plan field days. In October, through the camp officers, decide where the main field days take place (where many stakeholders should be present)  
• In 3<sup>rd</sup> week of January share the calendar for the minor field days (by one organisation only) and agree on the dates for the main field dates | MAL – through camp officers Committee (at a meeting)                                                                                                 | October committee meeting January 2015 committee meeting |
Immediate effects of Lundazi IP include improved farmers’ marketing opportunities. For example, participating Camp Extension Officers report that more buyers are venturing into their areas in search for produce (legume seeds and grain). These buyers learned about SIMLEZA-supported, community-based seed production and increased legume production during the IP meetings. They also approached the Camp Extension Officers after the meetings for more information and to schedule visits to the camps.

Another immediate result from the IP existence is better coordination. Whereas the DDCC has the formal task of keeping actors informed, the DDCC meetings do not go into operational issues. DDCC meetings are used to feed information to the District Administration, not to plan and coordinate field-level activities. As a result of discussions in the platform, the projects/organisations now organise farmer field days in close collaboration with each other, saving time and resources and enabling cross-project learning during field days. Better knowledge on what other projects are doing also helped stakeholders to avoid “double targeting”; i.e. working with the same farmers in similar projects.

Another important benefit that platform members mentioned is that researchers now better understand local realities. When the Zambia Agriculture Research Institute (ZARI) researchers go to Lundazi for the meetings they do not only hear from other organisations on the latest challenges and opportunities at farm level; they also often take the opportunity to visit the field. For example, in 2014 ZARI promptly diagnosed common bean stem maggots, saving many infested bean fields in the district, at the request of other platform members.

As the platform is the subcommittee of the District Development Coordinating Committee (DDCC), issues raised by farmers which require immediate attention are acted upon quickly. Future plans of the platform in Lundazi include broadening the types of organisations participating (for example to incorporate church leaders) and organising field days for platform members so that they can better understand each other’s work. Participation of the Camp Extension Officers from the areas where projects operate could still be improved, bringing the information shared at the meetings back to the farming communities and enabling CEO’s to raise farmer concerns at the platform.

**Discussion: institutionalising innovation platforms in local structures**

A number of challenges remain. First is the need to strengthen the capacity of the DCAL’s office to organise meetings, follow-up with key actors and to facilitate the action-planning oriented meetings. This demands a capacity building strategy for its staff.

The second major challenge is the difficulty of tackling complex issues. When the discussions concern a practical local problem, the platform members quickly design ways to tackle these. However, when faced with more complex issues such as the slow adoption of CA or a dysfunctional market for legume seeds, devising a concrete plan of action is much more difficult. As a consequence, the plans drawn up remain unclear to the platform members themselves or are not realistic. This is due to a number of reasons. Platform members realise they are ill-equipped and ill-positioned to fully understand the issue at stake. In addition, many participants are implementing projects that are designed elsewhere by people who have limited understanding of the local realities. The project implementers participating in the LUASP may feel they are not in the position to question the approach taken by their respective organisations. Finally some of these issues e.g. the slow adoption of CA are sensitive. Many
projects operating in the area focus on CA promotion, and any discussion that may be seen as challenging this approach is difficult to do publicly.

Thirdly there is a need to be alert as new agricultural development initiatives in the district are often very similar to existing ones. This problem at least refers to the setting up of multi-stakeholder fora. Innovation platforms are fashionable in development policy thinking and many donors want to create structures that ensure projects collaborate and coordinate. As few of these initiatives start with an institutional mapping exercise, there is a real risk of creating overlapping and even competing structures. For example, in another district where SIMLEZA operates, a new project is setting-up a maize value chain-based innovation platform. Without prior institutional mapping or deliberate attempts at integration of new initiatives into existing structures, such initiatives may lead to fragmentation of multi-stakeholder collaborations. The DCAL therefore has an important role to play in preventing fragmentation, in its role as “gate-keeper” for organisations and projects operating in or entering the district.

Conclusion

IPs are often seen as project-led. The project’s focus usually determines their organisational modus; platforms may bring together actors along a particular value chain, or stakeholders involved in the extension of particular technologies such as CA. Project focus and organisation usually influence whether IPs are organised locally or at higher levels; rather than a purposeful analysis of key challenges faced and the best level from which to tackle them.

Mapping the institutional landscape prior to IP establishment is often not done. As a consequence a plethora of fora tends to develop (often operating in isolation), as in the case of the CFU and the SIMLEZA-led platforms in their early years. When that happens two key functions of the IP’s are lost: network brokering and coordination. These functions are key to solving institutional barriers to agricultural development, including providing an enabling environment for bringing new innovations to scale.

Project-initiated IPs do also raise the issue of sustainability as these initiatives tend to disappear when a project ends. In Lundazi, the district government chairs the platform, while a stakeholder with long-term presence in the area runs its secretariat. Although a good start this does not mean that the platform’s sustainability is secured. ‘Ownership’ of the platform depends on how useful the platform members perceive the platform to be. ‘Usefulness’ of the platform hinges upon its successful dealing with issues at the platform operational level. In addition the platform will only be ‘functional’ if those attending commit to the proposed actions. This demands close follow-up and leadership. Finally, platforms are by definition dynamic and somewhat fragile. After all, they depend on an enduring capacity of local actors to bring together and broker interactions between stakeholders with only partially overlapping interests.

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Design and implementation of innovation platforms in facilitating the local adaptation of conservation agriculture: lessons from case studies in Burkina Faso

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Abstract: Numerous interventions implement innovation platforms (IPs) to support agricultural innovation processes and stakeholder interactions within a value chain in west Africa. Yet in this context, little research has been undertaken on the design and implementation of IPs focussing on issues other than market access, such as aiming to encourage the technical and organisational feasibility of complex cropping systems. Conservation Agriculture (CA) is one such area where IPs may be useful, since its complex nature calls for technical, organisational and institutional changes involving several stakeholders at both production system and village territory levels. This paper highlights the design and implementation processes of platforms established in three villages in Burkina Faso aiming to assess the relevancy of CA for the West African context by developing CA technical references with local stakeholders and analysing how to renew rules of interaction between stakeholders within a territory. The design of the IPs was initiated by a multidisciplinary research team and based on three complementary steps: (i) the diagnosis of existing forms of organisation; (ii) the development of an IP model, and (iii) the validation by stakeholders of the IP model followed by the planning of activities. After three years of activities, we assessed the effects of IPs on farmers’ perceptions, attitudes, practices and networking in relation to the initial objectives assigned to the IPs. The platforms enabled farmers in the three villages to actively participate in the specification of the cropping systems tested and to improve their perception of CA. They furthermore promoted networking in terms of exchange among farmers and the spread of CA principles in the communities as well as facilitating the development of new rules for crop residue use. The platforms thus appear to be relevant mechanisms enabling complex innovations to be explored. However some modifications and improvements are necessary to ensure the sustainability of the platforms and the evolution of their objectives and activities beyond those of the project under which they were launched.

Keywords: Forms of organisation, participation, innovation systems, Burkina Faso
Introduction

Conservation Agriculture (CA) comprises a family of cropping systems based on the use of three complementary principles (minimum tillage, organic soil cover, crop diversification) (Scopel et al., 2013). Across tropical countries, including Africa, CA promoters consider it to be a possible means to improve agricultural productivity and strengthen farmers’ resilience to climate variability (Pretty et al., 2011; Tittonell et al., 2012) in a context of increasingly frequent extreme weather events (Cooper et al., 2008) and rising demand for agricultural produce. However, the principles of CA depart from prevailing cropping systems typically based on tillage and monoculture and hence usually require a significant transformation of cropping practices, farm organisation and support networks (Ekboir, 2012, Goulet & Vinck, 2012). Before CA adoption may take place, farmers must be convinced that there is a need to switch to CA, and that CA can respond to their key objectives such as improving food security and income. For this, technical references adapted to local conditions must be developed. Also, because successful application of CA requires that soil remains covered, rules governing the management of and access to crop residues at the community level must be renewed, which usually implies delicate negotiations between crop and livestock farmers. Farmers’ access to inputs (cover plant seeds, herbicides) and equipment required in CA also must be facilitated (Kassam et al., 2009).

In the past, approaches based on a linear conception of technology transfer have had limited success in achieving CA adoption on small family farms (Giller et al., 2011; Knowler & Bradshaw, 2007; Nkala et al., 2011; Wall, 2007). New approaches are needed which allow local stakeholders to find acceptable solutions. In the wake of innovation system thinking (World Bank, 2012), innovation platforms (IP) have emerged as a relevant means for the support of innovation processes. IPs bring together different stakeholders to facilitate collective planning and decision-making, conflict resolution, negotiation, and social learning for concerted action around the development of technical and organisational innovations, recognising that innovation is a socio-technical process (Nederlof et al., 2011; Röling, 2002). In Africa, IPs have been tested in projects aiming to improve agricultural productivity, most often in tandem with the creation or reinforcement of local actors’ access to markets (Defoer & Dugué, 2012; Hounkonnou et al., 2012; Kilelu et al., 2013; Nederlof et al., 2011; Nyemeck, 2011; Nyikahadzoi et al., 2012; Sanyang et al, 2014; Tenywa et al., 2011). Few studies, however, have examined how IPs may be implemented to address complex systemic innovations such as CA, although the potential of the IP approach to respond to such challenges appears high (Ekboir, 2012; Nederlof et al., 2011).

This article assesses the process by which three community-level IPs were designed and implemented in Burkina Faso under the leadership of a research team working under the Agroecology-Based Aggradation Conservation Agriculture (ABACO) EU project. These IPs aimed to explore with stakeholders how relevant CA principles are to encouraging the development of sustainable production systems (Tittonell et al., 2012). After presenting the design process and the structure of the IPs, we analyse several monitoring indicators and discuss the relevance of IPs in facilitating the adaptation of CA.

Methodology

Study area

The three villages included in this study are located in contrasting regions in Burkina Faso (Table 1).
<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Sudanian zone</th>
<th>Sahelian-Sudanian zone</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Koumbia</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Latitude</td>
<td>12° 42' 207&quot; north 4° 24' 010&quot; east</td>
<td>13°0'020&quot; north 1°32'777&quot; west 13° 41&quot; 844&quot; north 13° 740&quot; 72&quot; west</td>
</tr>
<tr>
<td>Climate</td>
<td>Sudanian</td>
<td>Sahelian-Sudanian</td>
</tr>
<tr>
<td></td>
<td>Rainfall: 1200 mm/year</td>
<td>Rainfall: 900 mm/year</td>
</tr>
<tr>
<td>Cropping season</td>
<td>May-October</td>
<td>June-October</td>
</tr>
<tr>
<td>Population (habitants)</td>
<td>7 000</td>
<td>5 000</td>
</tr>
<tr>
<td>Socio-political organisation</td>
<td>Village community</td>
<td>Traditional chiefs</td>
</tr>
<tr>
<td>CA introduced</td>
<td>2011</td>
<td>2009</td>
</tr>
<tr>
<td>Other experiences with the introduction of innovation</td>
<td>Compost pit, legumes</td>
<td>Planting in rows, zaï and half-moon techniques</td>
</tr>
<tr>
<td>Main crops</td>
<td>Cotton, Maize, Cowpea, Peanut</td>
<td>Sorghum, Millet, Cowpea, Peanut</td>
</tr>
<tr>
<td>Stocking rate (TLU = Tropical Livestock unit)</td>
<td>4 TLU/hectare</td>
<td>2 TLU/hectare</td>
</tr>
<tr>
<td>Existing technical model</td>
<td>Monocropping, mineral fertiliser and mechanisation</td>
<td>Combined crops, little mineral fertiliser and manual farming</td>
</tr>
</tbody>
</table>

Koumbia, located in the Sudanian zone of the cotton production basin, has a good biomass production potential combined with significant pressure from livestock rearing. The dominant farming system in the area includes the monoculture of cotton in rotation with cereals (maize and/or sorghum) and the use of mineral fertilisers. Up until 2011, Koumbia farmers had not experimented with CA; however it had been a research site for the participatory design of agro-pastoral innovations (Vall & Bayala, 2014). Sindri and Yilou, are located in the Sahelian-Sudanian zone of the country. Compared to Koumbia, they have more limited biomass production potential, and face less pressure from livestock rearing. The dominant farming system in these two sites is based on cereals (sorghum and millet) combined with cowpeas or peanuts. The first participatory experiments involving CA were begun in 2009 under an externally-funded project (ACT et al., 2012).
Innovation platform design process
A multidisciplinary research team (two agronomists, one sociologist, two animal production scientists, one geographer) implemented the IP design and development process. Inspired by the three stages identified by Nederlof et al. (2011), the process relied on three complementary steps: (1) the diagnosis of existing forms of organisation, whether endogenous or exogenous; (2) the development of an IP structure; and (3) the validation by stakeholders of the IP structure followed by the planning of activities.

Diagnosis of existing forms of organisation
This step was carried out through semi-structured interviews with the leaders of existing farmers’ organisations (3 in Sindri, 11 in Yilou, 13 in Koumbia), local government representatives and traditional leaders. The interviews included questions about the identity of the organisation, how it emerged, its internal structure and governance, its operations, and its communication system, partners, strengths and weaknesses.

Development of an innovation platform model
Based on the outputs from the diagnosis, the research team developed a proposal for the structure and functioning of the IPs aiming to: (i) co-design technical references adapted to local conditions, facilitated by individual and collective learning about CA; and (ii) revise the rules governing stakeholder interactions at the community level in order to facilitate connections between local stakeholders and via them the technical and organisational challenges linked to the adoption of CA. The research team furthermore made two methodological choices coherent with the objectives pursued: (i) to focus at the village scale as it seemed best suited to entertain questions about adapting to local conditions and learning; and (ii) to rely on existing forms of organisations to build IPs, to avoid creating an artificial new structure overly dependent on the ABACO project.

Validation by stakeholders of the IP model and the planning of activities.
Four one-day discussion workshops were organised in the study area with the following stakeholders from each village deemed likely to join or interact with the IPs: seven representatives of farmer groups; two to five government outreach agents; between one and six retailers or artisans selling (or growing/producing?) agricultural products; between two and four local government agents; and one to two traditional leaders. Researchers from the ABACO project were also involved. These workshops aimed to allow stakeholders to define potential constraints on the application of CA, their expectations of the IP model proposed, adaptations which they might propose for this model, the role they wished or did not wish to play, and the activities they wished to conduct.

Operation of the IP
The activities conducted by the IP were recorded as follows: the number per actors that participated in these activities (number of participants was recorded for each activity); and the first outputs of these activities regarding the co-design of technical references and the revision of the rules for governing of stakeholder interactions at the community level.

Five of the co-authors of this paper were part of the IP construction process
Results

Design of the IPs

Step 1: Diagnosis of existing forms of organisation
Diverse forms of organisation co-exist in the three villages. The endogenous forms of organisation identified include self-help groups (exchanging labour) and service provision groups. There are also traditional organisations grouping male household heads or lineages under the authority of traditional leaders who play a role in the management of conflicts at the village territory level. These organisations are experiencing some difficulty in mobilising members due to a rise in individualism.

The exogenous organisations identified are the product of various external dynamics. Public authorities were behind the creation of village development councils (VDC) and chambers of agriculture (CA) committees. These organisations have formal structures and sometimes even action plans, but their actual activities are low (VDC) to non-existent (CA) because they do not have their own funding, members lack training, and they have become polarised by diverse power struggles. Farmer organisations were started by value chain promotion schemes. In Sindri and Yilou they are characterised by a lack of initiative, a low level of technical equipment and low skill sets among members, and are structured around cereal, legume and vegetable crops destined for home consumption rather than markets. In Koumbia, cotton farmer organisations have comparatively more equipment and technical partnerships. Village Coordination Committees (VCC) and farmer field schools (FFS) were initiated by research and development (R&D) projects. They group together farmers from diverse social and ethnic backgrounds. While they differ somewhat in terms of their history and operations, they all function as spaces or fora for interaction and learning about technologies between farmers, the research teams which launched them and public extension services. Beyond the solidarity between members, one of the main strengths of these fora resides in the desire of members to maintain a partnership with research teams to continue to test new techniques and gain access to training and agricultural inputs. However, those in charge of existing fora point to numerous difficulties and concerns such as a lack of interest and availability of members to participate in experimental activities without some form of material or financial compensation, failure on the part of members to apply the technical recommendations of the researchers, and questions regarding the legal status and sustainability of these fora.

Step 2: Definition of the innovation platform model
The diagnosis showed the strong interest of existing forms of organisation in learning via experimenting with new systems (VCC, FFS), managing shared resources and related conflicts (traditional authorities), and promoting access to inputs and markets (farmer organisations), which are objectives coherent with those expected of the IPs. Inspired by Faure et al. (2010), the research team opted for an IP structure consisting of two bodies, a technical body and an institutional body, with each addressing one of the two main objectives under pursuit (Figure 1).
The technical body (composed of farmers from R&D devices, government agriculture extension services and the research team that decided to participate on a voluntary basis) is meant to generate CA technical references by proposing and testing cropping systems based on CA principles. The institutional body (also called the “forum”) is meant to facilitate the coming together and interactions of all stakeholders with a link to CA that decided to participate on a voluntary basis. The interactions between actors gathered within the forum aim to identify and engage organisational changes needed to facilitate access to crop residues and land, markets and equipment. The forum also aims to lobby political decision makers at the village and communal level to support the implementation and spread of changes in the farming systems that build on CA principles. The research team proposed an informal mode of coordination within the IPs so that they could function in a flexible manner (Nederlof et al., 2011). The decision was motivated by lessons learned from past experience with more formal modes (within existing R&D devices) which had mixed results (Koutou et al., 2012).

Furthermore, some activities which had proven successful in previous projects conducted in the study sites were retained, such as the organisation of training, guided tours and inter-village exchanges focusing on innovative techniques. New tools to facilitate discussion and sharing were proposed such as maps to use with forum actors to identify areas where CA could be introduced (Diallo et al., 2014) and simulation models to assess at the farm or village scale the effect of different levels of CA adoption (Djamen et al., 2015).

Step 3: Stakeholder validation of the IP model and planning activities
All of the actors who attended the validation workshops appeared to share a common vision of an IP as a space for coming together and exchanging information and experiences about CA. The stakeholders furthermore proposed ways to contribute to the functioning of the IP coherent with their respective conventional roles, for example, the public extension services offered to monitor the implementation of cropping system trials based on CA. Each type of
stakeholder, however, also had his or her own, at times opportunistic, vision of the IP. For example, men saw in it a means to acquire inputs and agricultural equipment while women saw a means to add value to their production and commercial activities involving milk, shea butter, peanut butter, and cowpeas. The IP validation workshops also provided an occasion for some stakeholders to express their doubts, particularly in relation to the CA technical model, regarding the feasibility of obtaining permanent soil cover and of consequently modifying rules on access and management of crop residues. Some public extension agents expressed doubts regarding the possibility of intensifying existing systems through CA. Despite these various expectations and specific doubts, the stakeholders were able to define an activity plan structured around activities involving training, field trials, study visits and trips, and work on a land charter, with clear responsibilities shared between different members of the IPs. The heads of the VCC in Koumbia proposed innovative instruments such as a field trial competition which would award prizes to farmers who had best conducted their trials and who could explain the principles of CA to stimulate respect for the collectively defined technical specifications. Communication and awareness raising activities were proposed also by farmers to promote better understanding of CA among other villagers.

**Operation of innovation platforms**

IPs activities

The action plans served a route for action in the different study sites. The activities actually carried out from the end of 2011 to the end of 2014 are presented in Table 2. They include training, on-farm experiments, exchange visits, radio shows, and fora about crop residues management at the territorial levels. In the implementation of these activities, the themes of the training sessions conducted were proposed either by research (on CA principles) or by the farmers (on the use of the direct seeder). The trials were the products of the interaction between hypotheses made by the research team, farmers’ expectations and lessons learned from the first trials.

**Table 2. Activities carried out by the IPs in Koumbia, Sindri and Yilou**

<table>
<thead>
<tr>
<th>Learning and spread of knowledge</th>
<th>Koumbia</th>
<th>Sindri</th>
<th>Yilou</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 Training sessions on CA and leadership</td>
<td>2 Training sessions on CA</td>
<td>2 Training sessions on CA</td>
<td></td>
</tr>
<tr>
<td>6 Protocol discussion meetings</td>
<td>3 trials of CA based systems</td>
<td>3 trials of CA based systems</td>
<td>5 Protocol discussion meetings</td>
</tr>
<tr>
<td>4 ex-post assessments of trial meetings</td>
<td>3 pilot assessment general assemblies</td>
<td>3 trial campaigns</td>
<td>3 pilot assessment general assemblies</td>
</tr>
<tr>
<td>3 Guided visits</td>
<td>2 Guided visits</td>
<td>11 Guided visits</td>
<td></td>
</tr>
<tr>
<td>1 Study trip</td>
<td>1 Study trip</td>
<td>2 Study trips</td>
<td></td>
</tr>
</tbody>
</table>

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Stakeholders’ participation and contribution to IPs operation
The IPs attracted a growing number of stakeholders over time to their meetings including researchers, farmers, extensions agents, municipality agents, private actors and traditional leaders (Table 3). This may have been due to some activities carried out such as study trips, competitions, guided visits and open door day which were seen as opportunities to enhance farmers’ interactions and knowledge around CA while emulating their interest. Among them, three stakeholders contributed strongly to keeping IPs running. The researchers performed the major role, followed by the farmers and the municipalities. Extension agents, traditional leaders, private actors and NGO performed a marginal role. This difference in contribution to IPs operation among stakeholders may be explained by the focus of the IPs on CA participatory experiments. Those actors who assumed that IPs and CA could be useful for them participated strongly compared with those who were more doubtful re the benefits.

Table 3. Stakeholder mobilised and their contributions to IPs operation in the three villages

<table>
<thead>
<tr>
<th>Types of stakeholders</th>
<th>Number of participants (*)</th>
<th>Contribution to IPs operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmers (individual and organisation representatives)</td>
<td>351</td>
<td>Provide meeting rooms and plots for implementing CA trials; take part in CA trial monitoring; sharing their knowledge and experience; provide information; organising IP’s activities</td>
</tr>
<tr>
<td>Researchers (researchers, technicians and students)</td>
<td>36</td>
<td>Finance, organise, coordinate, monitor and evaluate IPs activities; sharing their knowledge and experiences</td>
</tr>
</tbody>
</table>
Municipality agents | 16 | Provide meeting room; sharing their knowledge; provide information
Extension agents (agriculture, livestock and environment) | 13 | Sharing their knowledge; monitor CA trial; provide information
Private actors (inputs providers, artisans and products sellers) | 12 | Sharing their knowledge; provide information
Traditional leaders (land chief and village chief) | 7 | Sharing their knowledge; provide information
Value chain actors | 5 | Sharing their knowledge and experiences during the meetings
NGO | 3 | Sharing their knowledge and experiences during the meetings
State representative | 2 | Sharing their knowledge and experiences during the meetings
Microcredit agents | 1 | Sharing their knowledge and experiences during the meetings
Total | 446 |

(*) the figure corresponds to all the persons in each category who participated in all IPs meetings organised during the three years across the 3 villages, based on monitoring data.

**IPs achievements**

After three years of existence, the IPs demonstrated two main achievements in line with their declared objectives: the adaptation of CA principles (minimal tillage, permanent soil cover and intercropping) to local conditions; and the definition of the rules governing the stakeholders’ access to crop residues. Firstly, the IPs’ members defined a new CA cropping system adapted to local conditions after a long process of interaction and exchange among them. In Koumbia, the CA system selected at the end of the process (mechanised direct sowing of maize intercropped with cowpea with soil cover) was different to that selected at the beginning (direct manual sowing of sorghum intercropped with pigeon pea) because farmers rejected the manual sowing given its arduousness, the sorghum given its low performances and the pigeon pea due to its late flowering (Table 4).
### Table 4. Dynamics of co-construction of cropping systems in Koumbia

<table>
<thead>
<tr>
<th>Year</th>
<th>Farmers’ objectives</th>
<th>Research team’s proposal</th>
<th>System tested after discussion/validation by farmers</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>Ensure grain production to feed the family and forage production to feed the herds</td>
<td>Over 10 cropping systems consisting of various combinations of main crops, associated leguminous crops and soil tillage patterns</td>
<td>Direct manual sowing of sorghum intercropped with pigeon pea, soil cover by residues from other fields or brushwood</td>
</tr>
<tr>
<td>2013</td>
<td>Limit the arduousness of sowing and soil cover given the difficulty of conserving biomass in the dry season</td>
<td>Introduction of animal drawn direct seeders. Test of three levels of soil cover on yields and water infiltration</td>
<td>Mechanised direct sowing of maize intercropped with cowpea with three levels of soil cover</td>
</tr>
<tr>
<td>2014</td>
<td>Improve use of animal drawn direct seeders</td>
<td>Test of different conditions of use of animal drawn direct seeders</td>
<td>Mechanised direct sowing of maize intercropped with cowpea with three levels of soil cover and analysis of conditions of use of direct seeders</td>
</tr>
</tbody>
</table>

In Yilou and Sindri, the process was similar and led to the selection of two CA cropping systems: (i) cereal (sorghum or millet), directly sown under a mulch of crop straws, intercropped preferably with leguminous food crop for resource (land) constraint; and (ii) cereal, directly sown under a mulch of crop straws, intercropped or in rotation with leguminous fodder crops for farmers with larger farms and who also keep cattle. The majority of the farmers opted for leguminous food crops (mainly cowpea and groundnuts - that can more easily be found on the local market - and amberique) leaving leguminous fodder crops (*Mucuna* sp., *Dolichos* sp.) to farmers who keep cattle between several existing or new species of leguminous crops presenting specific or combined functions including food, fodder and soil fertility, and which were proposed initially by the research team.

The specific activities conducted around the revision of the rules governing stakeholder interactions at the community level were focussed on the access to crop residues. Iterative discussion and experience sharing in the IP’s fora showed that: in Koumbia there was an existing land charter that could be a valuable tool to regulate the access to crop residues, but that needed support to overcome specific challenges linked to the activation of the land...
conciliation village commissions; in Sindri and Yilou, where land charters do not exist, the fora supported the collective definitions of rules regulating the access to crop residues (Table 5).

Table 5. Rules of crop residue use defined in the forum to be included in the land charters of the villages of Sindri and Yilou

<table>
<thead>
<tr>
<th>Sindri</th>
<th>Yilou</th>
</tr>
</thead>
<tbody>
<tr>
<td>- collection of crop residues prohibited in degraded areas</td>
<td>- systematically cut down the stems after the harvest</td>
</tr>
<tr>
<td>- residues collected in low-lying areas and ravines</td>
<td>- common pasture is not prohibited as long as the owner is notified</td>
</tr>
<tr>
<td>- collection prohibited in gravel areas</td>
<td>- burning crop residues prohibited</td>
</tr>
<tr>
<td>- inform the owner before collecting</td>
<td>- stealing crop residues prohibited</td>
</tr>
<tr>
<td>- open the fields to animals</td>
<td>- collect thin stems to keep and feed to livestock</td>
</tr>
<tr>
<td>- lay down stalks produced in sealed and crusted bare soils (locally called zipéllé) after the harvest</td>
<td>- collection of residues on degraded areas (zipéllé) prohibited</td>
</tr>
<tr>
<td>- lay down stalks produced in low-lying areas and let animals feed on leaves</td>
<td></td>
</tr>
<tr>
<td>- use the stems of millet, the piliostigma pods (bagna), the stems of sesame and sorrel for the potash</td>
<td></td>
</tr>
</tbody>
</table>

Discussion

Our results show that the three village-level CA IPs attracted a growing number of participants who shared responsibilities for implementing and assessing CA activities, despite the predominant role of research. A monitoring and evaluation of the process is in progress regarding new knowledge, attitudes, practices, networking and skills gained by the IPs members (and particularly the farmers) but first outputs obtained are positive with cropping systems co-designed by farmers and research, and new decision rules defined. We chose to base the IPs on existing organisations as opposed to creating them from scratch. The option to base on existing networks is often considered to be the best and the most sustainable in terms of “institution building” allowing IPs to quickly gain legitimacy and an audience, and to rapidly become operational and limit the risk that parallel, but conflicting, processes of decision making may take place. However, with this option, it can be difficult to propose “innovative” activities, modes of operation, or interactions which depart from those which the existing organisations and their members are accustomed to and are prepared to undertake. Furthermore, like local society, these organisations are underpinned by more or less structured and stable power relations linked to the socio-cultural and religious functioning of the communities involved.

The degree of leadership actually exercised by local stakeholders and their progressive empowerment with respect to the role played by outside intervention and resources (reflecting a deliberate increase in their capacity to innovate) are two key features of the sustainability of IPs which have not yet been explicitly addressed in our work (Kilelu et al., 2013; Leeuwis et al., 2014; Nederlof et al. 2011).

The research team was well-placed and indeed almost obliged to exert leadership and steer the process of building and putting into operation the village IPs. This was due to the relative
lack of experience with CA and the IP approach in the study area, a lack of technical
references, and the relative weakness of local organisations. In the context of a short-term
project, it also aims at saving time so that meaningful activities take place rapidly. Yet it has
its drawbacks: by remaining in the driver’s seat, whatever the valid reasons it had to do so,
research was less able to change some of its typical ‘top down’ attitudes and practices towards
multi-stakeholder approaches. Consequently, the points of view of local stakeholders were
perhaps not sufficiently taken on-board in the design of the IPs and in their functioning
(focused mostly on experiments and knowledge production). A more bottom-up approach
would most probably have yielded a different type of IPs, perhaps easier to sustain in the long
run. If nothing is done soon to reduce this dependence on the research team, these IPs could
very well rapidly disappear or fall dormant as soon as the ABACO project ends, as has often
been observed in similar situations elsewhere. The importance of local leadership is
demonstrated by the fact that the cases where CA has been developed successfully have
occurred in the context of multi-stakeholder, ‘bottom-up’ processes in which farmers had
and/or still play leading roles (Ekboir, 2012; Triomphe et al., 2007). To avoid the risk of the IPs
getting bogged down we must identify among the ‘local’ IP members those who are most likely
to assume leadership (farmers’ organisations, public organisations – notably extension
services – or NGOs with a long term local or national level presence) and sufficiently interested
in continuing the IPs. For these stakeholders this would involve obtaining (including through
self-financing activities) a sustainable source of resources needed for their routine operations
(cost of periodic member meetings, exchange visits for experimental trials) (Nederlof et al.,
2011; Triomphe & Hocdé, 2010), even if that means modifying the initial objectives and
operations of these IPs.

Lastly, it seems evident that regardless of their purpose, there is a limit to what village IPs can
do to help change local agriculture. It is critical to also work at the level of the “enabling
environment” (Hounkounou et al., 2012) in order in particular for agricultural policy to be more
supportive of the implementation of complex systems such as CA systems. A medium-term
strategy would thus need to be developed, as a complement to local platforms, with one or
several provincial or national level platforms better able to influence institutional and policy
changes which could promote CA production systems. These may include, for example,
training for extension services required to accompany the CA transition, setting up subsidies
or financial incentives for good practices, changes in rules of land access for migrants and
women, or, more globally, innovation policies favourable to family farming (Devaux et al., 2009;
Kilelu et al., 2013; Nyikahadzoi et al., 2012; Thiélé et al., 2011).

Conclusions
This article presents the design and implementation of innovation platforms piloted by a
research team aimed at promoting the co-design of local technical references and adapting
the rules of interaction between stakeholders in three villages in Burkina Faso. At the initiative
of research, these IPs were structured into two components: a technical body to test new
cropping systems; and an institutional body to organise local actors into a network to address
the challenges posed by CA, such as access to crop residues and land. The IPs thus
structured engaged in a wide range of activities (negotiation of protocols, experimenting,
annual assessments, meetings, competitions for the best pilot farmers) while the research
team steering the process provided appropriate methods and animation tools.
This mode of functioning has allowed stakeholders, and foremost among them the farmers
themselves, the opportunity to design cropping systems based on CA principles and define
new rules of access to land The IPs thus appear to be an appropriate instrument to promote the design of complex innovations such as CA among a diversity of stakeholders.

Various improvements should be made in the near future if these platforms are to outlive the framework and funding of the project through which they were created. In particular, this will involve reducing the platforms’ dependence on the research team. This may also involve a closer link with economic objectives and more clearly reinforcing the capacity of diverse local actors to take part in innovation, notably the extension services, which are the real "innovation facilitators". This may allow the platforms to address relevant innovations other than CA in the future. Another challenge will be to eventually complement the village level mechanism with the development of provincial and national platforms, which will allow key institutional and economic challenges related to the enabling environment to be addressed.
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The merits and limitations of innovation platforms for promoting Conservation Agriculture in sub-Saharan Africa

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Abstract: Despite many efforts, Conservation Agriculture (CA) has not been embraced on a large scale by African farmers. CA requires technological, organisational and institutional changes, as well as a strong capacity in problem solving from farmers and service providers to adapt CA practices to the local context. Such a broad set of changes is not suited to a top-down, linear approach of technology transfer. Over the last decade, various CA initiatives have therefore adopted an innovation systems approach, using innovation platforms (IPs) as an instrument to promote CA. However, to date CA innovation platforms have tended to focus on CA as a solution, thus overtaking the attention to tackle underlying problems and constraints such as declining soil fertility, insecure property rights, conflicting demands on farm resources, or lack of inputs and services. Innovation platforms that have functioned well in terms of experimenting with different CA practices required a lot of time and effort to facilitate the platform activities. Drawing on experiences from different projects (primarily ABACO¹, but also from DONATA²), we identified several lessons and strategic questions regarding the use of innovation platforms for CA. Some of the issues to be considered when using IPs for sustainable agriculture are: identification of suitable themes for IPs; the influence of different starting points and structures that are used for the set-up of IPs; the use of external resources and facilitation in establishing and maintaining the IPs; opportunities and constraints to foster autonomous IPs; and relevant criteria for measuring success of IPs. The paper further discusses under which conditions, and to what extent, IPs are an improvement on conventional ways of developing and promoting agricultural technologies.

Key words: Conservation agriculture; innovation platforms, agricultural innovation systems

Introduction

The rapid environmental, economic and social changes occurring at national and local levels in sub-Saharan Africa require a research and development approach that is able to identify suitable technologies and provide the enabling environment (i.e. suitable policies, technical adaptation, social structures, infrastructure, facilities, resources, materials, skills and information) that will make them viable innovations in different situations. For this, donors³ and government programmes are increasingly turning to agricultural innovation systems (AIS) approaches (Pound & Essegbey, 2007). Since the 1970s, alternatives to top-down, linear approaches to research and extension (e.g. technology transfer) have been evolving. They include farming systems approaches, and a host of participatory approaches, such as Participatory Rural Appraisal, Participatory Technology Development, Participatory Learning and Action, Farmer Field Schools and Action Research. Each one stresses different aspects

¹ Agro-ecology Based Aggradation-Conservation agriculture (ABACO) funded by the EC and managed by the African Conservation Tillage Network through in-country and international organisations
² Dissemination of New Agricultural Technologies in Africa funded by the African Development Bank, managed by FARA and implemented by ASARECA in eastern and central Africa
³ Including the World Bank, DFID, the African Development Bank and Regional organisations such as FARA
or different stakeholders in the technology generation and utilisation continuum. During the same period there have been major shifts towards the de-centralisation of extension, the liberalisation of input supply, the empowerment of farmers to demand services relevant to their needs, and greater emphasis on post-harvest activities and marketing of products. The agricultural innovation systems approach brings these different components and actors together by emphasising the linkages between actors, covering the spectrum from producers through processing and marketing to consumers (Triomphe et al., 2007). The AIS approach is still evolving, and there is no blue-print for how to apply it. Rather it is a set of principles, experiences and best practices that together add up to a new way of conducting agricultural research for development (AR4D). The applied nature of the AIS approach is clear from the definition. It places innovation at the centre of a partnership, rather than technology or research organisations. One of the practical applications of the AIS approach is the design or strengthening of multi-stakeholder coordination to address a challenge or exploit an opportunity. One such way is through innovation platforms (IPs) that can operate at national scale (e.g. a task force made up of partners from government, academics, NGOs and the private sector) or local scale (e.g. local government, locally-based NGOs, locally-operating extension, training and research organisations, local entrepreneurs along the value chain and interested farming families).

Conservation agriculture (CA) is heralded by many as a means to achieve sustainable agricultural intensification, increase farmers’ resilience to climatic variability and address soil degradation in sub-Saharan Africa (e.g. Kassam & Friedrich, 2011; Marongwe et al., 2011) through its three central principles of soil cover, zero (or minimum) tillage and intercropping. However, there is also increasing recognition that the spread of CA in sub-Saharan Africa has been limited because of diverse agro-ecological and socio-economic factors, and that CA needs to be tailored to local circumstances (Giller et al., 2009; Knowler & Bradshaw, 2007; Nkala et al., 2011; Tittonell et al., 2012). The transition from conventional agriculture to CA requires technological and institutional changes, as well as a strong capacity in problem solving from farmers and service providers to adapt CA practices to the local context (Posthumus et al., 2011). The promotion of CA as a full and indivisible package that farmers need to adopt leaves little room for manoeuvre for local adaptation, and has contributed to the very limited adoption of CA by resource-constrained farmers in Africa.
The 4-year ABACO project, funded by the European Commission, applied an AIS approach to the promotion of CA. ABACO aimed at establishing site-specific innovation systems that rely on agroecology principles and recuperation measures to restore soil productivity in semi-arid regions of Africa. ABACO tried to achieve this through the creation and support of co-innovation platforms that involve the farmer, extension and research communities interacting with other relevant stakeholders specific to each situation. The participation of farmers in technology development through action research, with a solid involvement of researchers working together with farmers and others (co-innovation), was thought to be a pre-requisite to the adoption of soil improving technologies. Figure 1 depicts how co-innovation should work in theory, bringing together a range of relevant actors (stakeholders) and activities.

This paper reflects on the outcomes of the ABACO project, in particular on the use of IPs in its project approach, and presents the lessons learned. The authors also draw on first-hand experience with the DONATA\textsuperscript{4} project (African Development Bank project managed by FARA\textsuperscript{5} and implemented by ASARECA\textsuperscript{6} in eastern and central Africa).

**Innovation platforms for the promotion of CA: experiences from ABACO**

At the start of the project, it was decided that the IPs would be a core tool in the ABACO project. The IPs were expected to involve a range of stakeholders (community, state, commercial, civil society, international) in dynamic, creative and productive partnerships that benefit all of the stakeholders in some way. Without benefits of a magnitude and over a timescale that are significant and interesting to the stakeholders, it was assumed that the partnership would falter.

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\textsuperscript{4} Dissemination of New Agricultural Technologies in Africa (DONATA)  
\textsuperscript{5} Forum for Agricultural Research in Africa (FARA)  
\textsuperscript{6} Association for Strengthening Agricultural Research in central and Eastern Africa (ASARECA)
The functions of the project IPs were defined as:

- Coordination: provide co-ordinated relationship between organisations (leadership, common goals, roles and planning)
- Information and capacity building: assist the flows of information and knowledge (including training) for the understanding and application of CA
- Experimentation: testing and adaptation of CA options
- Socio-economic study: understand farmers’ circumstances, aspirations and support needs for CA options
- Advocacy: engagement with national-level actors – influence on policy

IPs can exist at different levels (e.g. national, district and local). Some ABACO countries already had stakeholder structures of different sorts and at different levels at the start of the project. The priorities assigned to the various functions outlined above was different at each level, as follows:

- **National level functions** included: awareness raising of CA at Ministry and general public levels; influence on relevant policy formulation; influence on national strategy/action plan for CA; influence on allocation of resources to CA; import or manufacture of CA equipment; training of CA technical personnel (research, extension, NGOs etc.), resource mobilisation, linkage with District level
- **District level functions** included: coordination of District-level partners and resources, linkage and communication with national and local level Co-IP; information exchange; capacity development; development and implementation of workplans; diagnosis and assessment, monitoring and evaluation,
- **Local level functions** included: site-specific definition of CA and how it should work; planning and implementation of CA workplans including experimentation; linkages with District partners (for input supply, marketing, information, training...); capacity development.

**ABACO field experiences with Innovation Platforms**

The functions and priorities of IPs given above constitute the theoretical model that the project ideally would have followed. In reality there was a big difference in the application of the IP principles between the five project countries: Zimbabwe (functioning IPs at four levels); Mozambique (partially functioning but fragile IPs at local and national levels); Kenya (no functioning IPs - but established Farmer Field Schools and a wide range of associated stakeholders); Madagascar (relatively weak and unsustainable farmer groups inherited from a previous project); and Burkina Faso, where a strong research-led process has had some success in establishing functioning IPs.

In Zimbabwe, there are functional Innovation Platforms at Ward, District, Provincial and National levels. At local level these are centred around Farmer Learning Centres that were present before the project started. At Ward level the Platform members are female and male farmers, the Ward extension worker(s), locally active NGOs and locally active private input suppliers or traders. District level IPs are coordinated by the District Agricultural Office with the participation of other District-level officials as well as private companies and the District representative of the Zimbabwe Farmers Union (ZFU). At National level the Zimbabwe Conservation Agriculture Network (ZIMCAN) is coordinated by AGRITEX (the national
extension service). The ABACO project IPs were expected to mobilise farmers and stakeholders to co-learn, innovate and generate specific solutions around Conservation Agriculture, climate change and variability and other identified agricultural problems constraining food, nutrition and income security in the smallholder sector. The function of the District IPs (DIPs) was to link smallholder farmers to extension, the Environment Management Agency, the University of Zimbabwe, Rhizobium manufacturer, input suppliers, markets (including the Grain Marketing Board), Banks, the ZFU and the Meteorological Department. Although no NGOs are members of the DIP committee at present they are invited to meetings when relevant (e.g. Environment Africa). The DIP mobilises farmers into groups for the dissemination of technology and the sharing of experience. The DIP identifies training needs and coordinates input provision across all commodities. The DIP also coordinates inter-farmer visits. Modest resources come from ABACO through SOFECSA\(^7\) to facilitate this agenda (e.g. stationery, refreshments for meetings etc.). Because CA is a mainstream government activity, government resources - such as transport - can be used to mobilise farmers. Apart from training, inputs, information and market access, the DIP now organises CA Learning Centres, field days and farmer exchange tours with the facilitation of the SOFECSA National Innovation Platform (NIP) and the research group at the University of Zimbabwe (UZ) These include prizes, which introduces an element of competition and pride among farmers in good work. The DIP links to the national level IP for support. For instance training advice is provided by CIMMYT/CIAT, E-Africa, Restless Development and UZ. A specific challenge is the very limited quantity of CA equipment at present (only one jab planter and one ripper per District). The DIP has a wider scope than CA. It is more correctly seen as an IP for agriculture as a whole into which issues such as soil fertility, climate change and CA can be inserted. It is both a discussion forum and a platform for action. CA participatory trials are conducted through the District IPs, while the local IPs are also used for wider objectives, such as advocating for a new community hall.

In Mozambique there is a national level Conservation Agriculture Working Group that comprises research, extension and the National Farmers Union which meets once per month, and reviews present activities, identifies future needs and shares experiences. There are, as yet, no IPs at District level or at local level. However, the National Agricultural Research Institute (IIAM) is conducting a set of trials on CA in two locations. The sites were selected for the presence of research and extension staff and other service providers, accessibility and their provision of contrasting agro-ecological circumstances. Efforts have started in building IPs at the two locations but the Mozambique research system is suffering from a serious lack of human capacity to fulfil its mandate. The facilitation of meetings and problem solving tends to be done by individuals from the Provincial level because those at the lower level lack the skills and experience necessary. Training and support is needed for them to be able to act more autonomously.

In Kenya there are two starting points for IPs – the national-level Conservation Agriculture Task Force, and the local-level Farmer Field Schools (FFS). As they stand, neither could be
seen as a fully functioning IP\textsuperscript{5}, and there is also little linkage between the two. The National CA Task Force was not active during the project period. At local level there were 9 FFS groups engaged in participatory research through group plots that compare CA maize with conventional agriculture, but there has been a diminishing trend in membership partly due to some poor harvests because of waterlogging (leading to members working for wages on flower farms and elsewhere), and due to old age (the group members have a high average age). Each FFS group has its own internal governance structure, but there is no structure coordinating service providers and the FFS groups (which would constitute an IP). At District level (Laikipia East) there is a wide range of stakeholders (including other projects/NGOs promoting CA), but again no structure that meets to discuss direction, assign roles and coordinate actions. There is a lack of materials and skills at farm level to implement CA properly, and there is a negative social pressure on the group members from the community. CA farmers were accused by their peers of laziness as they do not remove the stover nor produce a clean, ploughed seedbed. There is also social tension within some families. Normally only one family member, either the husband or the wife, attends training and works on demonstrations as a member. While they may be convinced of the benefits of CA, they have a hard time convincing their spouse, who then continues with his/her traditional practices. However the project has stimulated discussion within the family, and raised the status of women in the eyes of their husbands. Progress of the ABACO project in Kenya has been limited in terms of the number of committed adopters. However, encouraging signs are the number of knowledgeable, committed, extension staff who now have good experience with the practicalities of implementing CA in the field, and the level of interest shown in field days by non-CA group farmers. They have noted that many of the CA-group member families are at, or near to, food self-sufficiency unlike many of their conventional farmer neighbours.

In Madagascar, ABACO was working with two existing local farmer groups near Lake Alaotra, but no regional IPs for CA have been created. The two farmer groups were considered as technical IPs, but operated as FFS, where researchers, farmers and extension agents carried out on-farm CA experiments. Farmers in the North used the group in an effective way to achieve rather advanced, technical objectives, but the group was perceived to be exclusive and closed to non-members, while the less-organised group in the South was more open to interested people but less active. The farmer groups allowed its members access to services provided by a previous comprehensive development project, BV/Lac. BV/Lac was instrumental in CA research and extension in the region. BV/Lac came to an end in 2013, and NGO activity has remained low since then as funding and staff capacities are low. CA adoption remained low and various constraints (e.g. lack of public and private service providers, insecure land tenure) and other interests (e.g. alternative income activities on- and off-farm) restrained farmers’ interest in the groups as well as in CA. A national umbrella organisation, Groupement Semis Direct de Madagascar, engages stakeholders interested in agroecology and CA at national level by sharing knowledge and experiences.

Numerous IPs have been implemented in Burkina Faso to encourage the adoption of agricultural innovations and stakeholder interactions within a value chain, in particular under DONATA. Innovation platforms have emerged gradually as a relevant means for the

\textsuperscript{5} According to the ABACO project document (page 18): “ABACO will adopt a definition of co-innovation platform which is a flexible and informal, dynamic, multi-stakeholder partnership working together to develop and use technologies and processes to improve livelihoods – in this case to implement/monitor/promote CA.”
development and diffusion of many kinds of innovations. Few studies have examined how to implement IPs to address complex systemic innovations such as CA. Under the ABACO project three complementary steps were followed to establish three local innovation platforms for CA: (1) the diagnosis of existing forms of organisation; (2) the development of an IP model; suited to local conditions; and (3) the validation by stakeholders of the IP model and the planning of activities. The emphasis was on the village scale, building on existing structures, rather than imposing new ones. Following analysis, the research team opted for an IP structure consisting of two bodies, a technical body and an institutional body. The researchers viewed IPs as a space for experimenting and assessing innovative cropping systems, a means to ensure more effective participation on the part of local stakeholders in the production of knowledge and the adaptation of CA, and, in the medium term, a means to promote the adoption of CA. Stakeholders defined an activity plan and farmers played an active role year on year in modifying the cropping systems. As a result IPs attracted a growing number of farmers to their meetings. IPs improved the networking of farmers and interaction with external stakeholders was strengthened. The IPs also resulted in changing perceptions and attitudes regarding crop residues and grazing regimes. IPs have been an effective space for the joint design, testing and discussion of new cropping systems and crop residue management modes, and for training, emulation and networking of stakeholders. Basing the IPs on existing organisations allowed the IPs to quickly gain legitimacy and an audience, and to rapidly become operational. However, it can be difficult to propose “innovative” activities which depart from those which the existing organisations and their members are accustomed to and are prepared to undertake. There is a dependence for facilitation and ideas on the research team that suggests weak prospects for sustainability. Regardless of their purpose, there is a limit to what village IPs can do to help change local agriculture. It is critical to also work at the level of the “enabling environment” in order for agricultural policy to be more supportive of the implementation of agro-ecological systems like CA.

Experience with innovation platforms for the dissemination of technologies in DONATA

The experience of ABACO can be contrasted to those of DONATA. This African Development Bank-funded project, managed by FARA, operated in three regions - western, southern and eastern/central Africa. In eastern and central Africa the 10 national research institutions served by the regional research body, ASARECA, chose two novel technologies for promotion through innovation platforms: orange-fleshed sweet potato and quality protein maize. Both were seen as ways to improve nutrition and to provide income through sale of the primary product and processed products along the value chain.

The national research organisations established innovation platforms at district and local levels. This was a time consuming process as it took a long period of negotiation for the stakeholders to understand and appreciate the idea of innovation platforms. In the first instance the platforms were mainly used to multiply the planting material of the two commodities, but as this became more readily available attention switched to developing the value chain. Thus for sweet potato, farming families and some private entrepreneurs started to use orange-fleshed sweet potato for making and selling cakes and doughnuts, while quality protein maize was found to enhance the growth of chickens and was used for fortifying the nutritional quality of bread. These linkages along the value chain took time to develop, and some were more successful, or on a larger scale, than others.
Kimenye and McEwan (2014) found that the factors that tended to result in successful innovation platforms in the DONATA projects in eastern and central Africa were as follows:

- Bringing together a diversity of actors to support learning, innovation, technology generation and dissemination processes.
- Using a range of tools and processes that can support the establishment and functioning of the IP, such as value chain analysis, stakeholder analysis and SWOT analysis.
- Building capacities and competencies for supporting innovation processes and IP functioning.
- Choosing a committed and energetic lead organisation to coordinate and advocate for the IP at institutional level.
- Taking time to establish democratic, participatory governance and management processes.
- Ensuring good flows of information and feedback, and encouraging continued innovation.
- Encouraging sustainability by founding platforms on a sound business model and good business management principles.

Contrasting the use of IPs for promoting CA and for promoting value chain commodities

The main difference between the ABACO and DONATA situations is that ABACO was trying to promote a way of working that might bring environmental and production benefits in the long term, whereas DONATA was promoting technologies that brought tangible, short-term results (once the innovation platform was established and once good quality planting materials were available). DONATA technologies had a commercial driver, giving all stakeholders along the value chain an easily appreciated benefit in participating in the platform. Both of the DONATA chosen technologies had nutritional benefits\(^9\) that provided further incentive for the involvement and support of international bodies such as CIMMYT and CIAT, and humanitarian NGOs (see Kimenye & McEwan, 2014).

\(^9\) Orange-fleshed sweet potato is rich in Vitamin A, while quality protein maize has enhanced levels of the amino acids lysine and tryptophan
Figure 2 shows that Conservation Agriculture operates very much at the production end of the value chain. Unless there is a developed market paying a premium for CA products there is not much of a commercial pull driving the adoption of CA. An alternative might be policy instruments (such as a government payment to farmers during their transition from conventional to CA farming) to provide a push for the adoption of CA. For the widespread adoption of a set of practices such as CA, the enabling environment and the provision of inputs and services have to work in harmony and have continuity over time.

Farmers have to be convinced that the new way of doing things is better than what they have been used to for many years, and the trade-offs are, on balance, more productive (and carry less risk of failure). For instance leaving crop residues on the field means they either have to find new sources of animal feed to replace the residues or dispose of some livestock. Social change may be necessary within the village to stop cattle owners from free grazing the residues in the field, as happened in Burkina Faso. Technical changes will be needed to plant through the trash left on the soil surface and new skills need to be learned to apply herbicides at the correct time and in the correct dosage, assuming the farmer has cash to purchase these inputs. The farmer has to weigh all these factors and decide if radical change is worth the investment and the risk. In addition, CA is a long-term measure, and the investment and upheaval caused by changing to CA are not recompensed in the first one or two years. For
resource-poor farmers with little spare capacity (cash, labour or land), it may be difficult to weather this transition without some assistance.

Conclusions
The introduction of **CA requires fundamental change in the production system**, with implications for many farming operations and activities (including land preparation, stover management, cropping practices, weed management, animal feeding and grazing management). These imply big changes in commitment and behaviour for a range of stakeholders (farmers and service providers), requiring innovation in the ‘software’ (knowledge, information, skills of farmers and service providers) and ‘orgware’ (structures, linkages and ways of working) of the agricultural system (World Bank, 2012). There is also a need for the ‘hardware’ (materials, equipment) specific to CA (including specially designed hand, animal or tractor-mounted planters and weeders, herbicide applicators and effective herbicides) to be readily available to farmers, and accessible to them in terms of cost - with credit where necessary.

To date CA innovation platforms have tended to focus on CA as a solution, thus diverting attention from tackling underlying problems and constraints such as declining soil fertility, insecure property rights, conflicting demands on farm resources, or lack of inputs and services.

This suggests that **innovation platforms should not focus solely on CA**, but rather on underlying shared complex problems which form obstacles to sustainable agricultural intensification and agricultural sector development. The focus on these problems enables innovation platforms to widen their mandate, to bring in innovative solutions that are not prescribed and go beyond technological fixes. Innovation platforms are instruments to reduce barriers to innovation in the agricultural sector. Low adoption rates of CA are not the issue, but the underlying problems and constraints that farmers face are. Solutions may include farming systems that are based on elements of CA, but do not adhere rigidly or exclusively to all CA principles.

The complexity of the challenge means that, despite many efforts, Conservation Agriculture (CA) has not been embraced on a large scale by African farmers. Such a broad set of changes is not suited to a top-down, linear approach of technology transfer, but **if innovation platforms are applied fully and supported over an extended period by a dynamic enabling environment**, they would seem to be a valid instrument for experimenting and adapting CA systems, within a broader sustainable intensification agenda.

However, establishing, supporting and maintaining innovation platforms is very resource-intensive, and there is not enough skilled capacity available in most countries to coordinate and facilitate them as a public good (as in the case of conservation agriculture, which enhances the environment) where there is no commercial driver bringing in service providers and providing an economic incentive to farmers to change their practices.

The experience of the five ABACO countries suggests that it is possible (as in the case of Zimbabwe and Burkina Faso) to build on existing farmer group structures, and, with intensive external support, to change farming attitudes and practices, at least among some farmers and
in some ecological situations. But the impacts of the innovation platforms has remained limited to the localities of the platforms.

Some of the issues to be considered when using IPs for sustainable agriculture are:

- Identification of suitable themes for IPs;
- The influence of different starting points and structures that are used for the set-up of IPs;
- The use of external resources and facilitation in establishing and maintaining the IPs;
- Opportunities and constraints to foster autonomous and sustainable IPs;
- Relevant criteria for measuring success of IPs.

A major constraint to adoption has been the inadequate linkage of farmers to CA service providers for production inputs, output markets and financing. The design of the ABACO innovation platforms has failed to deliver as expected because they were anchored on the delivery of knowledge to farmers, rather than the tangible services demanded by farmers.

Discussions in Zimbabwe and Madagascar in particular have crystallised the opinion that IPs should be broader-based than CA, and that they should be “an innovation space” looking for value chain opportunities, with CA being integrated into those value chain activities.
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Workshop 1.7: Scaling up and scaling out transformative farming practices: critical assessment of tools, methods and skills
Convenors: Marianne Cerf, Boelie Elzen, Lorene Prost and Marie Helene Jeuffroy

Over the past years, many initiatives have been taken to design and develop transformative farming systems, i.e. new farming systems that contribute to sustainability on a variety of dimensions. They cover a range of farming subsectors (e.g. arable farming, horticulture, fruit production, animal production) and may start from various backgrounds, e.g. research, co-creation between research and practice, or practice directly. Rather than offering “off the shelf” sustainable farming systems, such initiatives boost ‘transformative farming practices’, in which the term ‘practice’ covers new hardware or software, as well as orgware. To enable farming as a whole to contribute to sustainability transitions, it is crucial to scale up and/or scale out such new practices. Across Europe, numerous initiatives (whether bottom-up or policy driven) have been taken to achieve this for various subsectors, but the results to date have been meagre. To make this more effective, it is important to critically evaluate such attempts and to try and learn across a variety of cases what works best under which circumstances. At conferences like IFSA, the emphasis is usually on presentation and discussion of individual papers, which makes the cross-comparison needed in this case problematic. To tackle this, this workshop was organised somewhat differently, to get the required coherence. The workshop was built around examples of concrete attempts to scale up and scale out new, transformative farming systems. Attention was paid to the methods and tools used, and the skills required to apply these in the specific circumstances where such scaling up and out processes are at stake. Furthermore, it appears that scaling up and scaling out is not a matter of simply transferring a new practice from one location to another, but typically involves further development and learning in a new location to tune the new practice to the needs of that location. Hence, scaling up and scaling out is an active learning and development process, involving a range of stakeholders. The contributions to this workshop discussed which tools and methods were used to shape this process, what skills were required, and what the experiences were in applying these. Although the focus in this workshop was on ‘scaling up and scaling out’ transformative new practices, we knew from experience that this is often closely connected to how the new practice was created and who was involved in its initial design and development process. Hence, contributions were also expected to address this design process, insofar as it co-determines the approaches for scaling up and scaling out. To get as close as possible to how this works in practice, we sought examples presented by people who are or have been involved themselves in such scaling up and scaling out attempts (who could be researchers), rather than researchers who study such attempts made by others. To satisfy the overall objective to learn across various experiences, the workshop consisted of four sessions, the first three for presentation of cases and the final one for cross-comparison and general discussion and learning. To facilitate the cross-comparison, the convenors made a list of topics that each presenter of a case was asked to address. It was felt that such a cross-comparison would be most fruitful if the cases were presented and discussed in considerable depth. To achieve this, only two cases were presented per session (hence, six in total), a discussant directly after each presentation highlighted key issues, and there was plenty of time for discussion. After the three sessions the convenors assessed these and made an agenda of the most important items to discuss at the final, cross-comparison session. These were introduced at the final session by the convenors and/or the commentators to the three other sessions, as a starting point for the general discussion.
Upscaling of integrally sustainable animal production systems: the dynamic of anchoring processes

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Abstract: This paper analyses the combination of a method to design new sustainable animal husbandry systems by the name of RIO with efforts to stimulate the uptake of these new designs in practice. Over the past 15 years, this approach has been applied in a variety of animal production sectors in the Netherlands, two of which will be analysed here, one for broilers (chickens for meat) and one for pigs. To analyse the uptake process we build on the concept of anchoring that describes how a novelty becomes newly connected, connected in a new way, or connected more firmly to a niche or a regime. In the literature, three forms of anchoring are distinguished, notably technological, network and institutional anchoring. In this paper we seek to develop this general conceptualisation further to understand the dynamics of anchoring processes. On the basis of the cases analysed we conclude that to make technological anchoring more robust, a process takes place that we have called the ‘specification of technology’. Furthermore, we distinguish two patterns in institutional anchoring, one in which the technology adapts to existing institutions and one in which new institutions are adapted to fit the developing novelty. This latter process seems to be key in transition processes to develop ‘integrally sustainable’ solutions.

Keywords: Anchoring, niche-regime interaction, system innovation, sustainable agriculture, animal production, reflexive interactive design

Introduction

In traditional innovation studies, the issue of upscaling (which is the central topic at this workshop of the 2016 IFSA symposium) is conceptualised as the ‘diffusion of innovations’ (Rogers, 1962). More recent work on transitions has shown, however, that innovation is a much more complex process, especially when looking at ‘radical’ innovations or ‘system innovations’ (Geels, 2002; 2004, Elzen & Wieczorek, 2006). The widely used multi-level perspective (MLP; Geels, 2002) sees innovation as the interplay between the three levels of niches, regimes and landscapes. A regime denotes an existing socio-technical system which may be under external pressure from a socio-technical landscape to change. Thus, the agricultural regime is under large landscape pressure to become more sustainable. The reaction of regimes to such pressures typically is to transform via a path of incremental innovation.

Alongside that, various actors may be tinkering with radical alternatives in ‘technological niches’. In a niche, these alternatives (novelties) are protected from market forces via a variety of protection mechanisms and the niches thus provide a space for the actors involved to
develop the novelty further and learn about how to make it work in practice. A novelty not only concerns technical aspects, but also social aspects like how it is to be used, a network of actors to sustain it, etc.

One key issue in transition studies is how niches can link up to regimes and start a process that may lead to a transformation of the regime (Smith, 2007). This linking is a first key step in a process of upscaling. In this paper we will address this linking issue by building on the concept of ‘anchoring’. We will apply this to two cases from the RIO projects that the authors have been involved in over the past decade. The next section will describe the general RIO approach and the anchoring concept. Subsequently we describe the two cases and end with some conclusions.

**Reflexive Interactive Design and Anchoring**

Around the year 2000, Wageningen UR Livestock Research (WLR),¹ was assigned the task of tackling the sustainability challenges associated with large scale animal production in the Netherlands. This led to the development of the RIO approach, a Dutch acronym for “Reflexive Interactive Design”. The authors of this paper have applied this approach in several projects targeting various animal sectors and developed it further, taking into account what was learned in previous applications.

Details of the RIO approach have been described elsewhere (Bos et al., 2011; Bos & Groot Koerkamp, 2009; Bos et al., 2009). Here we only describe its main features. RIO starts with a design phase that builds on the approach of *Structured Design* (Cross, 2008; Siers, 2004; Van den Kroonenberg & Siers, 1998), in an interactive fashion. The design groups consisted of various types of agricultural stakeholders (including farmers, farming equipment suppliers, policy representatives, NGOs) to ensure the incorporation of practical and tacit knowledge, and prevent a research bias with respect to the values underlying the design.

To study the uptake of the results from the RIO design sessions, we build on the concept of anchoring, which was developed in the context of system innovation programmes (Loeber, 2003; Grin & Van Staveren, 2007). In a study of the uptake of radical energy novelties in glasshouse horticulture, the concept was defined more specifically as follows:

“*Anchoring is the process in which a novelty becomes newly connected, connected in a new way, or connected more firmly to a niche or a regime. The further the process of anchoring progresses, meaning that more new connections supporting the novelty develop, the larger the chances are that anchoring will eventually develop into durable links.*” (Elzen et al., 2012a, p.3)

Building on a distinction between three constituent components of a regime, notably technical, network and institutional components (Geels, 2004), the authors distinguish three forms of anchoring. These are technological anchoring, network anchoring and institutional anchoring (Elzen et al., 2012a, p.4-6). *Technological anchoring* takes place when the technical characteristics of a novelty (e.g. new technical concepts) become defined by the actors involved and, hence, become more specific to them. *Network anchoring* means that the network of actors that support the novelty changes, e.g. by enrolling new producers, users or developers. *Institutional anchoring* relates to the institutional characteristics of the novelty, i.e. the new rules that govern its further development and uptake. Institutional anchoring implies

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¹ In 2000, WLR had a different name (ID Lelystad) but for simplicity we use the name WLR for the whole period.
that developments within a niche or regime become translated into adapted or new rules that
govern, at least temporarily, the activities of both niche and regime actors.

Elzen et al. (2012a) have described anchoring in rather general terms, providing evidence that
the distinction of three forms of anchoring can help to understand how novelties are picked up
in niches and regimes and can start a transformation process. The next step is to analyse in
further detail how the dynamic of anchoring progresses. In this paper, we will analyse how the
results of two RIO projects, one on broilers (chickens for meat) and one on pigs, were taken
up and what we can learn from these on the dynamics of anchoring processes.

Concerning the research methodology, all authors have been involved to some extent in the
projects described. Most of the empirical material is based on our own presence in various
meetings and interactions with relevant actors. A secondary analysis of this material allowed
us to give a detailed account of the anchoring of the core radical concepts in the two RIO
cases. We use them in this paper (i) to illustrate and refine the concept of three forms of
anchoring; (ii) to show the dynamic of these forms of anchoring; and (iii) to answer the question
whether we can deliberately anticipate and stimulate anchoring.

Windstreek case

Introduction
The formal origin of the Windstreek henhouse can be traced back to a government funded
RIO project that started in 2009. Farmer Robert Nijkamp (together with two other farmers)
became involved in the second half of 2010, during the first round of interactive design
sessions.

One of the authors of this paper (Bram Bos) was involved as project leader in 2010 and played
an active role in the follow-up of the Broilers with Taste-project, after its end in 2011 (Janssen
et al., 2011). The follow-up was spurred by a special policy instrument (Small Business
Innovation Research or SBIR) used to elicit societally desired innovations from private
enterprise by means of a tender, in which competition is firstly based on quality and business
prospects, and only secondarily on price. Eventually, a consortium of five private parties
around the concept of Windstreek was the big winner of the SBIR-tender “Sustainable barns
in the landscape” that ran from 2011-2015. Helped by the considerable amount of financial
support from SBIR (about 500k€), the consortium was able to further develop and establish
the first pilot barn of Windstreek, at the Nijkamp farm.

The consortium consisted of a poultry slaughterhouse (Interchicken), a climate technology firm
(Sommen), a landscape architectural bureau (Vista), farmer Nijkamp himself and Wageningen
UR Livestock Research. Engineering MSc-student Hendrik Kemp was firmly associated. Later,
Interchicken was substituted by the largest Dutch slaughterhouse Plukon after a takeover,
while Vista was replaced by the bureau Circular Landscapes.

This led to the development of Windstreek, opened late 2015, a henhouse very unlike the
traditional ones in the Netherlands. Its iconic, asymmetrical form (cf. Figure 1) is noticed from
almost a kilometre away. Its 11 meter high transparent front on the north side can be opened
across the full 95 meters of its length, both in the upper as well as the lower 2 meters. As a
result, the animals live by the natural rhythm of day and night. The air inside is refreshed by
natural ventilation. The very young chickens (that enter the barn as one-day old chickens or
as eggs) are kept warm in a special isolated ‘mini-barn’ - the brooding hood - that captures
their own warmth and can be heated additionally by PV powered infrared panels. The higher parts of Windstreek are used as living space, both on the ground, as well as on long stretching tables that can be reached via straw bales. Special mats under the brooding hoods can be used to remove the litter (with manure) from the barn, to prevent the emission of ammonia and fine dust. Trees on the outside, facing the high open front, capture part of the remaining fine dust before it is emitted to the environment. As a result, the Windstreek housing system is claimed to be very animal friendly, to have a very low energy consumption that can be renewably supplied by solar panels, and to have low emissions, while the working environment is healthier than in regular systems.

As the system differs in so many respects from traditional housing systems, and is under a much bigger influence from weather conditions, testing of these and other claims will take at least a year. The economic prospects of the system, and thus its ability to scale up to a larger number of barns without subsidies, still have to be established.

Figure 1 presents a timeline of the history of Windstreek since the start of Broilers with Taste in 2009. Below the timeline, the visual and technical evolution of three central concepts are depicted, notably the barn system as a whole, the concept of the brooding hood and the concept of regular litter removal.
Figure 1. Timeline of Windstreek development for the overall concept and two ‘partial innovations’

Anchoring of the Windstreek concept as a whole

As can be seen from Figure 1 (Barn concept), these features were already present in one of the designs (the ‘Samen-wei’) from the first interactive design session. During the second, extended design round, these ideas got different shapes, but were maintained as core elements. The use of the third dimension to enlarge the living area and the radical ‘halving’ of the architectural form and curving of the remaining slope were added. This curved slope was originally conceived as (technically) functional to natural ventilation, but appeared not to be critical to achieve this. But it was kept, even though it increased building costs, to become part of the Windstreek ‘logo’, and it was registered by the consortium as a trademark together with the name itself. Thus, although the technical reasons for the curved slope weakened, it became firmly anchored in the network for aesthetical reasons. This was the distinctive feature that made immediately clear to an outsider that this broiler barn was very different from any other in the country.
Landscape quality was an important provision under the SBIR-tender and a landscape architecture firm (Vista) developed the initial shape of a ‘barn’ into a concept that moulded with the landscape. This helped the local government to bypass institutional barriers (building aesthetics regulations) that initially prohibited both the height and form of Windstreek. These and other distinctive features helped to get Windstreek through the local and regional regulative systems. Early visuals by Vista from 2012 were not only used in the SBIR tender phase II, but also in an NGO publication on sustainable food.

The application of natural ventilation throughout the system became technologically anchored in the existing network via the involvement of a climate systems enterprise (by the name of Sommen), with whom Nijkamp had worked before. Contrary to many similar firms, their specific business model turned out to fit working with natural ventilation, since Sommen did not primarily depend on the sales of mechanical ventilation systems, but on the sales of computer systems and software for climate regulation in livestock production. Part of the SBIR-grant was used by Sommen to completely redesign its climate software.

**Anchoring of the brooding hood**

Enlarging the living space for broilers as they grow older was originally meant to decrease costs. This was combined with the concept of a ‘mini-barn’ to save energy and create a special climate for very young broiler chickens, as well as brooded eggs. Important institutional barriers were Dutch and EU-regulations that prohibited limiting the space per chicken, even very small ones. Thus, the 2011 Windstreek-concept, that featured a smaller inner barn for young chickens, faced an important hurdle that was unlikely to change. It was one of the reasons that the concept of a mini-barn morphed into the brooding hood.

Regular broiler chickens live for approximately 42 days, while slower growing varieties in more animal-friendly market-concepts live two weeks longer. In the first two weeks of their life, broiler chickens cannot maintain their own body temperature. For this reason, traditional barns are heated during these weeks to a temperature of about 32-38 degrees celsius, which consumes much (fossil) energy in the Dutch climate. The mini-barn in the original Windstreek design of 2011 was intended to solve this, by reducing the volume to be heated.

In the first phase of SBIR tender (spring 2012), the technical people from the Windstreek consortium developed an alternative to this mini-barn: they calculated that the warmth emitted by a large group of very young broiler chickens might be enough to keep an insulated enclosure warm, provided ventilation is reduced a minimum. The concept was called “warmteplu” (heat umbrella) and was developed further into a churchbell shaped device. On the basis of this it was renamed ‘moederklok’ (mother bell), a word play with ‘moederkloek’ (a broody hen in Dutch) and its churchbell form (‘klok’ in Dutch). Later it was renamed ‘brooding hood’.

In a subsequent visualisation by Vista, the whole Windstreek barn was equipped with over sixty bells with different bright colours, each to be used by about 500 young chickens. Since these brooding hoods hover 10-20 cm above the floor, the young chickens can move freely throughout the whole barn, thus circumventing EU and Dutch regulations. But chickens are

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2 Parallel to the first phase of the SBIR-tender, project leader BB was involved in a similar case of a farmer who invented an inflatable wall to decrease the volume of his traditional barn in the first weeks of a round to save on energy. This farmer approached BB after the publication of the brochure of Broilers with Taste that was sent to all poultry meat farmers in the Netherlands. After some backing and forthing with, among others, the Dutch Animal Protection Society (Dierenbescherming), it became clear that there was a short term view on institutional changes, that forbade this temporary decrease in living surface, despite the fact that there was evidently no animal welfare issue per se.
likely to stay underneath the warm hoods most of the time because it fits their thermal requirements and natural behaviour.

Shortly after the consortium won the second phase of the SBIR tender, climate systems firm Sommen got in touch with VDL Agrotech, an industrial supplier of agricultural equipment, and part of one of the largest Dutch industrial conglomerates (VDL). Sommen saw a chance to enrol a partner that could develop and mass produce the brooding hood, a vital part of Windstreek that would be needed in considerable numbers. Furthermore, the director of Sommen saw an important general business opportunity to collaborate with VDL Agrotech.

The new partner was reluctantly welcomed by the consortium. Initial contacts suggested a lukewarm and sceptical reception of the brooding hood concept by VDL. Especially the non-manufacturing partners in the consortium (Nijkamp, WLR, Vista) feared that a distinctive feature of Windstreek, with the most commercial potential, would be gradually appropriated by an outside partner and sold to anyone, as the brooding hood would also be applicable in standard broiler barns. Without exclusivity, the upscaling potential of the Windstreek concept as a whole might be in danger. Partners Plukon and Sommen, however, stressed the inevitability: the consortium would not be able to develop the brooding hood by itself and, more importantly, lacked the capabilities needed to produce them in large numbers at an affordable price.

Sommen and VDL started a series of small scale pilot experiments with the brooding hood. First in Nijkamp’s open cow barn during winter, later in a covered alley way between two poultry barns of a farmer near Sommen headquarters in Ulicoten. These pilots involved a few hundred chickens and hand-made constructions of metal and plastic. Both mechanical and natural ventilation were tested. Heating was supplied by a warm water heating device.

After a few months of experimenting, VDL Agrotech decided to prominently present the brooding hood, as well as Windstreek, at the VIV-fair 2014 in Utrecht, an annual fair for the global equipment industry for intensive livestock production. This again sparked the doubts of the non-manufacturing partners on concept ownership.

At this point in time, for ease of construction reasons, VDL played with the idea of connecting a number of brooding hoods to a large tunnel, but farmer Nijkamp objected to this. Furthermore, Sommen and VDL were about to conclude that, for control reasons, the brooding hood should be mechanically ventilated. Nijkamp opposed this vehemently, since he wanted a robust system that would be as independent as possible from fallible technology. Additionally, he wanted to experiment with infrared heating, instead of warm water heating, since this could be powered by solar panels which would save the costs of a separate gas connection to the new barn.

Infrared heating and natural ventilation were implemented reluctantly by Sommen and VDL in the subsequent pilot experiments. Both features reduced the controllability of the brooding hood with traditional sensors, and required new ways of thinking. As they proceeded, however, they became more and more convinced that these features were possible and an important characteristic of the brooding hood concept.

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3 The first phase is a feasibility study; the second phase a pilot, proof of concept or full scale implementation, aiming to show the commercial relevance.
While the construction of the Windstreek barn commenced in March 2015, pilot experiments in Ulicoten were still under way. VDL had a contract with Nijkamp to deliver and install sixty brooding hoods in Windstreek. When the construction of Windstreek was almost finished, VDL told Nijkamp that, for construction reasons, the sixty brooding hoods would be fused into six large tunnel-like brooding hoods. Since Nijkamp planned to start production in July 2015, he had no option but to agree. Production in Windstreek eventually started in November 2015.

**Anchoring of the regular litter removal**

The concept of regular litter removal (by means of belts) was a central idea from the start of the design process. Yet, the actual implementation in Windstreek has been half-hearted. An important reason seems to be that it is a solution for a problem that is not perceived to be urgent by anyone except the researchers of WLR and the former project leader: the emission of fine dust. Since Windstreek is naturally ventilated with large volumes of air, fine dust is not seen as a problem inside the barn, nor in the rural surroundings of the village of Raalte. Additionally, some partners believe emissions will be low because of the slow air velocities associated with natural ventilation. On this basis, expensive dust reducing belts were replaced by cheap composting mats. Attempts to get a machine for removing and cleaning these mats failed because of high costs and lack of motivation from third-party enterprises to innovate on this. Thus, the network anchoring of this concept was limited to WLR people only and it never took off.

The risk, however, is that emissions of fine dust may be higher than desired. This will pose institutional obstacles (regulations on fine dust emissions) that limit the applicability of the Windstreek concept elsewhere in the Netherlands. Moreover, since regular litter removal is also meant to limit the emission of ammonia, Windstreek also might not be able to comply with the regulations in this respect, especially if the barn were used with higher stocking densities.

**Vair Varkenshuis case**

In 2009, pig farmer Marijke Koenen joined a multi-day interactive design session that was part of a WLR-led RIO project by the name of Porc Opportunities. She fattened pigs on an outdated pig farm in the south of the Netherlands and wanted to renew her business. But she did not want to proceed with fattening pigs as she had done before as she was dissatisfied with the current production system and had been looking for alternatives for several years. Most important to her was to become an autonomous entrepreneur and disentangle from the straitjacket of production efficiency. She wanted to be proud of her farm again, and to be able to show the general public how she kept pigs without having to be afraid of disgust. As possible alternatives, she had looked into systems by the name of “ecological production” and “Canadian bedding”, but in her view these limited the autonomy of the farmer too much.

By joining Porc Opportunities, Koenen hoped to find an alternative that would satisfy her objectives. She took part in a design workshop in which the participants designed new pig production systems on the basis of the requirements and functions that this production system should fulfil. By thinking in terms of requirements and functions, without directly jumping to solutions, the solution space was enlarged, so that problems in the current production system could be solved in new ways via radically different designs.

In Porc Opportunities there were several design sessions. In the first session only pig farmers and researchers participated. They worked together on three designs for radically new ways of keeping pigs. In the second design session, researchers only acted as facilitators. The
actual design process was carried out by participating pig farmers, builders of housing systems, agricultural advisors and a municipal and a provincial policy maker. Another difference between the first and the second design session was that in the first session participants worked on generic designs, while the second design session put the needs of pig farmers in the centre of the design process. They designed their own potential future farm. To further stimulate the practice-orientation, the participants were informed of the possibility of participation in an SBIR tender with their new design to finance realisation of their plans. Here the foundation was laid for "Vair Varkenshuis" (meaning Fair Pig Home).

One of the core elements of Vair Varkenshuis is the ‘pig toilet’ that uses the rather clean excretory behaviour of the pigs to improve animal welfare, reduce ammonia emissions and raise the quality of manure. Following the second design session, not only Koenen started working with it, but also a national pig innovation centre, VIC-Sterksel, applied it in a pilot farm.

Her involvement in Porc Opportunities did not only provide Koenen with a draft design for her farm, but also with a small network of parties who were enthusiastic about various concepts that were embedded in the Vair Varkenshuis, and who were willing to join her in developing an SBIR proposal. She was joined by another pig farmer and three service suppliers/system builders.

On the basis of the promising results from the SBIR feasibility study, the consortium wrote a proposal for the second phase of SBIR (to build a pilot barn), which was granted. Supported by a 500k€ grant, a first pilot barn was built and several experiments were carried out. At the end of the SBIR trajectory this pilot barn was improved and expanded to finally form Vair Varkenshuis.

This was not a smooth process, however. Although all parties were eager to make it a success, they clearly had differing interests and objectives. Koenen’s ultimate aim was to create a new market concept for pork while the service suppliers/system builders were only interested in the technical aspects. This resulted in several discussions on what to put on the agenda and how to spend the SBIR grant. This resulted in a process of continuous negotiation within the network to specify the various technological details.

The SBIR grant was an important resource to make this process possible. The provisions of the grant determined to a considerable extent what could happen, in terms of content as well as in terms of the network. On content, SBIR specified that the concept should be integrally sustainable, i.e. combine several sustainability aspects. Furthermore, the concept should be scalable and have a good market perspective. On the network, SBIR provided specifications for the participating consortium. To be eligible the consortium should consist (at the very least) of farmers and service suppliers/system builders. SBIR ensured a certain commitment and continuity by not only providing money, but also a ‘project’ infrastructure with outsiders monitoring the process and the outcomes. Without SBIR, the network would possibly have split up at an earlier moment in time.

Thus SBIR also offered a degree of robustness. For Koenen this meant that the SBIR trajectory gained a rather technological focus. The system builders focused on perfecting the technical features and developing them in such a way that pig farmers could implement them in their existing barn. Although this was not very successful in the end, it meant that there was very little attention paid to the marketing and communication aspects of Vair Varkenshuis.
Thus Koenen had to work on these aspects separately from the SBIR consortium and largely after the realisation of the barn.

In terms of anchoring, due to the provisions of SBIR and the objectives of the majority of the consortium, there was a focus on technological anchoring. By contrast institutional anchoring (economic, but also influencing and connected to world views/problem definitions of other farmers or consumers) received minimal attention.

To pay attention to these aspects as well, Koenen teamed up with a marketer, who supported her in building the story of Vair for the consumer. Furthermore, she involved product developers and advisors to work on the meat products and worked on developing sales channels. She first entered into a dialogue with supermarkets, but when they refused to satisfy her requirements, i.e. give compensation for improved sustainable production, she turned towards a combination of house selling, internet marketing, market sales and other regional marketing solutions.

Although Koenen reached her goal - she created a radically different pig farm that provided her with autonomy and pride - anchoring to prelude upscaling is ongoing and continuing along two routes. Firstly, Koenen is constantly trying to find new ways to consolidate what she obtained and pursue new opportunities. She started her own crowdfunding initiative (institutional and network anchoring), continues to explore new sales channels (institutional anchoring) and tries to encourage colleague pig farmers to adopt Vair Varkenshuis (network, technological and institutional anchoring). Secondly, other innovation trajectories have started: system builders try to sell the technology they developed in the SBIR trajectory, various farmers appear to be inspired by the technological features of Vair Varkenshuis, and various stakeholders see potential in the way product development and marketing of Vair is being shaped.

Concerning upscaling, several pig farmers built a variation of the farrowing pen from Vair Varkenshuis, and various pig farmers started to consider adopting the pig toilet or other elements of Vair Varkenshuis. This offers an interesting dilemma from the perspective of system innovation. Adoption of a sustainable farrowing pen, without changes in the rest of the production system, could enable farmers to satisfy important sustainability conditions imposed by the market and public society. With this (relatively easy) modification they might realise more sustainable production circumstances, but at the same time they would hold back from a more radical shift towards sustainable pig production, as is realised in Vair Varkenshuis. This is different for the pig toilet that can be considered an integrally sustainable partial innovation, by offering advantages for animal welfare, reducing emissions of ammonia and odour, and improving manure quality.

Conclusion
In this paper we used the three forms of anchoring distinguished by Elzen et al. (2012a), i.e. technological anchoring, network anchoring and institutional anchoring. Our main interest is to shed more light on the dynamic of these anchoring processes as a stepping stone towards understanding the linking between niches and regimes (Smith, 2007) or, in terms of the theme for this workshop, the upscaling of the application of novelties.

It appears that the various forms of anchoring do not neatly follow one another in a specific order but show a process of continuous leapfrogging. Moreover, two or three or these may be
occurring at the same time and become visible depending on the perspective taken. For technological anchoring, the reasoning starts from the perspective of an actor or a network. Technological anchoring takes place when a radical concept (which can either be a rather abstract technological concept or a concrete material manifestation of a concept) takes on meaning as something they support (as user, maker, or outsider). When we reason from the perspective of the technology, however, network anchoring takes place, i.e. the network of actors for whom the technology becomes meaningful grows.

Does this mean, then, that all forms of anchoring are really describing the same process? This is certainly not the case if we acknowledge that technological anchoring is not just a quantitative phenomenon (i.e. more or less, or weaker or stronger technological anchoring) but also has qualitative characteristics. In both cases, technological anchoring started on the basis of a rather abstract concept of a novelty. Gradually, the concept became more specific without changes in the network (e.g. in a design meeting). We see this as an important characteristic of technological anchoring which we call the *specification of the technology*. It describes a process in which anchoring progresses by way of certain technological characteristics becoming seen as an essential aspect of the novelty while this specification is shared among the actors in the network.

Our cases suggest that this process of specification has the effect that anchoring becomes more robust. In our cases, both of which started as a design process, initial anchoring took place on the basis of rather abstract concepts. In this phase, the networks related to it frequently changed composition, showing that anchoring was not very robust. With the further specification of the technology, however, for the actors that remained part of the network their links with the more specific technology appeared to be stronger than with the initial more abstract concept. This process is clearly recognisable in connection with the “brooding hood” but also with the “pig toilet”.

Concerning institutional anchoring, the cases show two opposing processes. One is that the technology was modified to fit existing institutions. When the ‘mini barn’ appeared not to fit national and EU regulations, this concept was modified to eventually become the “brooding hood” that enabled the ‘bypassing’ of these regulations. The alternative process was that existing institutions are modified or ‘bent’ to fit the new technology. An example is the bypass of local building aesthetics regulations to allow the construction of the curved shape of the Windstreek. Other examples can be found in the cases for both processes.

From the very beginning, the RIO projects had the ambition to radically change the current animal husbandry system in the Netherlands, i.e. to contribute to a system innovation or a sustainability transition. In both cases, this was quite successful at the local scale, i.e. the development of a first production farm with far better sustainability performance on a range of issues. Whether this marks the beginning of a wider change to the sector, however, remains to be seen.

One striking phenomenon in both cases is that there were repeated attempts to downgrade the ambition to better fit the existing system, i.e. to realise institutional anchoring by adapting the technology to existing institutions. Even if these were not successful eventually for the pilot barns, they may well be successful in terms of the uptake of various ‘partial innovations’ in conventional husbandry systems. The interest in doing so is already emerging in connection with the “brooding hood” and the “pig toilet”. This would increase the sustainability
performance of such conventional systems somewhat but the ‘integrally sustainable’ ambition from the initial RIO project would be lost.

This raises the question of how such a high ambition can be upheld against the forces to downgrade the ambition. Key to this is to understand in further detail the issue raised before, i.e. how institutional anchoring is shaped: by adapting technology to the existing institutions or by adapting the existing institutions to the emerging technology. To answer that question is beyond the scope of the present paper and will have to be the topic of further research.
References


Practical lessons for successful long-term cropping systems experiments

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Abstract: Many lessons in long-term cropping systems experiments are learned from practical experience. The senior author has conducted large-scale, long-term, multidisciplinary dryland and irrigated cropping systems experiments with numerous colleagues (mostly with the coauthors of this paper) at university and government research stations and in farmers’ fields in the United States and in developing countries for 30 years. Stakeholder input is critically important for designing these experiments. Several practical lessons learned through the years are outlined in this conference proceedings paper. While some of these lessons learned may be intrinsically obvious, results of many cropping systems experiments have not been published in scientific journals due to fatal flaws in experimental design, improper transitioning between phases of the experiment, and many other reasons. Ongoing active support by stakeholders is critical to maintain funding for long-term cropping systems studies. Problems and unexpected challenges will occur, but scientists can often parlay these into opportunities for discovery and testing of new hypotheses. Better understanding and advancement of stable, profitable, and sustainable cropping systems will be critical for feeding the world’s projected 10 billion people by the mid 21st century.

Key words: Long-term cropping systems experiments, crop rotations, world food needs, adoption of new systems by farmers

Introduction

Long-term cropping systems experiments are widely recognised as an ideal mechanism to encourage scientists of different academic disciplines to work towards a common goal (Johnston, 1997). There is a wealth of information on long-term cropping systems experiments related to agronomy, sustainability, environmental concerns, weeds and diseases, soil quality, fertility, economics, and other factors (Peterson et al., 1993; Tanaka et al., 2002). There is also a vast quantity of information in the scientific literature and in textbooks on how to design and interpret data from long-term experiments. However, the “practical” and “everyday” aspects of successful long-term cropping systems endeavors have received much less attention.

The senior author has spent the majority of his professional career as a cropping systems research agronomist in developing countries and in the Pacific Northwest region of the United States. The junior authors have collaborated widely in these experiments. There are some basic principles or “lessons learned” from this experience with successful long-term cropping systems experiments that have not been adequately emphasised in the scientific literature and in university classrooms. The principles outlined below apply across diverse cultures and
environments, whether: (i) average farm size is 0.2 or 2000 hectares, (ii) implements are pulled by bullocks or 450 hp tractors, or (iii) grain is threshed by hand or with a fleet of modern combines.

**Lessons learned**

1. Form a farmer advisory group of progressive individuals who have a strong vested interest in the research. Allow farmers an active role in designing crop rotation treatments. When farmers feel ownership in a project they will likely remain strong supporters throughout the life of the project (Lawrence et al., 2007).

2. Set term limits for farmer advisors (e.g., 3 to 6 years). Some advisors will make numerous valuable contributions and maintain a high level of interest whereas others will not. The most valuable advisors will likely agree to serve an additional term. Term limits provide a diplomatic means to end the service of the less energetic advisors and open opportunities for new members.

3. Your collaborating scientists will largely determine the success of the study. Put a great deal of thought into what academic disciplines will best contribute to the cropping systems team. Look closely at the publication record of experienced scientists. If an individual has an excellent track record, they will likely continue to publish regularly. Certainly seek out and mentor enthusiastic new-career scientists and encourage their participation.

4. Involve a statistician from the very first to ensure that the experimental design is valid and the most appropriate for the study (Cady, 1991).

5. Plan to conduct the cropping system experiment for at least six years or through two complete cycles of the crop rotations. Each crop in all rotations must appear each year for valid statistical analysis.

6. Ideally, systems experiments should have a staggered start to account for temporal entry into the rotation, but this is seldom imposed because it is not practical.

7. For valid statistical interpretation of results, all crop rotation treatment combinations must have a common year denominator. For example, if you have 2-year, 3-year, and 4-year crop rotations, the experiment needs to be conducted for 12 years.

8. Obtain and archive baseline soil samples at the beginning of the experiment so that changes over time in carbon, microbial activity, and other soil quality indicators can be documented.

9. If possible, conduct long-term experiments at a university or government research station where land and facilities are guaranteed to be available (Drinkwater, 2002). Mistakes are less likely to occur at a research station than in a cooperating farmer’s field. Labour and equipment resources are most efficiently utilised when travel and equipment hauling is kept to a minimum. It generally costs much less to conduct a cropping systems experiment at a research station than in a farmer’s field. In addition, personnel at research stations are available to check the experiment daily, if needed.

10. If the long-term experiments are located on farmers’ fields, do not expect cooperating farmers to use and operate their own equipment to conduct field operations (e.g., planting, harvesting, herbicide application). This may be feasible for the first few years when the experiment is new and novel, but the farmers need to manage their own field operations during the same time period and the experiment will likely not receive high priority. Plan to provide your own personnel and preferably your own equipment to ensure that field operations are conducted in a timely manner.
11. Become a trusted friend of your cooperating farmer. Do not become a burden. Pay an annual rental fee for the land. List the cooperating farmer as a coauthor on all popular and extension publications from the experiment.

12. Consider purchase or fabrication of smaller customised implements, such as no-till drills to facilitate transport of equipment to and from sites and to reduce tractor size requirements.

13. Equipment may need to be customised for cropping systems experiments. For example, many cropping systems experiments involve conservation-till or no-till management. A small-plot combine is accurate for grain yield determination, but most machines lack proper chaff and residue spreading capability. Residue and chaff spreaders can be fabricated for small-plot combines (Schillinger et al., 2008).

14. Many cropping systems experiments do not contain enough treatments and/or replicates to provide adequate degrees of freedom for error to statistically detect treatment differences (Gomez & Gomez, 1984). Try to maximise the degrees of freedom for error. Remember that degrees of freedom for error is based on the number of treatments and replications.

15. When field operations or data collection cannot be completed in one day, always stop work for the day at the end of a replicate. This ensures that all treatments within a replicate are exposed to the same environmental factors (e.g., rain, heat, shattering) that may occur from one day to the next.

16. Funding for long-term cropping systems research is often difficult to obtain (and maintain) because answers cannot be obtained within the typical 3-year grant cycle (Soane & Ball, 1998). Even modest set-aside funds from the university experiment station (e.g., Hatch funds) or other sources can go a long way in sustaining long-term experiments.

17. Long-term cropping systems experiments provide critically important data on soil quality (Blanco-Canqui et al., 2011), soil biology (Kirkegaard et al., 2008), carbon sequestration (Wienhold et al., 2016), nitrous oxide emissions (DeAngelo et al., 2006), nutrient cycling (Ritcher et al., 2007), and weed ecology (Anderson, 2004). Such information is of interest to a worldwide audience.

18. If feasible, include a production economist on the team as economic returns of cropping systems are of foremost concern to farmers (Young et al., 1994).

19. Be open to new ideas and view problems and surprises as potential opportunities. As an example, Rhizoctonia bare patch (Rhizoctonia solani AG-8) appeared in year three of a long-term no-till dryland cropping systems experiment in eastern Washington. The fungal root pathogen stunted all cereal and broadleaf crops in the experiment. Rhizoctonia bare patch at these high levels had not previously been encountered in the United States. Scientists decided to map the distribution of bare patches from year to year with a backpack-mounted global positioning system. The severe expression of Rhizoctonia bare patch was unexpected, but led to a unique opportunity to publish journal articles about the epidemiology of this pathogen under long-term no-till management (Cook et al., 2002).

20. Although scientists need to “lock in” and stay with the crops and crop rotations throughout each phase of the long-term experiment, there is often opportunity to superimpose new experiments, especially with wide plots. If plots are narrow to begin with, options for future additional treatments are limited. Long-term cropping systems experiments continually generate new hypotheses to be tested. Embedding sub-experiments within a long-term study can be a good way to obtain grant funding to support the long-term effort without comprising the integrity of the treatments already in place.
21. Hold field days at your research site. Scientists, graduate students, farmers, and others involved in the experiment will welcome the opportunity to share their data, expertise, and insights. Hands-on demonstrations, such as soil quality changes with different management practices, are popular and can carry an excellent take-home message. For field days at off-station cropping systems research sites, always feature the cooperating farmers as key speakers as they will have important insights into what does and does not work on their farms.

22. Publish results in peer-reviewed journals at regular intervals. Decide beforehand which scientist(s) will take the lead on articles and the time frame for when the articles will be written.

23. Do not stop with the publication of your research in a scientific journal article. Publish your research as an Extension Bulletin, Extension Video, or other popular format. Convert units of measurement to those used by farmers. For example, farmers in the US use English, not metric, units. Delete unneeded verbiage (e.g., scientific names for plants and herbicides), and include interesting and relevant photos. Remember that you must obtain permission from the scientific journal in which the research was published before making the information available to stakeholders in an alternative format. We have never been refused permission by a journal to make information available in an alternative format for stakeholders. Many universities and government agencies have extension publication units that publish Extension Bulletins at no cost to the authors.

**Conclusions**

Following basic common-sense principles will help scientists achieve success in long-term cropping system experiments. As a research agronomist, the senior author has collaborated most closely with a soil microbiologist, production economist, plant pathologist, and soil scientists in cropping systems research endeavors. The specialty areas of scientists needed to address key issues will, of course, vary depending on the experiment. A major goal of the United Nations and other organisations is widespread adoption of conservation agriculture (Hobbs, 2007). To achieve this goal, more long-term systems experiments need to be conducted throughout the world. Long-term experiments provide the best and foremost scientific information for understanding the sustainability and stability of cropping systems and for successful adoption of tested systems by farmers.
References


Upscaling of more sustainable cropping systems: a framework to analyse and support intermediation processes

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Abstract: The Ecophyto Plan 1 was devised to achieve a 50% decrease of pesticide use in France between 2008 and 2018. Based on available agronomic knowledge, collective expertise showed that reaching such a target at farm level implied in-depth redesigning of the current cropping systems. The DEPHY Network is one of the main policy instruments to support such a redesign process and to contribute to inviting more and more farmers to take up this challenge. To analyse the ways in which intermediation is organised in this network, we developed a framework which we also applied to two farmer-led networks that support farmers in redesigning their cropping systems and that seek to increase farmers’ participation in such processes. Grounded in former studies on transition pathways at farm level and in participatory design processes in work system design projects, or in open source communities, our framework distinguishes three levels (strategic, experiential and collaborative) to analyse the organisation of intermediation. We apply it to the DEPHY Network and then point out the differences that we identify between the 3 networks analysed. Based on this, we make recommendations about the way each level should be addressed in order to support on-farm redesign processes in a large and inclusive network. We finally conclude by highlighting the limits of our framework and the need to test our recommendations.

Key words: Intermediary objects, pesticide reduction, sustainable agriculture, cropping systems, participatory redesign, peripheral participation.

Introduction

Since the year 2000, various expert reports in France (CPP, 2002; Momas et al., 2004; ESCo Pesticides, 2005) have pointed out the noxious effects of pesticides on workers’ health and on the environment. In 2006 a European Directive invited all the EU Member States to draft National Action Plans for a sustainable use of pesticides. In France the “Ecophyto 2018” plan was launched in 2009. It targeted a 50% decrease of pesticide use “if possible” within 10 years (starting point 2008). The first phase, the Ecophyto 1 Plan (2009-2015), was led by the French Ministry of Agriculture. It was funded by the “tax on indirect pollution” paid mainly by farmers. The plan was divided into 9 themes and 114 actions. During the 2009-2014 period, it cost M€361, of which M€194 came directly from taxes (Potier, 2014).

2 Pesticides sellers and State programs also contributed to the funding of the Plan
3 The 9th theme only appeared in 2011, to address workers’ health issues.
The objective was ambitious, as the Ecophyto R&D expert report pointed out (Butault et al., 2010). The experts noted that such a reduction in pesticides would require in-depth redesign of cropping systems, and would certainly reduce the total amount of agricultural production. This objective was nevertheless supported by environmental and citizen associations and by networks of farmers who had already developed new practices contributing to limited use of pesticides (Organic Farming associations, Sustainable and Autonomous Farming Network, among others). Representatives of the incumbent players argued however that such an objective would not be achievable and would make French Agriculture less competitive. Many controversies erupted on the targeted reduction, on the best practices to significantly decrease the use of pesticides, and even on the way to promote large-scale adoption of such practices.

While some experts pointed out that this redesigning would require changes to the supply chains, to the input providers’ strategies and in the advisory work, such shifts were hardly taken into account in the Ecophyto Plan which mainly targeted changes at farm level. In fact, the DEPHY network was one of the major thrusts of the Plan in terms of ambition (190 groups of about 10 farmers to be involved in a national network, each group being supported by an advisor working half-time) and of funds allocated (around M€18 per year). A mid-term evaluation of the Ecophyto Plan pointed out poor achievement in terms of reduction of pesticide use at national level since 2008. A second plan, the Ecophyto Plan 2 (2015-2025), was launched in 2015 under the aegis of both the Ministry of Agriculture and the Ministry of Ecology. This plan still targets the farmers: the network is supposed to involve 3000 farmers and a new goal is agreed for the Plan: it will be accountable for supporting upscaling of the best practices from the DEPHY farms to 30,000 farmers.

It is difficult to know the extent to which the lack of achievement of the first Plan should be attributed to a lack of consideration of systemic barriers. In this paper we chose to pay attention to another issue: how intermediation is organised in the Dephy Network. Various studies (Coquil, 2014; Chantre et al., 2015) have shown that transition pathways at farm level imply in-depth change in farmers’ jobs and activity. How is such transformation supported within the network? How is the network organised to support up-scaling processes and such transformation outside of itself? More precisely, how does it support in-depth redesign of cropping systems and create opportunities for large-scale involvement of farmers in such a redesign process? To examine these questions, we developed a specific framework which we present in the next section. We apply it to the Dephy Network and briefly point out the differences that we found between this network and two other farmer-led networks, in the way up-scaling processes are organised. We then discuss its limits and the ways in which it can usefully support intermediation work in transitions towards a more sustainable agriculture.

A framework for analysing intermediation in sustainability transitions

Approaches to and studies of up-scaling processes have often considered them as a dissemination and adoption process (e.g. Rogers, 1983). They have tended to focus mainly on the attributes of the technologies and adopters that determine adoption likelihood. Adoption thinking also pays attention to social networks and increasingly looks at how the configuration

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4 Hill & Mac Rae (1995) distinguish different strategies to change farming practices: efficiency, substitution of inputs, and redesign. In addition, some farmers adopt an efficiency or a substitution strategy, we chose to focus on the network which claimed to support redesign processes.
of social networks influences adoption behaviour (Compagnone, 2014). In contrast, innovation system scholars working on sustainability transitions propose a more systemic approach and point out technological and organisational lock-in and/or system failures within a socio-technical system. Such approaches give a “big picture” of the processes that take place and suggest some relevant levers for policy makers. They often take as a starting point a new technology. They do not really consider the process by which the technology and its use in practice are co-developed at farm level (Béguin & Cerf, 2004; Klerkx et al., 2010; Béguin et al., 2012), but the reduction of pesticide use is rather a withdrawal of a technology. The cropping system redesign does not necessarily rest on new technologies. It rather rests on new insights on the ecological processes and on developing new practices in order to cope with their unpredictability and with the complex dynamics within the cropping system.

Nevertheless, these studies emphasise the role of brokers or intermediation workers (Klerkx & Leeuwis, 2009) who create new links between a network of players and technological artefacts in order to stabilise a technological niche and to support scaling up and out processes (Hermans et al., 2013) or anchoring processes (Elzen et al., 2012). Following Meyer and Kearnes (2013), we consider that intermediation is a specific type of practice in processes of change. Intermediation not only creates links to overcome systemic barriers or to develop anchoring processes, it also contributes to shaping understandings, new practices and new interaction rules among participants involved in a process of change (Steyeart et al., 2007). We therefore chose to understand the ways in which intermediation is organised to support: (i) the co-evolution of the designed cropping systems and of the activity required to manage them; and (ii) the participation of more and more farmers or other stakeholders (experts and knowledge providers, farm implement manufacturers, input providers, supply chain actors, policy makers, researchers, etc.) in the design process in which farmers re-create both the technology and their work activity. But how can we identify the key conditions to be created?

To answer this question, we built a framework which is grounded on existing results on intermediation found in work systems redesign studies (Barcellini et al., 2014) and in studies on participative and collective design in Online Epistemic Communities (Detienne et al., 2012). According to these results we considered that intermediation means: (i) to identify or create a space in which discussions can take place among various stakeholders (where who is invited to join the discussion is key!), whether about the transformation intention or the data needed to analyse the work situations (farming systems) to be transformed; (ii) to support the test of innovative farming practices (implementation and analysis) in order to support the co-evolution of the artefact (the cropping system) and the farmers’ activity; and (iii) to support the emergence of specific socio-cognitive roles that contribute to discussions about design and use of new cropping systems, and to proposals for rules and mechanisms that can create peripheral participation in a constantly on-going design process.

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5 Innovation systems studies is a research field grounded in STS and evolutionary economics. The multi-level perspective is a heuristic framework focusing on the interplay of niches, regime, and landscape in a transition process (see Geels & Schot, 2010 for details).

6 The latter point has however not been adequately documented in our analysis and further data need to be collected in order to fully identify the way these players are interested or enrolled to support the shift in farming practices.

7 E.g. communities involved in producing an Open Source Software or an encyclopaedic article, for instance in Wikipedia.
In our framework we therefore considered three intertwined levels of intermediation in the up-scaling process: a strategic one which is meant to grasp the way the transformative intention is set and discussed over time; an experiential one that addresses the way work activity is represented and supported so that farmers can participate in tests and simulation loops; and an interactive one that specifies the rules and roles which are at work to create inclusiveness and participation of various stakeholders in the design process. We now describe how we chose to acknowledge each level:

1. **Strategic level:** we identified the transformative intention which serves as a seed to the building of the network, and analysed how discussions are organised around it (Who takes part in it? Where does it take place? What makes it change over time?).

2. **Collaborative level:** we focused on the roles and rules that are built during the up-scaling process or created from scratch within the network in order to perform this process. We also paid attention to the way the collective production (whether it be knowledge or cropping systems) is capitalised on by participants, and to the way peripheral participation (inclusion of newcomers) is organised.

3. **Experiential level:** we paid attention to the way intermediation supports relations between design and use in the up-scaling process through the development of intermediary objects or tools (Vinck, 1999). We also identified the discussion spaces that were created to support design-use exchanges. More specifically, we analysed the way scientific knowledge and farmers’ experience were translated and shaped in order to support the co-evolution of both the designed cropping systems and ways of managing them. We also identified the way intermediary objects took on board a given representation of farmers’ activity.

We applied this framework to various networks to identify how they differ in their way of supporting the up-scaling process while also supporting in-depth redesign of cropping systems that contribute to reducing pesticide use. Box 1 below gives a quick overview of the three networks. We develop a full analysis only of the DEPHY Ecophyto Network, but then point out the differences we found between the three different networks.
Box 1. Three different networks supporting the redesign of cropping systems

The Dephy Ecophyto Network was initiated in 2010 and gradually (from 2010 to 2012) came to involve 190 groups of about 10 farmers. The initiator was the Ministry of Agriculture. The Network was devised as a new policy instrument to support farmers in redesigning their cropping systems in order to reach a 50% reduction of pesticide use. A common indicator, the frequency treatment indicator (FTI) was defined to measure the reduction. The organisation of the network was created from scratch. More details can be found in the next section.

The BASE Network was initiated by a farmer who encouraged other farmers to explore farming practices with a view to restoring and enhancing biological dynamics in the soil (no tillage, direct sowing and conservation agriculture). The network was initiated in the 1990’s and now involves about 2000 farmers. It is a loose organisation which holds an annual assembly of the participants. A core team proposes some training sessions and expertise for the participants and supports a journal (TCS) and a website (Agricool). Local associations (farmer groups) can emerge but this is not encouraged by the core team even though it does not reject such associations. The reduction of pesticide use is controversial both within the network and outside (opponents are mainly other farmers or agronomists) as no tillage and direct sowing practices are often related to intensive use of glyphosate. The pros and cons of this are discussed mainly in the journal or on the website but also at local levels. Since 2006, participants have been invited to seek practices (mechanical destruction, covering crops, etc.) that target both the enhancement of soil biological dynamics and the reduction of pesticide use.

The RAD-CIVAM Network is part of a national organisation that coordinates local associations of farmers who explore new farming systems mainly oriented towards a high level of decisional and technical autonomy (from input sellers and supply chain buyers). Each local association is supported by a facilitator and has to find its own financial support. Local groups as well as R&D projects can contribute to the funding of the national coordination. Originally the main driver for designing new farming systems was the quest for autonomy and economic efficiency but since 1994 attention was paid to pesticide use. In 2006, they address a document to the Ministry of Agriculture in which farmers stated their experiences in reducing pesticides use. The network was invited to take part to the round tables organised on the issue of pesticide reduction during the Grenelle de l’Environnement. In the follow-up to this involvement, the RAD-CIVAM chose to design cropping systems that could also meet certain environmental challenges (e.g. less use of pesticides and nitrogen, sustaining of functional biodiversity through landscape infrastructures). They chose to put this to discussion in two different arenas: within farmers’ groups that were connected through a dedicated government-funded R&D project; and within the Ministry of Agriculture with the policy makers in charge of the agrienvironmental measures (AEM) and more specifically of the ones called AEM “system”. The starting point was the establishment of a list of requirements drawn up by farmers and their group facilitators during the R&D project. Facilitation tools were also developed during this phase and used later by other facilitators within the DEPHY Network. The RAD-CIVAM encouraged some farmers’ groups to participate in the latter network with the intention to upscale their own way of coping with the reduction of pesticide use. The RAD-CIVAM also proposed a new AEM “system” which it viewed as a way to support farmers in developing less input-dependant and more environment-friendly cropping systems.

Intermediation to support up-scaling processes in the DEPHY Network

The DEPHY Network has three main arenas in which the transformative intention is discussed: the national strategic committee in which representatives of various farmers’ associations, cooperatives, advisory and R&D organisations are invited to participate, along with representatives of the State and research organisations or environmental associations; the
National Core Team (NCT) which defines the procedures (roles and rules, intermediary objects) to be developed within the network; and a third arena with looser boundaries, the farmers’ group at local level which can develop interactions with other local farmers and stakeholders.

The collaboration is driven at national level. In 2010 a classical call for projects was launched. Applicants (farmer groups and their facilitators) were required to fill out an application form in which details about the current cropping systems, the levers to reduce pesticides use and the targeted systems had to be described. A scientific committee composed of experts designated by the Ministry of Agriculture assessed the proposals. After that, the strategic committee decided which groups to support financially.

Each farmer group then entered into a contract with the national board and had to commit: (i) to developing the testing phase (i.e. putting the proposal into practice), (ii) to feeding the national database, and (iii) to opening their farms to show their results. Such contracts were under the responsibility of the national core team which was also responsible for developing procedures, tools and knowledge to feed the network, to collect and analyse data, and to report annually to the Ministry of Agriculture and the strategic committee about the way the network intended to meet its target (Ecophyto 1: 50% reduction of pesticide use in 2018; Ecophyto 2: 50% reduction of pesticide use and reaching 30,000 farmers in 2025). In 2016 new contracts are being negotiated with the groups already involved and newcomers are invited to submit their proposals following a new call (to expand the network from 2000 to 3000 farmers). From scratch, in 2010, specific roles were assigned to the group facilitators (NE) within the network: they have to support the design-implementation process in their group, to collect data to feed the data base, to communicate on the SCEP, and to organise farm visits. To this end they have a 50% part-time job paid through a contract between their employer and the NCT. After two years a specific role has emerged called territorial engineer (TE). Some NE and some of the NCT experts have become TE. All have a part-time contract between their employer and the NCT. Their role is to support the NE in facilitating design and implementation processes in their groups, and to check and aggregate the data collected in each group in order to feed the data base. They also discuss with the NCT how to analyse the data and, more generally, they discuss the shape and content of the mediation tools.

Five main tools are currently operational in the network and give some consistency to the experiential level of intermediation. Two of these are primarily dedicated to group facilitators (called network engineers NE) in order to support their interaction with farmer groups for designing and implementing new cropping systems: (i) the “STEPHY guide” which proposes a procedure to diagnose the current cropping system and to support its redesign in order to achieve a certain reduction of pesticide use; and (ii) the “Ishikawa graph” which enables a farmer to visualise the main levers to be activated for each crop in order to reach the target. Three other tools support interaction among all the participants within the network and with other audiences outside:

- A 4-page leaflet which is meant to disseminate information on “SCEP” (SCEP is an abbreviation for a cropping system which is seen as a good example for a 50%

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8 It combines scientific evaluation criteria and other criteria such as the types of cropping systems, in order to cover the diversity of criteria or the types of advisory organisations involved in supporting the farmers.
reduction of pesticide use). Such SCEP are sorted out statistically from the various cropping systems designed and implemented by farmers within the network. The expertise of NE can also be used to point out which cropping systems they consider to be a SCEP;

- On-farm visits that NE have to organise to present what was achieved in the farm network, especially to farmers who are not yet engaged in reducing pesticide use;
- A national database on cropping systems tested in the network (data on crop sequence and crop management of each crop) can include data from experiments conducted on experimental plots or farms. Data are collected on-farm with a shared protocol and are accumulated in the data base. Statistical analysis is applied to identify the SCEPs. The database can also be used for research purposes.

Discussion: what lessons can be drawn?
As the scope of this paper does not allow us to make an in-depth comparison between the three networks that we studied, we would like here to point out some differences that the framework enables us to highlight. In doing so, we will also make some recommendations about the way intermediation can be organised to support redesign of cropping systems in order to reduce pesticide use, with an increasing number of farmers involved in the process.

We first wish to acknowledge that the intermediation work is differently shaped in the networks. The DEPHY network was developed as a policy instrument to encourage farmers to commit to the Ecophyto Plan, and intermediation work is covered by massive public funding. The other two networks are made up of farmers who are willing to change their cropping systems according to a transformative intention they all share, and who have to seek funds in order to support the intermediation work. But such differences should not play down other issues that our framework enables us to point out.

The first issue is about the way the transformative intention is settled and the way discussions are organised around it. We suggest that volunteer farmers’ participation can be increased if they share a common motive to change rather than just a quantified target to reach. Targeting only the reduction of pesticide use does not clearly identify the motive for which a redesign of the cropping system is required (pesticides are only a means within a cropping system). Such motives are much clearer in the other two networks, and discussions within these networks are not about the transformative intention as such but about the means to achieve it. In the DEPHY network many discussions are about the target as such. For example, the NCT is an operational team but the experts who take part in it sometimes endorsed institutional positions to discuss the legitimacy of the target while their role was to discuss the available means to reach it. At local level, the target was discussed less from an institutional point of view than in relation to the room to manoeuvre that existed at farm or

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9 The core team is composed of various crop production experts who mainly belong to technical institutes, cooperatives, and Chambers of Agriculture, i.e. incumbent players whose leaders often contest the targeted objective. In order to limit political discussions on the target and to focus the debates on the knowledge uncertainties or on the facilitation and data-base tools to be developed, the Ministry of Agriculture took the lead after an initial period during which it delegated it to the National Assembly of the Chambers of Agriculture (NACA). Nevertheless, as the leader of the team is hired by the State, he works within the NACA which still has responsibility to develop the network.
supply chain levels (in terms of the required quality for international markets, for example in fruit production systems, in terms of crop diversification and work organisation or available market opportunities in arable cropping systems, etc.). As a result, the participants of the DEPHY network share neither a transformative intention nor the means to achieve it.

The second issue is about the way intermediation supports the experiential level. **We suggest that the development of intermediary objects and experiential spaces needs to support both constructive and productive dimensions of farming activity.** Constructive refers here to the farmers’ ability to explore new ideas and new practices and to be engaged in redesign processes and through trial and error a new cropping system. Productive refers to the way farmers manage the cropping system efficiently in order to reach their productive goals (yield, quality of work, etc.). In the BASE network the intention is clearly to support the constructive dimension. This is achieved by giving a lot of space, in the TCS journal and on the website, to farmers’ narratives about successes and failures in experiencing new cropping practices and systems. The core team also creates “experiential platforms” so that farmers can share their experiences regarding a given new practice and assess it jointly (but without necessarily sharing a common experimental protocol). In the RAD-CIVAM network we noticed that they develop tools which can support both productive and constructive dimensions.

While farmers’ narratives and experiential platforms are key ways to support the constructive dimension, tools are also built to support facilitators in collecting data on such experiences and in supporting the monitoring of the change process in the cropping system. In both cases such tools not only target the farmers already taking part in the network, but are also built to involve newcomers. In the RAD-CIVAM network the development of an AEM “system” was also seen as a means to support farmers in joining the network. This type of tool can however obscure the motive which initially drives the farmers who developed such an AEM and cannot sufficiently support the constructive dimension of the activity. The list of requirements in the AEM “system” mainly defines means or thresholds to commit to, and does not mention all the experiences and the monitoring that enable the farmers to develop new cropping systems in line with these requirements. The same can be said about the SCEP in the DEPHY Network. Moreover, in this network the tools developed are mainly based on available agronomic knowledge. Finally, they give little room to farmers’ experiences and the way the constructive and productive dimensions of their farming activity were developed during the redesign process. In fact, in most of the intermediary tools developed in the DEPHY Network (except perhaps for the on-farm visit), farmers’ activity was represented mainly through a management scheme rather than as a constructive and productive process in which the farmers experienced new ways of coping with the uncertain system dynamics.

Last but not least, the third issue is about farmers’ participation within the networks. **We suggest that collaborative roles should also be taken on by farmers who are experimenting with a new cropping system. Farmers should contribute to shaping the intermediary tools as these are crucial in supporting the co-development of the cropping system and of their activity. We also suggest that new participants need to be enabled to develop both constructive and productive dimensions of their activity while redesigning their cropping systems.** In the BASE network, the collaborative level is organised by the core team (mainly farmers) to let other participants (mainly farmers) take different roles or to be recognised by the other participants as assuming such roles (experts, boundary spanners between the network and other ones, project leader for promoting a new...
experiential platform, etc.). Farmers can take part in defining the transformative intention, proposing new practices, testing and implementing them, sharing experiences and building shared designing principles. In the RAD-CIVAM network, the collaboration takes place within a public funded project in which farmers have a key role in defining the brief of requirements, in designing and implementing new cropping systems that comply with the brief of requirements, and in contributing to a reassessment of the practices and thresholds indicated in the brief. But facilitators also have a key role in collecting and analysing data that can support this assessment process and can be used to plead with the Ministry of Agriculture for an AEM “system”. The collaboration is organised at project level: the project core team draft a contract and the farmers and the facilitators involved in the project have roles assigned in the design process. The way to support the inclusiveness of newcomers is subject to discussions within the network mainly to identify which intermediary tools (such as an AEM “system” but also videos, on-farm visits, facilitation toolkit, etc.) could support the redesign process for these newcomers. The DEPHY network does not really give farmers much latitude in the way collaboration is organised. For example, during the inclusion-selection process no attention is paid to the way farmers participate in the design of the proposal\textsuperscript{10}. Although farmers’ group discussions are encouraged to support farmers in their transition pathways towards less pesticide use in their cropping systems, they have no real influence on the way data are collected and analysed within the network in order to produce useful knowledge either for themselves or for newcomers. While they have discussions within their own group about how to implement their new cropping systems, few opportunities are given to groups to meet together, even if there is room for the NE or TE to organise such meetings. Formal roles are assigned to the NE, TE and NCT, but our analysis shows that these roles are assumed differently. More informal roles have emerged, mainly for two purposes: the first is to involve more farmers and other stakeholders locally in discussions about the targeted objective and the means to reach it; the second is to open discussions on the advisory practices that can support on-farm design and implementation of new cropping systems. Finally, such informal roles try to take on board ways of involving newcomers in an open and inclusive process rather than just by SCEP production or on-farm visits. But inclusiveness might have been hindered by the fact that in this network the participants receive funds as soon as they are considered as part of the network (indirectly, whether by funding advice for farmers or by funding the advisory and expert organisations for the other network participants), and the total amount of funds do not allow for the network to expand.

Conclusion
The framework we developed looks at intermediation in sustainability transitions mainly through its ability to support large-scale transformation of cropping practices at farm level. It points to the need to take on board the normative dimension underlying redesign processes (strategic level), the productive and constructive dimensions of the activity developed to redesign and implement new cropping systems (experiential level) and the interactive

\textsuperscript{10} Most of the proposals were directly written by the advisor with little participation of farmers at this stage of the process. As recommended in the call, the proposals included a diagnosis of each farm’s situation at the beginning of the process, and some levers to be combined for achieving a given level of reduction. But most of the time the way farmers participate in the choice of these levers, their analysis of the way they could change their practices and the meaning they gave to change was not addressed in the proposal. Inclusion was therefore based mainly on an evaluation by the scientific committee experts of the credibility of what was written on the proposal regarding the proposed targets and their consistency with the proposed levers and time schedule.
dimension thereof (collaborative level). By contrasting different networks involved in such intermediation processes, some key attributes for organising an effective intermediation were established. None of the networks really combine all the attributes we identified.

Our recommendations need to be strengthened by testing them within existing networks if possible. The way we analysed intermediation did not however pay attention to the way it addresses some of the lock-in processes that various studies have pointed out (Cowan & Gunby, 1996 for the United States; Vanloqueren & Baret 2009 for Belgium; Lamine, 2011 or Fares et al., 2012 for France). We did not identify intermediation work directed towards supply chain actors who are concerned by the potential reduction not only of pesticide sales, but also of production levels, and who are key actors for the development of new crops (for which they do not have markets and conservation silos), or of cultivar mixtures or intercrops (which are used as an efficient lever to reduce pesticide use). Even the Ecophyto Plan which has the largest spectrum of actions does not really address this. Also, we did not identify the intermediation work directed towards the exploration of collective solutions (for example by designing collective agro-ecological infrastructures and by organising crops among farmers). Indeed, the networks we studied address change mainly at an individual level. A question is then how they might adopt a broader approach such as this, and how it might challenge their way of organising farmers’ participation in the whole change process.

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Competing socio-technical transition pathways towards implementation of conservation policy aimed at enhancing hedgerow and grassland networks

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Abstract: Rural landscapes containing hedgerow networks and permanent grassland have diminished in France and current legislation aims to conserve and restore such habitats and their wildlife. Our multidisciplinary study aimed to identify how livestock farm viability could be reconciled with biodiversity conservation planning policy, in three regions with hedgerow networks. The implementation of the green network policy is legally imposed, though local parties must determine the methods for achieving it at local level. Therefore, the state puts local authorities in charge of organising spatial, ecological planning, from farm scale up to the scale of a small region, a process involving a diversity of local stakeholders. We consider this process as a test case for upsca ling and outscaling. The results of sociological analysis of interviews show that local stakeholders tend to envisage three different possible pathways to attaining the policy’s requirements: (i) ecological knowledge-driven network design which promotes minority forms of agriculture (niche innovation); (ii) protection of the dominant socio-technical regime, as it is considered to have produced the hedgerow networks and their biodiversity; (iii) Agro-ecological innovation and reconfiguration of the socio-technical regime in order to better integrate biodiversity. Results from ecology and animal science / agronomy approaches shed additional light on the pathways envisaged. It emerged from this work that (i) ecological results do not necessarily provide clear recommendations about the optimal approach for land planning; (ii) the diversity of farming situations is such that one cannot consider that the contribution of each farmer to ecological continuities will be equal; (iii) increasing natural elements within livestock farms may be possible but must be achieved without neglecting the up-scaling dimension of ecological networks.

Keywords: Biodiversity conservation, ecological connectivity, crop-livestock farms, agriculture, governance, “Trame Verte et Bleue”

Introduction
Currently nature conservation policy is evolving as society searches for ways to stop biodiversity decline. This international, shared objective should have been achieved by 2010, but failure to do so has called into question traditional conservation methods, which have been largely based on the preservation of protected areas that occupy a limited proportion of the land area. Now it is generally believed that limiting conservation action to such protected areas will not suffice and that a scaling-up of conservation efforts, to include the wider landscape, is needed (Jongman, Külvik, & Kristiansen, 2004). This approach implies a better integration of biodiversity conservation with regard to a diversity of land-users and human activities (Jongman & Kristiansen, 2001). One step in this direction is the introduction, in many European countries, of legislation to support the definition of ecological networks which should help to increase habitat availability and more particularly enhance connectivity, and thereby plant and animal dispersal, in the vast areas that are not subject to strict nature conservation laws (Bonnin et al., 2007).
Agriculture is one of the major human activities to be concerned by this shift in policy; in France, farming occupies two thirds of the land and is associated with a considerable and partly highly specialised flora and fauna. It is also an activity known to have had major impacts on biodiversity over the past few decades. In Europe, agricultural intensification and homogenisation have led to declines in many groups of species and this is best illustrated by major losses in common farmland birds (Jiguet, 2010, Inger et al. 2015). These declines do not relate to rare or endangered species but to the common species that form the bulk of our ecosystems and that play key roles in the provision of ecosystem services. The focus of our conservation efforts therefore also has to shift to take into account this “common biodiversity”. In this context, attempts are being made to preserve and enhance farmland habitats of high ecological value. Among these, hedgerow networks and permanent grasslands represent two key types. At national scale, these habitats have generally diminished, but in north-western regions of France they are still present and are the focus of some considerable attention in the context of nature conservation in farming areas.

Since 2009, national legislation in France has required that ecological networks called “Trame verte et bleue” (TVB) be established at national, regional and local levels. Each level of organisation must define its own method for implementing the policy, using national guidelines. These guidelines explain the ecological basis for the legislation and the general methods to be used for defining and delimiting the areas of ecological continuity to be protected using appropriate planning laws; the precise form of implementation is open to regional and local interpretation. At the scale of each French “commune”, the smallest planning sub-unit, the network must be translated into the local land use planning document known as the “PLU” (Plan Local d’Urbanisme) and for larger rural and peri-urban areas these sub-units may be jointly administered by a cohesive planning document known as a “SCoT” (Schéma de Cohérence Territoriale). Hence this policy, by its very nature, cannot be limited to ecological considerations but must be directly reasoned in terms of the multiple landscape functions (farming, urban, industrial, recreational….) considered by planning documents. Therefore, at SCoT level, the negotiations involve a wide diversity of organisations of which farmers and their representatives constitute just one contributor (Allag-Dhuisme et al., 2010).

In the context of rural landscapes dominated by agriculture, the policy will require stakeholders to think beyond the possible actions of individual farms in order to scale up to the minimum scale for TVB implementation which is the “commune” or group of “communes”. Only if this process of upscaling is successful will it be possible to preserve and enhance the ecological elements forming the desired, and hopefully ecologically functional, network. Hence, the success of this new policy will also depend on outscaling processes: on the involvement of a significant proportion of the farming community, on efficient coordination and on the capacity of local and farming communities to work together.

We are therefore concerned with the classical question of how agricultural change is operated and can be guided. Pioneered in France by (Mendras & Forsé, 1983), this field of research has in particular shown the importance of social configurations within peer groups and their influence on transformations to the ways we see and think (Darré, Le Guen, & Lémery, 1989). When considering current environmental policies, such approaches to the study of changes in standard practice meet with three limits. Firstly, changes to standard practice made in this context depend on objectives that are imposed by public policy. Secondly, these policies are declined regionally such that negotiation between local stakeholders must be arranged, posing
the question of how farmers and farming groups interact with each other as well as with other types of stakeholder. Finally, the urgency of environmental problems leads us to explore radical forms of change to current farming systems (Turnheim et al., 2015). Geels (2004) proposed a framework for the analysis of transitions, defined as changes from one sociotechnical regime to another. Geels & Schot (2007) extended this work by suggesting different forms of transition pathway (transformation, de-alignment re-alignment, technological substitution and reconfiguration). These pathways involve varying degrees of reconfiguration of technologies, supporting infrastructures, business models and production systems as well as of consumer preferences and behaviour and they combine different levels of organisation (socio-technical landscape or regime, technological niche) in contrasting ways. This multi-level perspective (MLP) is interesting because it provides a framework for analysing the interactions between the institutional sphere and cultural dynamics within socio-professional groups, or in our case for considering the socio-technical processes that could enable a shift from a situation where some farmers preserve good quality habitats for wildlife, but in a fragmented configuration, to more coordinated and widespread nature protection. Although the MLP was originally based on an analysis of major technological revolutions of the past, we feel that it may also be useful for the study of transitions to come.

In this paper, our aim is to examine how various stakeholders involve themselves in setting up ecological networks in their locality. While our study does not go as far as examining the process of policy implementation, it does shed light on the specific question of how the farming sector’s view may be fully taken into account during local negotiations. We describe and discuss the different views of stakeholders in relation to the possible transition pathways for achieving ecological network implementation. Ultimately we aimed to detect the pathways with the most potential to achieve the upscaling objectives of the nature conservation policy. In order to assess this, we will draw upon ecological and farm survey results from our multidisciplinary study.

Methods
Our work was carried out in three study areas close to the urban centres of Angers, Nantes and La Roche-sur-Yon (with between 50 000 and 300 000 inhabitants) in north-western France, with different histories of collaboration between local stakeholders. These areas corresponded to three different “SCoT” planning documents and all contained relatively well-preserved hedgerow networks and permanent grasslands, with a dominance of livestock farming. In all three areas, the process of integrating ecological network policy (TVB) into the SCoT was in progress during the study period (2012-2015). We interviewed 26 stakeholders who had in the past or were at the time collaborating for TVB policy implementation in a variety of ways (consultancy or expertise, local consultation participant for planning document construction, persons employed in ecological network implementation). These stakeholders were local elected representatives, employees or representatives of professional farming organisations or wildlife conservation organisations, or environmental consultants. Based on each respondent’s account of their contribution to TVB policy implementation, semi-structured interviews were used to more thoroughly examine their view of the relationships between agriculture and biodiversity, and then more specifically in relation to ecological network policy. In parallel to these interviews, grey literature produced locally by nature conservationists and other professionals was analysed and 11 SCoT construction meetings were observed at one of the study sites (La Roche-sur-Yon). This qualitative material was analysed through a cross-analysis based on four main themes: representation of biodiversity, its links with agriculture,
representations and judgements of the ways TVB policy is negotiated locally in order to enhance biodiversity, links made to related issues. We paid particular attention to the ways in which knowledge was used and presented and to the manner in which the diversity of farming situations was described. Based on this analysis we were able to give detailed descriptions of the different representations of the desired transition pathways for enhancing biodiversity, from farm to regional scale, using three Weberian ideal-types (Weber, 1992). The described viewpoints were subsequently linked to the three transition pathways proposed by Geels and Schot (2007), which they closely resembled.

We also drew upon results of farmer interviews conducted by a team of agronomists, animal scientists and sociologists, as well as the results of observations of the avifauna of the hedgerows and grasslands made by ecologists. Farmer interviews were carried out exclusively in the La Roche-sur-Yon study area in order to determine, using a number of approaches, how local farming systems might adapt to implementation of TVB policy. A first survey of 68 farms was used to describe the diversity of bovine mixed farming systems to include hedgerows and grassland and to classify these systems into groups on the basis of their animal production types, levels of intensification and of the spatial and temporal organisation of their cropping systems. Secondly, a sub-sample of 22 of these farms were questioned in more detail to assess the extent to which farmers had the possibility to modify the spatial and temporal organisation of hedges and grasslands, without changing their overall farm strategy. Thirdly, 20 mixed farms belonging to a single landscape unit were questioned individually and then in a group, about their willingness to adopt scenarios involving large increases in hedgerow length and grassland area. The ecological surveys aimed to determine the differences in bird communities of well-connected as opposed to isolated grasslands and hedgerows. In the Angers and La Roche-sur-Yon study areas, we identified two types of survey site: large areas of continuous permanent grassland and small remnants of permanent grassland surrounded by other land-uses, mainly crops. In one field within each of these areas we carried out bird surveys in two breeding seasons using standard territory mapping methodology and the total area surveyed was approximately 85 ha. These grasslands were always associated with well-preserved multi-tier hedgerows. The results from these three disciplines were used together to discuss the viewpoints and pathways and their possible impact, in ecological and agricultural terms, on future policy implementation and success.

Results
Our interviews revealed that stakeholder viewpoints depended mainly on socio-professional category, and were not influenced by the specific contexts of each study site. The viewpoints regarding the best transition pathways for achieving the objectives of TVB policy were varied and this diversity could be structured around three ideal-types:

(i) Ecological knowledge-driven network design which promotes minority forms of agriculture (niche innovation);

A proportion of the stakeholders that we questioned, mainly employees and managers of nature protection organisations, tended to view the development of ecological continuities as a project which should be based upon scientific ecological knowledge. They attached a great importance to landscape ecology and its concepts. Network construction should involve the acquisition of better knowledge of local ecology, based on ecological surveys and/or landscape analyses. This type of knowledge keeps farmers at a distance: at best they may be consulted to give permission to access to their land or information about their farm, but the
data collected is analysed without their participation (in order to ensure objectivity) using analytical tools and spatial scales that tend to exclude them, such as spatial modelling of landscapes and aerial photography.

This posture leads them to an assessment of the relationships between different uses of rural areas and the maintenance of biodiversity. They distinguish two types of farming. On the one hand, most farmers have intensive, modernised practices, with short rotations, conventional farming methods and increasing areas devoted to cash crops. In some areas of France these farmers have seriously degraded local biodiversity. On the other hand there are farmers that contribute to biodiversity preservation. One survey respondent describes them, “They have farming systems and practices that are ecologically compatible. This means that they are people already involved in alternative techniques, selling methods, farming practices. They are at the margins of conventional systems, and their installations rely on as little investment as possible; they are mostly organic farmers, who sell their produce locally.”

Therefore these stakeholders perceive the fact that local authorities are now required by law to propose an ecological network as a window of opportunity which might allow groups of farmers considered virtuous to replace today’s conventional farmers. This situation also provides an opportunity for nature protection organisations themselves to display their expert knowledge (and sometimes to sell it to local authorities). This view corresponds to Geels and Schots’ “technological substitution”, whereby a network of stakeholders that represent a minority, composed of alternative farmers, militant organisations and groups of consumers, develop a niche innovation that matures and could come to substitute the dominant farming regime if a modification to the legislative framework favours its development.

(ii) Protection of the socio-technical regime, as it is considered to have produced the hedgerow networks and their biodiversity;

This second view mostly belongs to elected representatives or project managers from professional farming organisations concerned with representation of farming interests (farmer’s unions, extension services). For this group, the link between farming and ecological networks is limited to the view that maintaining livestock farmers leads to the maintenance of hedgerow networks. The knowledge they use is of a sociological nature. They consider that the livestock farmers they represent are relatively homogeneous, with generally similar practices and a belief in the preservation of hedgerow networks and biodiversity. From their perspective, biodiversity declines are above all related to the difficulties facing the farming profession such as devalued food prices, the economic crisis (in particular for the meat industry), the unattractiveness of farming careers, urbanisation, political uncertainty relating to CAP reforms, etc. If adaptations to current practices are to be accepted, they must be compatible with farmers’ everyday concerns. From these stakeholders’ viewpoint, biodiversity preservation is also professional farming matter and they demand that a special delegation be put in charge of the design of the ecological network in rural and agricultural areas. Moreover, these stakeholders ask that the ecological objective be integrated into land planning documents along with the broader aim of maintenance of farmland in peri-urban areas. This leads them to defend the ecological functions of farming areas, but also to demand that space for nature conservation be limited to allow room for agricultural production.
This posture corresponds to the socio-technical regime transformation pathway (Geels & Schot, 2007). As the socio-technical environment exerts pressure on farming, incremental innovations may be undertaken by the current farming majority. This pathway is characterised by adaptations resulting from a tension between niche stakeholders who defiantly point the way forward and socio-technical stakeholders who demand the right to transform their regime from the inside.

(iii) Agro-ecological innovation and reconfiguration of the socio-technical regime in order to better integrate biodiversity

This is a view that is common among advisors and technicians from rural and farming development organisations. They see the relationships between agriculture and biodiversity in terms of techniques, citing, in no particular order of importance, a great diversity of beneficial methods: tractor-mounted flushing bars, planting hedgerow networks, woodland and grassland management, ecological infrastructure management (field margins, grassy strips, hedges, ponds, trees), etc. They quite accurately perceive a wide diversity of farming systems, but rarely judge them in terms of their impacts on biodiversity. When accompanying farmers they are more interested in identifying possibilities for improvement.

While these respondents have a clear vision of the types of innovation that are relevant for farmers and for biodiversity, the ways in which agricultural biodiversity can be defined and observed are of lesser importance than the fact that farmers are engaged in agro-ecological and innovative approaches. To achieve this aim, it is necessary to increase awareness, by experimenting, to produce reference results that will convince farmers of the merits of agroecology, and through training. For this group, the farm scale and farmer involvement are the key aims while local and regional approaches, and therefore ecological continuities, are only secondary concerns. Nonetheless, implementation of TVB policy is seen by some as an opportunity to increase farmer awareness, or to improve knowledge of the notion of ecological continuity, or indeed to develop training activities with financial input from local authorities.

This view corresponds to a socio-technical regime reconfiguration pathway (Geels & Schot, 2007). The socio-technical regime encounters pressure that encourages the development of agro-ecological innovations. This pressure may take the form of technological dead-ends, such as problems with the control of green cover as authorised chemical products are progressively banned, economic pressures, legal or political influences, development of environmental labelling schemes... In this context, the diversity of farming systems constitutes a resource, allowing stakeholders to pick from a whole repertoire of innovations that can be integrated into the socio-technical regime. In this way, the regime will be subject to both technological and sociological adjustments which could, over time, lead to a better coordination between farmers contributing to the construction of ecological continuities. These stakeholders envisage these reconfigurations as occurring within an agricultural sphere, in which they themselves play a coordinating role based on technical knowledge.

Discussion

Hedgerow or grasslands networks: a diversity of types, uses and ecological values

The farm survey results revealed a real diversity of livestock farming systems, that related to both structural criteria (Utilised Agricultural Area, land parcel fragmentation, local soil and
climate, workforce) and to conceptions of farming (specialisation versus diversification, intensification versus extensification, workforce or animals, ecological farming practices). Hence the areas and functions of grasslands within these systems vary greatly; we classified a number of types of grassland (short temporary, long temporary, long multi-species temporary, permanent) whose place in the farm depended on a number of important factors. Four archetypal production logics, with different degrees of flexibility, were identified. For each, with no change to production strategy, we found that it would be very difficult to modify the surface area and spatial arrangement of grasslands to improve their connectivity. In a few cases a reduction in the areas cultivated with maize could be envisaged, leading to a reduction in the security of the forage system and a change to the animal feeding strategy. It should be added that recent meat production crises have led a small number of farmers to rethink their production methods and to see grasslands as a means of reducing production costs; some are redesigning their farming systems to include more grassland.

Secondly, the farm surveys made it clear that to consider hedgerow-grassland continuity as a whole, was not practical from a farming perspective. These two habitat types were viewed in different ways by farmers and integrated in different ways into their farming systems. Development of grassland continuities represents a radical change for a majority of farmers. As far as hedgerows are concerned, farmers are more inclined to plant, as they view these landscape elements as positive and multi-functional. Hedgerows are usually replanted around permanent grasslands, much more rarely in field interiors. This does not significantly interfere with production strategy and can be considered as an incremental innovation.

From an ecological viewpoint, also, the characteristics and value of each habitat type need to be examined both separately as well as jointly. Landscape ecological research has tended to focus on the spatial configuration of wooded habitats and its effects on forest specialist species, often considering open farmland habitats to be less favourable for biodiversity. Semi-natural open habitats support different forms of biodiversity and more knowledge is needed about the value of increased connectivity of open habitats like grasslands. Our results focus on birds, though this taxonomic group cannot alone provide a full assessment of the value of hedgerow and grassland habitats for biodiversity. What is can do is provide an illustration of the complexity of ecological knowledge in relation to TVB policy. The bird surveys at our study sites showed that the majority of the nesting community utilised hedgerows while only two species of lark (Skylark *Alauda arvensis* and Woodlark *Lulula arborea*) used grasslands for ground-nesting. The majority of observations of feeding behaviour were also in shrubs or trees at the field margin. There was no positive effect of increasing grassland connectivity on overall species richness and abundance or on the presence of any functional group. A closer analysis of the species using hedgerows revealed that the community was dominated by generalist species that are able to adapt to most environments, along with several forest specialists. The levels of bird abundance observed in the Pays-de-la-Loire Region hedgerows were higher than average when compared with around 40 other studies in similar farming contexts. The value of wooded habitats was therefore clear for these species groups. However, farmland specialist species do not seem to benefit from the maintenance of these continuous areas of permanent grassland and their hedgerows. With one or two exceptions, farmland specialists were less abundant in our samples; hedgerow density was perhaps too high for true open specialists like Skylark, but we no doubt observed, at local scale, the results of recent steep declines in farmland bird populations measured at regional or national scales. Other authors have alerted conservationists to the need for appropriate protection strategies for open
farmland specialist groups that are of greatest conservation concern (Filippi-Codaccioni et al., 2010).

The relative merits of the three pathways for TVB implementation

We will now discuss the transition pathways envisaged during TVB construction with a view to highlighting the differences between the knowledge presented by stakeholders and that obtained by researchers at the Roche-sur-Yon study site.

(i) ecological knowledge-driven network design which promotes minority forms of agriculture

This pathway is founded on a simplistic view of how hedgerows and grasslands are considered in agricultural systems that does not reflect the local situation. There are “good” and “bad” farming systems and not much in between; this dichotomy is particularly untrue as regards grasslands. In reality, a gradient of grassland use exists, ranging from grassland-based systems to total absence of this land-use type. Moreover, it relies upon a rather vague definition of grasslands, although a great diversity of grassland types can be found on farms. Even in the minority of farms that include a large proportion of grass (23% of farms are grassland-based), and that may therefore be considered desirable for this pathway, the grasslands present are of different types and the areas and spatial configuration of these are not necessarily optimal for conservation purposes.

Although this is the only pathway to base its views and actions upon ecological objectives and a clear attempt to implement policy to accentuate ecological connectivity and functions, it relies on a rather utopic view of ecological knowledge. It should be stressed that the results we obtained in our study cannot be generalised for all taxonomic groups, but they illustrate the complexity of ecological knowledge and the difficulty of guiding action based on this type of knowledge. What we and others have shown, is that increasing hedgerow density will have both positive and negative effects depending on the species considered. One of the TVB policy “target species” for the Pays-de-la-Loire Region is the Little Owl *Athene noctua*, a species that thrives in areas with grassland and loose hedgerow networks. For this species a degree of hedgerow maintenance is desirable, but not too much. However, for many farmland specialists of conservation concern, modifications to hedgerow networks will not suffice as their ecological needs depend on actions within the areas used for production. The broad ecological principles guiding TVB policy need to be accompanied by an analysis of context-specific ecological knowledge, which is sometimes lacking, to establish clear and shared objectives for biodiversity, and this represents a major challenge, also for the future assessment of policy success.

However, this pathway is the only one that recognises the major changes that up-scaling of grassland networks would require, and as such is likely to meet with various structural obstacles. For example, certain farms may not have enough suitable land for growing grassland or may not be in a position to evolve for economic reasons. In addition, this pathway’s view of the spatial arrangement of grasslands is at odds with the way in which farmers view these areas, i.e. above all in terms of their functions in relation to agricultural production. This is why this group aims to transform the dominant socio-technical system by aiding the installation of farmers possessing what they would term agro-technical principles. It seems unlikely, at this stage, and without any other major disruption of socio-technical
landscape, that the debates surrounding the implementation of TVB policy will allow this technological substitution to occur.

(ii) protection of the dominant socio-technical regime, as it is considered to have produce the hedgerow networks and their biodiversity
Like the previous pathway, the major limit of this pathway is the fact that it is based on a caricatured view of the local farming situation that considers the farming community as one homogeneous block. By protecting the dominant socio-technical regime while ignoring its internal diversity, this posture does not correspond to the local situation. In ecological terms, no objectives are defined and the diversity of environmental situations to be found locally is glossed over. Lastly, by demanding that TVB design be delegated to the farming sector, this approach prohibits out-scaling and cross-learning processes. This attitude reveals the many pressures to which farmers are subjected such as drops in milk and meat prices due to high costs associated with imported inputs or the effects of decreasing land availability due to urbanisation, and which farm sector representatives hope to address in the context of land planning negotiations.

(iii) agro-ecological innovation and reconfiguration of the socio-technical regime in order to better integrate biodiversity
This pathway is the one that best considers the diversity of farming situations observed locally, but it does not pose clear ecological objectives. Its main limit, as regards the implementation of landscape-level policy, is its focus on farm scale operations, therefore minimising the changes needed to achieve effective ecological grassland continuity. At landscape level, coordinated increases in grassland continuity are unlikely in the medium term, without more profound changes to farm production strategies. Through a process of incremental innovation, this pathway is more likely to achieve up-scaling of wooded habitat continuities.

A first major obstacle for TVB implementation seems therefore to be the definition of clear regional objectives from a diversity of stakeholder viewpoints. The way in which different types of knowledge, either ecological or socio-technical, are used to define objectives as well as the definition of the role of the farming sector in achieving these objectives are particular challenges.

Coping with diversity: a test for the transition pathways
Here we will suggest ways to overcome this difficulty basing our analysis on i) what can be learned from a discussion of ecological objectives with a group of farmers and ii) an analysis of what local authorities make of this diversity of stakeholder viewpoints.

The farmer workshop involved livestock farmers with differing production methods. It confirmed that livestock farmers found it difficult to imagine making changes to areas of grassland (quantity, type or localisation) without also changing production logic (animal productivity, income, workforce organisation). For this reason, they were not able to agree upon a scenario for a future grassland network. Conversely, they were able to spontaneously imagine collective scenarios for creating hedgerow connectivity. This result confirms the importance of considering hedgerow and grassland continuities separately. The second clear result was the farmers’ view that the most important factors limiting hedgerow development are the time needed for hedge maintenance and the risks of conflicts with adjacent
landowners. Putting in place hedgerow networks would depend on the collaboration of local authorities, farmers and owners to plan planting, determine management methods in such a way as to minimise conflictual situations and promote and finance new hedgerows and maintenance initiatives. The workshop results seem to support a view of transition achieved by organising the combined inputs of a diversity of stakeholders (close to view iii).

Among the different stakeholders involved in local implementation of TVB policy, a final group plays a very specific role: they are the local authorities required by the state to put the legislation into practice. As such they organise the working methods between all the local stakeholders.

Elected representatives and civil servants of local authorities, or the consultants they mandate, coordinate the work of constructing an ecological network. Their view of the most suitable method for writing the ecological plan is situated between the ecological knowledge-driven network design viewpoint (i) and the socio-technical regime protection viewpoint (ii). The similarity with the naturalists is due to the importance often attached to the need for better local knowledge for policy implementation, resulting in ecological surveys being funded during network construction, to complement existing data. However, their vision differs from the first because they also give weight to majority social groups in the locality, therefore allowing agricultural extension services to make a significant contribution or even delegating certain forms of expertise to such services. It also differs from all visions in the importance accorded to pre-existing protected areas (for nature or other purposes in urban areas), which for this group constitutes a base upon which the ecological network must be constructed.

As they conduct the project, they seek to organise a form of compromise between an ecological planning approach, strongly influenced by local ecological knowledge, and a more negotiated, political approach linking, in as much as local stakeholders are prepared to allow, areas already identified or protected by previous documents and legislation. In our study areas, this led to different levels of importance being accorded to nature protection organisations (local ecological expertise) or to agricultural organisations as work progressed. We can therefore see, as regards the three pathways previously described, that this group in charge of policy implementation see their role as attempting to conciliate the opposite views of the socio-technical regime and niche stakeholders but not at all as facilitators of agro-ecological innovation or reconfiguration of the socio-technical system.

Conclusion
We showed that stakeholders involved in ecological network implementation had contrasting views of the possible pathways for TVB policy implementation. The three archetypal views we distinguished closely resembled the three transition pathways described by Geels and Schot (2007). This framework therefore provided a useful tool for explaining the divergent views of stakeholders involved in putting local policy into practice. A primary difficulty in the implementation of this conservation policy is the coordination of a local, political project involving stakeholders with contrasting viewpoints and methods. These viewpoints are above all related to the positions different stakeholders occupy in the process; they participate as nature protectors, farming representatives or farming or development advisors. Each position is associated with a particular form of experience and knowledge as well as a set of interests for each stakeholder. The writing of the planning document is partially an opportunity to
reinforce his/her influence in a context of increasingly regionalised farming and environmental policy.

Our analysis of the local approach to the TVB legislation, combined with research results from ecological surveys and a study of livestock farming in one of the study areas, show that this policy has to deal with high levels of uncertainty. The ecological knowledge used is incomplete and the sociological and technological knowledge is imprecise. In particular, in the context of spatial planning it seems to be difficult to integrate the diverse ways in which individual farms function. Therefore the goal of writing a fixed plan based on a negotiated balance between the interests of professionals and wildlife is unrealistic.

From the discussion it also appears important that ecological continuities of open and wooded habitats be considered independently in both ecological and farming terms, as well as in terms of their linkages and interactions. However, the work carried out by local authorities tends to focus on the wooded network, hardly considering grassland continuity, except as being generally associated with areas of dense hedgerow networks. This is partly due to the choice of legal instrument for policy implementation; it is easier to protect isolated woodland features in a planning document than areas used for production. It may also reflect the difficulties anticipated if farmer actions need to be coordinated in such a way as to increase grassland continuity. Finally, the role of local authorities in enhancing hedgerow networks may be decisive; the upscaling and outscaling processes may rely on the actions of this type of stakeholder, for example through active promotion of hedgerow creation and coordination of the involvement of farmers, landowners and their neighbours for the definition of management methods. As we have seen, currently stakeholders in charge of writing planning documents seem to opt for a compromise born out of the conflict between nature protection interests on the one hand and defence of the agricultural profession on the other (pathways i and ii in our analysis). This leads, via alternating contributions from each party, to a form of moderation of the initial ecological proposals. This method excludes the possible contribution of those stakeholders who defend agro-ecological innovation.

Could the way in which local stakeholders involved in agricultural development, so far generally excluded from the process, envisage reconfiguration pathways be a model for the development of wooded and grassland continuities? We think not, in as much as, at our study sites, these stakeholders tend to limit their actions to the professional farming sector and the farm scale, neglecting the need for a coordinated spatial organisation of farms if landscape-level policies are to be implemented. Additionally, these stakeholders belong to professional organisations and they risk being limited in their contribution by the need to defend certain groups of farmers who may feel unable to conform to the increases in grassland area and connectivity called for by the ecological network. It also clearly appears that, to succeed in ecological terms, the reconfiguration pathway would need to better integrate ecological propositions during the adaptive process.

This confrontation of the views of stakeholders with the different transition pathways opens up new questions about the interactions between local authorities and stakeholders involved in rural development and farming innovation. Perhaps the goal should no longer be the search for compromises between social groups but rather the reconfiguration of ecological, political and agricultural knowledge.
References


Workshop 1.8: Cooperation as a key issue for innovation and learning processes in sustainable land management
Convenors: Martina Schafer and Benjamin Nolting

Approaches of regional economy, rural sociology and industrial sociology as well as of innovation management stress the need for cooperation between different partners to generate innovations and position them successfully on the market. This workshop wanted to reflect theoretical approaches and empirical findings on innovation management and entrepreneurial cooperation from different fields of research with regard to sustainable land management innovations. The workshop discussed the following arguments:

1. Innovation for sustainable land management requires the integration of heterogeneous knowledge a) along the value added chain and of stakeholders from civil society and b) to be able to consider the different sustainability perspectives (ecological, economic and social). This is a prerequisite to generate specific sustainability qualities based on systemic innovations. These may be characterised as a bundle of products and services which can be traded on the market as well as of public goods like environmental benefits and biodiversity. The involved partners acknowledge these societal benefits.

2. Such sustainability innovations are confronted with competitive disadvantages in comparison to ways of production that externalise costs. The exchange in corporate innovation networks may compensate such disadvantages because cooperation is supposed to allow an efficient use of resources by each partner (focus on core competences), to facilitate risk sharing and to get access to new groups of consumers.

3. Cooperation for sustainability innovations is confronted with a dilemma. On the one hand, building social capital (trust) and developing comprehensive solutions for sustainable land management takes time. On the other hand, cooperation is supposed to foster rapid innovation cycles for economic purposes in order to compete in a dynamic competition. How can cooperative innovation networks cope with this dilemma?

4. The management of such cooperation is complex because a) not only the involved actors but society in general benefits from its additional value and b) it is difficult to build trust and common values in heterogeneous networks.

There is some empirical evidence that the relevance of cooperation for sustainable land use innovation is increasing during the last decade. Organisational forms like community supported agriculture, citizens’ shareholder corporations, crowd funding, association of farmers and domestic fair trade initiatives show the broad variety of actors that get involved and the different purposes linked to cooperation in this field. However, many initiatives also do not succeed in establishing themselves on the market for a longer time. Papers for the workshop were asked to reflect the benefits and risks of cooperation for sustainable land use innovation based on empirical data/ case studies or theoretical approaches. Guiding questions were: Which forms of cooperation can be differentiated (heterogeneity of actors and fields of activities) and how are they linked to certain types of land use innovations? How is it assured that innovation processes in land use contribute towards sustainability? How are risks and benefits distributed in different forms of cooperation of sustainable land use? Is this distribution formalised or managed in informal ways? Which role do trust and personal relations play in cooperation for sustainable land use innovation? How can innovation networks be managed and which learning processes are taking place?
Cooperation management as a distinct function in innovation processes for alternative food production and consumption – potentials and limitations

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Abstract: Cooperation is an important function in innovation processes for sustainable land management. Thus, cooperation management may determine – as one key element – the success or failure of such innovations processes. One goal of the transdisciplinary research project ginkoo is the development of a tool “cooperation management” that supports practitioners to plan and to improve their cooperation. In this paper we develop the specificity of cooperation for sustainable land management conceptually. Against this background, we sketch a first prototype of this tool “cooperation management” that consists of three levels with a different degree of abstraction. The first level provides general questions for orientation about cooperation for sustainable land management. The second level displays key functions of cooperation in specific phases in a matrix. The third level will supply a set of instruments that supports the users in solving concrete problems of cooperation management addressing key functions of cooperation. Further, we present empirical findings of a pre-test of the prototype with practitioners in two case studies.

Keywords: Cooperation, sustainable land management, innovation, alternative food production, preservation of cultural landscapes

Introduction

Market oriented specialisation, division of labour and economies of scale in the food production system have led to enormous increases in efficiency – and often to unintended environmental and social side-effects that are not sustainable. We think, however, that there are many excellent ideas for sustainable land management but they do not succeed under the dominant conditions such as food markets, regulations, subsidies and consumer preferences. Hence, alternative forms of land management and niche innovations do not evolve automatically to replace the incumbent agri-food regime (Grin et al., 2010).

The transdisciplinary research project ginkoo¹ addresses this problem by adopting an innovation research perspective. It asks how the management of sustainability innovation processes can be better organised by coordinating actors, such as network managers, regional managers etc. The research project covers mainly socio-economic aspects that are relevant for the success of such innovation processes for sustainable land management but are often lacking due to a technology driven approach. Therefore, the ginkooproject strives for a management model of innovation processes which fosters systemic innovations (institutional,

¹ The project “Designing integrative innovation processes: new institutional and regional forms of coordination for sustainable land management" (Gestaltung integrativer Innovationsprozess: Neue institutionelle und regionale Koordinierungsformen für das nachhaltige Landmanagement) is funded by the German Federal Ministry for Education and Research for five years (09/2014-08/2019) in the programme "Innovation Groups for Sustainable Land Management".
organisational, social innovations) and holistic systems solutions for sustainable land management.

The ginkoo-project chose a transdisciplinary research design in order to contextualise the research in a real world setting. We collaborate intensely with two organisations which develop innovations for sustainable land management. These project partners are the organic farmers’ association “Naturland Marktgesellschaft” (trading branch of the organic farmers’ association Naturland) and the Biosphere Reserve Spreewald. In the first case, small scale organic farmers seek to establish ethical organic poultry production. Partners cooperate along the value added chain trying to improve their technical knowledge and their joint economic performance. In the second case, the Biosphere Reserve Spreewald in the South-East of Berlin strives for alternative forms of land use and a value creation concept for marginal wetlands through regional cooperation in order to conserve valuable, typical cultural landscapes.

One crucial element in such innovation processes is cooperation. Our goal is to develop, test and improve a tool “cooperation management” for sustainable land management which is one element of a broader approach for the management of innovations in sustainable land management. This tool aims to support small and medium sized organisations to plan and to improve their cooperation. It enables them to balance diverse goals and requirements, to estimate costs and benefits, strengths and weaknesses of their cooperation as well as to manage it more efficiently. Possible users of this tool are change agents like pioneers of sustainable land management in enterprises or NGOs and intermediary organisations that manage interrelations between diverse actor groups and sectors along the value added chain. The paper describes the process of developing the tool “cooperation management” and presents first results such as a prototype of the tool.

The paper has the following structure: in the next section we outline our approach and methods; we then present hypothesis about specific requirements of cooperation for sustainable land management that were derived from a literature review; in the following section we present preliminary findings - a first prototype of a tool “cooperation management” and empirical findings of a pre-test of the prototype in two case studies; we then discuss these first findings and, finally, draw conclusions for further research.

Approach and methods
One goal of the project is the development of a tool “cooperation management” that will be implemented, tested and refined in both ginkoo cases (ethical poultry production and mise-en-valeur of cultural landscapes) together with the practitioners. In line with a transdisciplinary approach we develop tools and solutions for cooperation according to the needs of the practitioners, implement, test them, and analyse and evaluate the results for refining and validating the tool. We follow an iterative research process where we combine a deductive with an inductive mode and reflect empirical results and practical outputs in several loops to obtain a robust tool which is transferable to other initiators of sustainable land management innovations.

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2 Other important aspects are acceptance, marketing, knowledge management etc. that are addressed in further work packages of the ginkoo-project.
Based on a literature review including various disciplines and research strands we developed a framework for analysing cooperation for sustainable land management. As a result, we formulated four hypotheses about the character of this type of cooperation. These hypotheses hint, on the one hand, at key challenges and characteristics for successful cooperation management for sustainable land management and are taken up in the structure of the prototype of the “cooperation management” tool. On the other hand, these hypotheses guide our empirical research about cooperation in the two cases with the ginkoo-practitioners and in further small comparative empirical case studies. Empirically we analyse the specificity of cooperation in innovation processes for sustainable land management, test tools and implement model solutions for the two case studies involved. A joint transdisciplinary situation analysis and an intense exchange with practitioners provide deep and detailed insights in both cases providing e.g. access to implicit knowledge about the specific cooperation.

In order to develop the tool “cooperation management” we proceed in the following way. We formulated hypotheses about specific requirements for cooperation for sustainable land management and corresponding challenges. These “guiding” hypotheses set the frame for a first prototype of the tool “cooperation management” for practitioners. In workshops with practitioners we tested the applicability and use of an early version of the prototype. These empirical results were used to refine the prototype of the tool which is presented here. Hence, this prototype is inspired by scientific and practitioners’ perspectives.

For the empirical research the following methods were applied: about 30 expert interviews; document analysis; workshops with practitioners; and field excursions.

**Conceptual approach and hypotheses**

A thorough understanding of cooperation and its specificity with regard to sustainable land management is a prerequisite for cooperation management. A literature review provided insights into strengths and limitations of cooperation.

The perspective of *business administration* is a starting point to understand cooperation of enterprises. From this perspective the main motivation for cooperation is to achieve economic benefits through an improved market position (Swoboda, 2003). The underlying principle is that innovations can be introduced more efficiently to the market if each partner concentrates on its core competences. Via cooperation the enterprises get access to resources of other partners such as knowledge or market access and may accelerate innovation (Stein, 2003).

Additionally, *network sociology* and *industrial sociology* point out that cooperation goes beyond a purely economic optimisation strategy of single firms. Strategic cooperation is embedded in a network that relies on social relationships, communication and mutual trust. Consequently, social capital is a crucial element of cooperation and has to be developed in order to attain economic benefits (Sydow, 2010). Only a vivid social network may bring about innovation as an attribute of regional economic clusters (Porter, 1998).

*Institutional economics* emphasises the influence of a broader institutional context for cooperation. Rules and norms are crucial for the exchange between firms and other partners (North, 1992). Moreover, Ostrom points out that collective action and mutual dependency are important for designing the use of common pool resources which is linked with the natural environment through feedback loops (Ostrom, 1999, 2007). This is especially relevant for cooperation for sustainable land management. The more empirically oriented research of *rural*
sociology on (alternative) forms of land use reveal the importance of shared values and a similar entrepreneurial culture of the enterprises and organisations. Social relations and communication embed cooperation into social practices (Brunori et al., 2010; Holloway et al., 2007; Schermer et al., 2011).

From this review we derived crucial aspects for a cooperation management that aims to exploit the specific synergies of working together without overburdening the partners. Based on conceptual reflections we formulated four hypotheses on cooperation for sustainable land management:

a) Cooperation is a prerequisite for the provision of social, ecological and economic goods and services for sustainable land management.

Sustainable land management requires cooperation of heterogeneous actors along the value added chain, in regional settings and with actors from civil society, thus bringing together knowledge, expertise, resources and valuations from diverse perspectives in order to create sustainability qualities and avoid unintended negative effects. This form of cooperation for systemic innovation results in products and services for the market or public goods like ecosystem services which provide specific sustainability qualities. Coupling market goods and public goods as well as market actors and civil society is a main characteristic of innovations for sustainable land management.

b) Cooperation may stabilise the market position of sustainability actors with respect to the funding of the provision of sustainability qualities.

Innovations of sustainable land use management so far have disadvantages in the market compared to their conventional competitors since they externalise negative social and ecological effects to a lower extent. The project assumes that this structural disadvantage can be compensated for at least partly by cooperation. According to literature the exchange in corporate innovation networks is understood as “complementary cooperation” that allows the resources of each partner to be used more efficiently (focus on core competences), facilitates risk sharing and enables better market access (Sydow, 2010; Stein, 2003). Through “additive cooperation” the partners can also benefit from economies of scale. The other possible benefit of cooperation is to find partners who appreciate the created sustainability qualities (as e.g. organic production, fair wages, animal welfare) and are willing to acknowledge them by paying higher prices or providing other forms of financial compensation. These can be realised in producer-consumer cooperation or partnerships with public or private organisations (e.g. local communities, NGOs, foundations) and mostly result in niche markets. We assume that innovations in sustainable land management only succeed in the market and are able to overcome niche markets when they manage to optimise their alternative ways of production and, at the same time, generate additional forms of financial compensation – through cooperation.

c) Cooperation management for sustainable land management is a demanding task because it has to balance the competing goals of generating sustainability qualities and of stabilising the market position.

Cooperation for sustainability innovations is confronted with a dilemma. On the one hand, building social capital (trust) and developing comprehensive solutions for sustainable land management takes time. On the other hand, cooperation is supposed to foster rapid innovation
cycles for economic purposes in order to compete in a dynamic environment (Hirsch-Kreinsen, 2002). As a consequence, the balance between economic optimisation and providing holistic sustainability qualities is a specific challenge for the management of this type of cooperation and requires specific competences. A tool “cooperation management” therefore has to address a complex process with such diverse functions as allocating scarce resources, identifying an adequate range and number of partners and building trust between them.

These hypotheses guide the conceptual development of the tool. They emphasise the twofold function of cooperation for sustainable land management. On the one hand, it helps to integrate diverse actors along the value chain as well as different types of knowledge, interests and capabilities in order to generate specific sustainability benefits (common goods etc.) and to internalise negative effects (synergetic cooperation). On the other hand, sustainability innovations are confronted with competitive disadvantages in comparison to conventional ways of food production that externalise costs. Cooperation may compensate these disadvantages and, thus, stabilise the economic position of the partners. This might be achieved either by economies of scale (additive cooperation) or by including partners who accept higher prices or provide additional compensation. This is considered as a crucial step towards a sustainable food economy where producers and consumers share responsibilities and accept higher prices for a better sustainability performance, at least in a niche market. However, cooperation of this kind is confronted with challenges, e.g. because of the heterogeneity of the partners, the direct competition with the conventional market, and the limited resources of the actors. These challenges need to be addressed by the tool “cooperation management”.

Results

In this section we present preliminary results with regard to cooperation management. First, we describe a prototype of the tool cooperation management, then empirical findings about testing the prototype are presented for both case studies, thus reflecting the deductive as well as inductive procedure.

Prototype of the tool “cooperation management” for sustainable land management

The tool is developed in order to support users:

- To consider if cooperation is useful to realise their ideas or not;
- To plan and initiate cooperation;
- To analyse a specific cooperation;
- To structure and manage it systematically;
- To reflect on its usefulness and effectivity in attaining the goals; and
- To finalise the cooperation if necessary.

The tool is planned as a comprehensive approach for cooperation management in sustainable land management that covers all relevant aspects without overstraining the actors. The tool thus has three different levels, each becoming more detailed and specific.

The prototype also consists of three levels that correspond with different degrees of abstraction. While the more general level provides orientation, the more detailed level gives (precise) instructions for specific actions or interventions. So the users can choose which degree of differentiation is appropriate for their purposes. Thus, the levels describe the ways
of using the tool and guide users during the implementation process which requires decisions about how to proceed with cooperation management. This implies valuations, identification of pressing problems and decisions for specific instruments. The three levels are:

- General questions for orientation about cooperation for sustainable land management;
- A matrix (respectively a table) that gives an overview about crucial functions of cooperation in specific phases;
- A set of instruments that support the users in solving concrete problems of cooperation management.

Following that idea of different levels, the first level of the tool should provide an overview to users of the characteristics of planned or current forms of cooperation. However, not all of these aspects are necessary for each user and every implementation. Hence the second level of the tool displays several key functions and elements of cooperation for sustainable land management. This helps to identify starting points for structuring and managing a specific cooperation. On the third level, the key elements of cooperation are linked with instruments that support the users in solving specific problems of cooperation management or inspire specific tasks of cooperation management. This level provides a tool kit for specific tasks.

**Level 1: Guiding questions for orientation about the status of the cooperation**

The following set of questions (Table 1) is organised around six central functions of cooperation management which we identified via literature reviews and our first empirical findings. The objective of this part of the tool “cooperation management” is to provide a systematic and comprehensive orientation about the current status of (intended) cooperation.

**Table 1. Questions for orientation**

<table>
<thead>
<tr>
<th>1) Objectives of the innovation for sustainable land management and requirements for cooperation</th>
</tr>
</thead>
<tbody>
<tr>
<td>The questions distinguish between the objectives of the innovation for sustainable land management on the one hand and the requirements for cooperation that can be derived from that because cooperation is seen as a means to an end:</td>
</tr>
<tr>
<td>- Which qualities of sustainable land management does the innovation strive for? In which form, quality and degree? Which goals are excluded?</td>
</tr>
<tr>
<td>- Are there principals or a mission statement for the innovation?</td>
</tr>
<tr>
<td>- Can cooperation help to reach the aspired sustainability qualities in a better way?</td>
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<tr>
<td>- How will provision of the sustainability qualities be financed – through the market or through other forms such as public money from subsidies, taxes, fees or private money from donations, funds, sponsoring etc.? Which kind of cooperation is suitable?</td>
</tr>
<tr>
<td>- Does a (written) agreement about the goals of the cooperation exist?</td>
</tr>
<tr>
<td>- How will you evaluate the success of the cooperation?</td>
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</table>

Milestone: Objectives for the cooperation are formulated.
2) **Actors and their resources**

- Which actors are needed to reach the goals of the cooperation?
  - What types of organisations and actors are needed for the cooperation (enterprises, non-profit-organisations such as non-governmental-organisations, public entities, administration, associations etc.)?
  - With which resources (financial means, work force, time, land, knowledge, ideas, power, social networks, market access, reputation etc.) should they contribute to the cooperation?
  - What roles will they play in the cooperation (pioneer, expert, networker, promoter, mediator etc.)?
- Do the involved actors (individuals and groups) represent a broad range?
- Are actors lacking? Are there too many partners?
- Are the partners motivated, do they identify with the goals of the cooperation?
- Are the organisational cultures of the involved partners compatible (e.g. hierarchical vs. cooperative, formal vs. informal)?

**Milestones:**
- Partners for the cooperation are identified.
- Suitable partners are integrated in the cooperation.
- The “right” number of partners is involved.

3) **Distribution of costs and benefits (input and output)**

The questions distinguish between the overall cooperation and the level of the individual partners such as enterprises of the value added chain:

- Does the overall cooperation provide (or contribute to) the intended sustainability qualities? Is the cooperation effective?
- Which input (time, workforce, expertise etc.) does each partner bring into the cooperation?
- What is the benefit, what is the output for each partner? Does each partner consider the cooperation as worthwhile or profitable?
- How are “prices” made for the exchange of (sustainability) qualities of each partner in the cooperation?
- Are there rules and procedures to evaluate and redistribute costs for goods and services exchanged in the cooperation? Are they considered to be fair by all partners?

**Milestones:**
- The cooperation provides the aspired sustainability qualities.
- The partners consider prices and distribution of costs and benefits within the cooperation as being fair.
- Costs and benefits are balanced for each partner.

4) **Structure of the cooperation: institutionalisation and (formal) agreement**

- Are structures and tasks for the management of the cooperation clear?
- Is there a transparent distribution of responsibilities and accountability?
- Is it clear how decisions are taken in the cooperation?
• Is a network management established?
• Does a formal (legal) agreement about the cooperation exist? Or is there an informal agreement on the cooperation?
• How are the relations of power distributed within the cooperation? Is there a hierarchy?
• Do the partners consider the rules of the cooperation as fair?
• Are there rules for the exit of partners?

Milestones:
- Structure and rules for the cooperation are clear and accepted by all partners.
- A network management is established.
- A written agreement on the key points of the cooperation exists.

5) Operative steering of the cooperation and network management

The questions distinguish between the overall cooperation and the level of the individual partners such as enterprises of the value added chain.

• Is the cooperation effective?
• Does the (network) management enable efficient collaboration?
• How is the cooperation management financed?
• Is the management of the cooperation provided with a budget of its own?
• Does the network management monitor if the partners provide the (sustainability) qualities they agreed on (controlling)?
• Are moderation and conflict management established?
• Is there a regular evaluation of the goals and the performance of the cooperation?
• Do the partners consider the cooperation as efficient?

Milestones:
- The operative management of the cooperation works.
- Financing of the cooperation management is established.
- Conflict management exists.
- The partners consider the cooperation as being efficient.

6) Communication, knowledge management and cooperation culture

• How is the internal and external communication organised? How transparent is the communication?
• Do the partners provide their knowledge and expertise for the cooperation?
• How is the knowledge management organised? Can knowledge gaps be identified?
• How were/are lacking competences addressed (e.g. training, qualification, consultancy)?
• Do partners trust each other? Are measures implemented to improve mutual trust?
• How is the mutual perception of the partners (esteem, rivalry)?
• Is there a common moral concept? Does a team spirit exist?
Milestones:
- There is a communication concept.
- A knowledge management exists.
- The partners trust each other.

These questions sensitise users for crucial aspects and critical problems of their (intended) cooperation. Users can apply this part of the tool either by answering the questions on their own or by discussing them with colleagues and partners. This can be done in a “quick and dirty” way or in workshops. The questions implicitly refer to scientific knowledge (theories and empirical findings) but are formulated in a way that is close to the everyday experience of cooperation and, consequently, can be understood by users without previous scientific knowledge. The questions and “milestones” help users to evaluate the strengths and weaknesses of their cooperation, thus providing a comprehensive picture. These questions for orientation build a starting point when using the tool. Further, they can be discussed regularly in order to reflect about the status of the cooperation and its development.

Level 2: A matrix of central functions and phases of cooperation for in-depth analysis

The matrix combines six central functions of cooperation with four phases of cooperation that are: i) initiation and planning phase; ii) development phase (setting up the cooperation) iii) realisation of the cooperation; and iv) transformation of the cooperation including respectively the end of cooperation (Koller et al., 2006; Wodja et al., 2006). Central functions are allocated to those phases of cooperation in which they play a key role (see Table 2). After a quick orientation about the status of the cooperation by answering the guiding questions, the matrix provides a systemic overview over cooperation as a process. The matrix guides an in depth analysis of a specific cooperation and reveals links and interfaces between the different functions. Thus, main challenges for the cooperation can be identified and where to start improving cooperation management prioritised.

The third level of the prototype will be a set of instruments that exists only in a rudimentary form so far. In the next project phase we will search for suitable instruments and adopt or develop them for the specific requirements of practitioners from the two case studies. Step by step we will assemble a tool kit of various instruments that have different formats to facilitate cooperation management.
Table 2: Integrative matrix of phases as well as elements and functions of cooperation management for sustainable land management. *(For each function/element the most relevant phase is highlighted with a grey background).*

<table>
<thead>
<tr>
<th>Phase</th>
<th>Objectives of innovation + requirements for cooperation</th>
<th>Actors and their resources</th>
<th>Distribution of costs and benefits (input and output)</th>
<th>Structure of the cooperation: institutionalisation and (formal) agreements</th>
<th>Operative steering of the cooperation and network management</th>
<th>Communication, knowledge management and cooperation culture</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Initiation and planning phase</td>
<td>Clarify objectives of the innovation and need for cooperation; formulate guiding principle/mission of cooperation</td>
<td>Identify suitable partners and attract them for cooperation; watch out for good mixture of partners</td>
<td>Level of cooperation: describe costs and benefits Level of individual organisation: distribution fuzzy/relational, but perceived as being fair</td>
<td>First ideas regarding structure of the cooperation</td>
<td>Efforts for initiating the cooperation (contacting partners, moderating discussion about objectives, initiate measures for generating trust); conflict management if necessary</td>
<td>Informal (internal) approaching of potential partners (high level) Measures for trust building Development of a cooperation culture</td>
</tr>
<tr>
<td>2. Development phase</td>
<td>Level of cooperation: determine distribution of input and output/ costs and benefits; Level of individual organisation: describe costs and benefits, draft of distributional rules, perceived as being fair</td>
<td></td>
<td>Concept for the structure of the cooperation. Distribution of tasks: decisional rules, cooperation, management. Power relations are clear ( \rightarrow ) first contractual agreements</td>
<td>Efforts for the development of the cooperation: accompanying the structuration process, suggestions for managing the cooperation. Conflict management if necessary</td>
<td></td>
<td>Stabilise communication transparent design; Integration on the functional and experts level; Building trust and motivation; Develop appropriate way of management and communication</td>
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<tr>
<td>3. Realisation phase</td>
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<tr>
<td></td>
<td>Level of individual organization; Determine costs and benefits; Controlling of a) Qualities of the cooperation, b) Costs and benefits of the partners.</td>
<td>Cooperation contract is signed; Gradual adjustment of the structure</td>
<td>Design of operational procedures: provision of sustainability qualities; Control compensation of efforts; Moderation and conflict management; Mode of financing the cooperation is established.</td>
<td></td>
<td></td>
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</tbody>
</table>

| 4. Transformation phase | Check objectives, vision and adjustment | Check if there is a lack or abundance of partners | Check the distributional rules: are they perceived as being fair? Do the partners benefit from the cooperation? | Check the cooperation structure: is it appropriate, effective and efficient? | Evaluation of the operational processes; Continuous moderation and conflict management. | Check communication flows; Check cooperation culture; Develop knowledge management further. | Establish internal and external systems of communication; Measures of establishing a cooperation culture; Establishment of a knowledge management. |
First empirical test of the prototype in two case studies in Germany

The levels 1 and 2 of the prototype of the tool “cooperation management” were pre-tested in a first step as follows: The authors conducted a workshop with the practical project partners for each case study. The practitioners received a description of the prototype (level 1 and 2) for preparing the workshop. During the workshop researchers and practitioners discussed the questions for orientation (level 1) and analysed key elements and crucial functions of cooperation (level 2) for each case. Researchers and practitioners deliberated about strengths and weaknesses of the cooperation in the two cases, sketched elements of a preliminary strategy for cooperation management, and identified a starting point.

After the workshop the researchers formulated an analysis of the status of the cooperation for each case that serves as a baseline for further research and transdisciplinary intervention from the project. Moreover, the researchers formulated first suggestions for the practitioners on how to proceed with their cooperation management.

The hypotheses allow comparison of cooperation in the two cases, identification of best practice and learning from mistakes. They guided the reflection about the transdisciplinary exchange. In the following sections the analysis of the cooperation is presented for both cases.

As a second strand the practitioners gave recommendations regarding further development of the tool prototype which will be considered in developing the tool further.

Ethical organic poultry production – “ei care”

The background of the innovation “ei care” by the organic farmers’ association Naturland Marktgesellschaft are negative externalities resulting from an increase of large scale animal production entities based on economies of scale in organic farming. Highly efficient chicken production has led to ethical societal discourses – leaving room for innovative solutions besides a value chain with monopolistic structures in the breeding of either egg laying hens or hens for meat production. The regional initiative “ei care” for an ethical organic poultry production started in 2011 and provides a holistic alternative to large-scale poultry production based on hybrid breeds. It is based on a dual purpose breed that allows for integrated egg and meat production at small mixed farms in the Berlin-Brandenburg region. The challenge is to link limited production levels with established value chain infrastructures and routines. This includes new forms of cooperation along the value added chain as well as between farmers and consumers.

Status of the cooperation: The ei care-cooperation is in the realisation phase. The cooperation along the value added chain started several years ago and produces eggs and meat which are marketed by a regional organic wholesaler for regional consumption.

Whereas the objectives of the general innovation are quite clear and explicitly formulated on the website of the ei care-project (http://www.aktion-ei-care.de), the goals for the cooperation of the partners are still fuzzy. Fundamental issues have to be clarified again and again because the goals are not explicit and not written down, which affects the transparency of the cooperation and its management. The cooperation involves strong actors especially the organic farmers’ association and an organic wholesaler as well as about eight rather small poultry keeping mixed farms. Still missing are hen breeding and meat processors who are
willing to deal with comparatively very small quantities as well as a stronger involvement of organic food retailers and consumers.

The distribution of costs and benefits along the value added chain is not transparent for all partners. The prices for the eggs and the meat are negotiated orally and are strongly oriented at market prices for organic poultry. They hardly correspond with the costs of the farmers. As a consequence, several farmers do not get a satisfying compensation for their costs, time and effort. The fuzziness of the goals is reflected also in the structure of the cooperation. Important responsibilities, tasks and functions are not explicitly described, a written agreement for the cooperation is lacking. Furthermore, the partners are under market pressure as pricing is dominated by the logic and channels of the food market. Some of them perceive the wholesaler as powerful within the cooperation whereas the wholesaler sees himself as exposed to fierce competition within the food commerce.

An effective network management and operative steering of the cooperation is hampered by the fuzzy goals and structure of the cooperation which especially lacks long-term planning and priority setting. The internal communication does not reach organic retailers who might promote the “difficult” (ie expensive and complex) care-products.

Identification of critical functions of the cooperation management and first recommendations: The analysis revealed cooperation problems with regard to the goals and structure of the cooperation as well as with the current configuration of the partners. Both main partners of the cooperation – the organic farmers’ association (also representing the farmers of care) and the organic wholesaler taking care of marketing a “difficult” product – are responsible for clarifying the goals, structure and “rules” of the cooperation. A shift towards a more formal cooperation management could make the cooperation more transparent for all other partners. Thus, a formal agreement about the cooperation would be a milestone in its development. In addition, new partners (especially for a more specific marketing of the alternative care-products) could stabilise the cooperation.

Selection of an instrument: During the pre-test workshop practitioners and researchers agreed on an instrument that facilitates formulation of a written agreement. The instrument to be developed (or adopted) will include blue prints and examples of legal cooperation agreements and suggestions for how to negotiate such an agreement between partners.

New forms of site specific land use and value creation for marginal wetlands for the conservation of typical cultural landscapes – Biosphere Reserve Spreewald

The Biosphere Reserve Spreewald, South-East of Berlin, is confronted with a phase out of site adopted grassland management practices on marginal wetlands because traditional forms of land use are at the margin of profitability. The maintenance of the typical cultural landscape of high natural value demands new forms of land management. The innovation in the Spreewald consists of a combination of new forms of land use such as landscape preservation funded by compensation payment schemes and the use of biomass for small scale thermal production as well as cooperation between land owners, land users, natural conservation and the tourist sector for financing the preservation of the typical cultural landscape that is demanded by tourists.

Status of the cooperation: A first empirical analysis of the cooperation focused on the establishment of a so called “environmental pool” which allows the concentration of measures
for natural and landscape preservation on a specific site. These measures are financed by the Regulations on Intervention under the Federal Nature Conservation Act which obliges an individual or organisation to compensate for environmentally harmful interventions. The cooperation for this environmental pool is in the *initiation and planning phase*.

The *objective* of this pool in a narrow sense is financing landscape preservation measures by funds from the Regulations on Intervention. In order to be entitled to use this money, the objectives have to be in line with the regulation. Cooperation is needed to establish this pool and to meet legal requirements. In a broader sense the cooperation strives to combine these measures with other activities for landscape preservation and to develop a comprehensive strategy for cultural landscape development in the biosphere reserve. Central *actors* for the pool are the agency responsible for the pool - in this case a citizens' foundation - land owners, land users, the environmental administration and the management of the biosphere reserve. For a broader strategy additional actors like environmental associations and tourism are needed but they are not yet involved.

The *distribution of costs and benefits* is mainly organised by legal standards and full-cost pricing for the measures over 20 years. Additional measures have to be financed by other funds like sponsoring from tourism, which is so far not the case. The *structure of the cooperation* is also shaped by legal regulation. Measures have to be approved by the environmental administration. Moreover, a broad strategy for developing the typical cultural landscape needs a wider and more flexible cooperation structure to be able to involve and motivate heterogeneous partners. This calls for a very active network management. Because of the early phase of the cooperation, *operative steering* of the cooperation (network management) and a *communication* concept are not yet well developed.

*Identification of critical functions of the cooperation management and first recommendations.* The central cooperation partners should strive for a broad strategy for developing the typical cultural landscape using the environmental pool and funds from the Regulations on Intervention as a cornerstone. The latter should not become the structure and the purpose of the broad strategy but serve as a means to this end. This implies the involvement of heterogeneous actors who all have stakes in the cultural landscape like agriculture, nature conservation or tourism. These potential partners need to be addressed from the beginning so they can develop ownership in this strategy. This requires them to have resources for cooperation and network management in order to motivate and bring together actors despite rival interests in cultural landscape.

*Selection of an instrument:* During the pre-test workshop a checklist for identifying suitable actors with adequate resources was identified as a useful instrument that could be developed for practitioners during the following week.

*Discussion and reflection*  
The first test of the prototype (level 1 and 2) was considered useful by the practitioners in order to reflect their cooperation systematically. The questions for orientation (level 1) were assessed as easily applicable and could be discussed intuitively without profound previous knowledge about cooperation (theory). However, analysing the cooperation in detail using the matrix (level 2) required some knowledge about and experience with cooperation. The weighing of arguments and assessment of risks and opportunities for cooperation management was assisted by the researchers who gained deeper insights into the
cooperation at question. In both cases, trust and engagement are important assets. Challenges for cooperation are a clear definition of its goals, transparent internal and external communication and a fair distribution of costs and benefits between the partners as well as dealing with pressure from 'the market'.

The cases differ in the following way. The cooperation for the ethical organic poultry (ei care) is organised along the value added chain. Its products compete in the food market. Therefore they are exposed to market pressure that demands an optimisation of the production and marketing processes. In contrast the cooperation for alternative value creation to preserve typical cultural landscape in the Biosphere Reserve Spreewald, is organised following legal requirements and administrative procedures as a prerequisite to using finances from the Regulation on Intervention. There is hardly any market pressure with regard to funding through the Regulations on Intervention. When aiming for a broad strategy for preserving cultural landscape, however, a broad range of actors has to be involved and the goals of cooperation become even fuzzier than in the first case. This requires proactive network management.

The researchers got valuable feedback from the practitioners through the pre-test of the prototype. The formulation of the orientation questions was simplified at several points to foster a better understanding. Additionally the pre-test with the Spreewald case showed that an early check of the legal requirements and restrictions in the course of developing an innovation plays an important role.

Conclusion
In a next step, the prototype has to be developed further. The tool kit of specific instruments (level 3) has to be assembled step by step and tested with the practitioners. Further research on cooperation and on the tool “cooperation management” has to deal with the following questions:

- How far can “cooperation management” be decontextualised and developed as a generic tool for sustainable land management that is characterised by site specific and context sensitive solutions?
- What is specific to cooperation for sustainable land management? What are the particular challenges for this kind of cooperation management?
- Is cooperation for sustainable land management able to compete with conventional production in the market? What does this mean for the design of cooperation? Are new framework conditions needed?

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References


Collaboration for a more sustainable agriculture – when does it work?

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Abstract: Finding and implementing innovative solutions to sustainability problems in agriculture makes collaboration among farmers and other stakeholders indispensable. There has already been much work on conditions influencing success or failure of joint action in different contexts. However, aside from not providing insights specifically for collaboration in the context of sustainable agriculture, much of this research has been based on the investigation of one or a few case studies. Other works have investigated more specifically collaboration in the context of sustainable agriculture. Yet there is a lack of research on collaboration for sustainable agriculture that integrates insights into both internal and external factors for success and that assesses these factors against explicit and comprehensive success criteria. To fill these gaps, this research provides first results of a case survey of case studies of local or regional collaborative interventions in EU-countries that attempt to improve the sustainability of agriculture. The aim of this case survey is to identify which conditions contribute to or hamper general success of such interventions. Specifically, the first eight coded case studies were analysed to explore existence and type of causal relations between the (long-lasting) success of an intervention and factors related to group composition and social capital among involved actors on the one hand and factors of organisation and management of these interventions on the other hand. Apart from indicating a range of factors that potentially have an effect on the success of collaborative interventions for a more sustainable agriculture, for a selection of these factors mechanisms were identified through which this influence on success may occur.

Keywords: Sustainable agriculture, collaboration, case survey, success, social capital, shared norms, existing relations, management, capacity building, dialogue

Introduction
Finding and implementing innovative solutions to sustainability problems in agriculture makes collaboration among farmers and other stakeholders indispensable. On the one hand, cooperation has been identified as an important element of sustainable agriculture (Pretty, 1995; Bowler, 2002; Velten et al., 2015). On the other hand, addressing sustainability problems in agriculture often goes beyond technical fixes and requires systemic change, which includes for example changes in organisations, behaviour, and kinds of relations among stakeholders. For fostering such systemic innovations cooperation is also a key factor (Cooke et al., 1997). But under which conditions does cooperation lead to successful and long-lasting innovative solutions for sustainability problems in agriculture?

There has already been much research on why and under which circumstances joint action of different actors aiming at the achievement of a set of common goals is successful. Among these is literature on community-based natural resource management (CBNRM) (e.g. Measham & Lumbasi, 2013), collective action (e.g. Agrawal, 2001; Mills et al., 2011; Ramdwar et al., 2013), social networks (e.g. Newman & Dale, 2007), advocacy coalitions (Schlager, 1995), partnerships (Dyer et al., 2013), and cooperatives (e.g. Azadi et al., 2010). However,
aside from not providing insights specifically for collaboration in the context of sustainable agriculture, much of this research has been based on the investigation of one or a few case studies. Although small-N case study research allows deep insights into causal mechanisms, it does not allow identifying overall patterns and generalisability of the results remains critical.

Other works have investigated more specifically collaboration in the context of sustainable agriculture. For instance, the SOLINSA project studied 17 Learning and Innovation Networks for Sustainable Agriculture (LINSAs) in Europe and explored how successful LINSAs can be supported effectively and efficiently (Moschitz et al., 2014). Another example is a study of the Sustainable Winegrowing Programme (SWP) in Lodi, California, which assessed how effectiveness of this programme depended on different social processes (Shaw et al., 2009). While SOLINSA mainly focuses on how success of LINSAs can be supported from the outside, the study of the SWP concentrates on the influence of internal social processes on the effectiveness of this sustainable partnership. Furthermore, in the SOLINSA project, it remains rather unclear what is considered a successful LINSA, whereas in the study of the SWP success/effectiveness of a sustainable partnership is rather narrowly understood as a positive influence of the partnership on wine growers’ attitudes towards and adoption of sustainable practices. Thus, there is a lack of research on collaboration for sustainable agriculture that integrates insights into both internal and external factors for success and that assesses these factors against explicit and comprehensive success criteria.

To fill these gaps, a case survey of a larger number of case studies of local or regional collaborative interventions that attempt to improve the sustainability of agriculture may provide answers as to which internal and external conditions contribute to or hamper general success of such interventions. This paper presents first and very preliminary results of such a case survey which compares cases from EU countries. These results are based on the first eight case studies that were analysed for the case survey. They provide insights about the effect of certain factors related to social capital, learning processes and management of innovation networks for sustainable agriculture on the long-lasting success of such networks.

In the following section, the methods used for the analysis are described in more detail followed by the presentation of the results. The subsequent discussion of these results is structured around, first, the question about which role social capital plays in cooperation for innovation for sustainable agriculture and, second, the question of how innovation networks for sustainable agriculture can be managed and which learning process take place within them. In the end, summarising conclusions are drawn.

**Methods**

This work is part of a larger research project that aims at evaluating which conditions contribute to or hamper the success of collaborative interventions on the local and regional level which attempt to improve the sustainability of agriculture in their municipality, region, landscape etc. For the purpose of this project, a case survey is conducted. Case surveys integrate a relatively large number of qualitative case studies by transforming the qualitative into quantitative data and in this way make them accessible to methods of quantitative analysis. This transformation is realised through the use of a predefined coding scheme and the expert judgement of coders. “Thus, case surveys draw on the richness of the case material, on different researchers and research designs, and allow for a much wider generalisation than from single cases” (Newig & Fritsch, 2009, pp. 4–5).
In following the recommendations of Bullock & Tubbs (1987), Larsson (1993) and Newig & Fritsch (2009) for conducting a case survey, as a first step a definition of what would be considered a case was established in order to define criteria for selecting appropriate cases:

A case is defined as an intervention (initiative, project, putting a legislation into practice etc.) which is realised on the local or regional level (i.e. any level above farm-level and below national level) and which aims at improving the sustainability of agriculture in the concerned locality or region and is carried out in any EU-country in collaboration with several actors.

An intervention is considered to aim at the improvement of the sustainability of agriculture if it seeks simultaneous improvements or maintenance of an already good status quo in each of the sustainability areas (environmental, economic and social). This does not imply that such interventions have to place equal weight on each of these areas but that they must not neglect any of these areas. In other words: interventions that aim at the improvement of the sustainability of agriculture may focus on only part of the areas but still need to pursue their objectives in these areas in a way that also benefits the remaining, non-focal areas.

This definition is designed in a rather broad way and thus also allows cases to be included in the analysis that only seek incremental innovations to improve the sustainability of agriculture rather than trying to fully realise sustainable agriculture (which in itself is a highly contested concept). The main reason for keeping such a broad definition is that “[Incremental innovation can be as successful as radical innovation as it is more likely to be adopted more widely at regime level.” (Moschitz et al., 2014, p. 20) As both incremental and radical change can advance the transition to sustainable agriculture, both are considered in this analysis.

Based on this definition, a comprehensive internet-based search for appropriate case studies was conducted using different search strategies, including for example searches of databases and snowballing. In a next step, all found publications were screened for usability in more detail. This procedure led to a final sample of 51 cases that met the case definition and that were described in sufficient detail in the available documents.

For the cross-analysis of these cases a coding scheme was developed which allows the translation of the qualitative case descriptions into quantitative and statistically analysable data. For this coding scheme related literature e.g. publications on farmer cooperatives, community based natural resource management, and collective action with relation to agriculture, rural development, or environmental and sustainability issues (see Table A1 in the annex) was reviewed for factors possibly influencing the success of an intervention. All factors found through this review were included in the coding scheme. They were transformed into variables, which ask to what extent a factor was present in a specific case. The answers to these questions are expressed in the form of a numeric code, mostly on an ordinal scale from 0 to 4. Additionally, the degree of reliability of information on which the judgement was based is coded for all variables, ranging from 0 meaning ‘insufficient information available’ to 3 meaning ‘explicit, detailed and reliable information available’.

In order to be able to evaluate if a factor has an effect on the success of a collaborative intervention for a more sustainable agriculture (CIMSA), the concept of success needed to be defined and decomposed and its elements needed to be integrated into the coding scheme (for more detail, see Velten, 2014). In this work, only three of these elements of success are
considered. These are (i) the ambitiousness of the objectives of the intervention, (ii) the degree of the achievement of the different objectives, and (iii) the durability of the achievement of the objectives (which does not only consider for how much time an intervention has *de facto* existed but also includes an estimation of the probability that the intervention and/or its achievements will continue for a long time). However, ambitiousness of the objectives is not analysed separately but rather feeds into the evaluation of the degree of goal achievement in the form of a weighted mean of the goal achievement, i.e. the more ambitious a goal, the more its degree of achievement influences the score of total goal achievement. Thus, here two success indicators, total degree of goal achievement $G(i)$ and durability of the achievement of the goals $D_i$, are applied.

After a pre-test of the coding scheme, the 51 usable case studies were coded in a pre-defined random order. Coding was done by the author and one additional researcher. The case studies were mainly coded by only one of the two coders. Some case studies were coded by both coders to keep understanding of the coding scheme aligned. In these cases the coding results were compared and codes that strongly deviated from each other (i.e. usually a difference of 2 or more between the codes) were discussed and adjusted where appropriate. The final coding values were integrated by taking the mean values.

In this work, very preliminary and tentative results are presented. For this purpose, only the coding results of the first eight coded cases were explored (Table 1). Furthermore only a subset of 80 variables of the coding scheme was analysed. These were variables related to characteristics of the group of involved actors on the one hand and factors of organisation and management of these interventions on the other hand. In a first step, correlation between each of these variables and 1) the degree of achievement of the goals $G(i)$ and 2) the durability of the achievement of the objectives $D_i$ was calculated using Spearman’s rho. The results of this quantitative analysis were used to indicate which variables possibly have a causal relation with the success of an intervention. Thus, for a selection of those variables that showed a significant correlation with either of the success indicators the existence and nature of the relation was determined in a qualitative way through within-case analysis and counterfactual thinking.
Table 1. Overview over the analysed cases (in the order of decreasing success if both success indicators are combined).

<table>
<thead>
<tr>
<th>Case name</th>
<th>References</th>
<th>Country</th>
<th>Type of intervention</th>
<th>Level of the intervention</th>
<th>G(i)</th>
<th>D_i</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gailtal Alp Cheese</td>
<td>Rytkönen &amp; Gratzer, 2010; Borg &amp; Gratzer, 2013; Gratzer, 2013</td>
<td>Austria</td>
<td>Establishment of a PDO</td>
<td>County</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Graig Farm Network</td>
<td>Kirwan, Slee, &amp; Vorley, 2002; Marsden &amp; Smith, 2005</td>
<td>United Kingdom</td>
<td>Farmer network for organic meat</td>
<td>Cross-county</td>
<td>3.17</td>
<td>4</td>
</tr>
<tr>
<td>Tradice Bílých Karpat</td>
<td>Kučerová, Loštáček, &amp; Zagata, 2007; Tisenkopfs, Kovách, Loštáček, &amp; Šůmane, 2011</td>
<td>Czech Republic</td>
<td>Cooperation to support small-scale fruit growers</td>
<td>Landscape</td>
<td>3.03</td>
<td>4</td>
</tr>
<tr>
<td>Tablehurst and Plaw Hatch Community Farms</td>
<td>Pilley; Ravenscroft &amp; Hanney, 2011; Ravenscroft, Moore, Welch, &amp; Hanney, 2013</td>
<td>United Kingdom</td>
<td>CSA – two biodynamic farms owned by a citizen cooperative</td>
<td>Municipality</td>
<td>3.44</td>
<td>3</td>
</tr>
<tr>
<td>BioPlus Berlin-Brandenburg</td>
<td>Segert &amp; Zierke, 2004a, 2004b</td>
<td>Germany</td>
<td>Regional organic farming association</td>
<td>Subnational (federal state)</td>
<td>1.57</td>
<td>4</td>
</tr>
<tr>
<td>Zeeuwse Vlegel</td>
<td>Boef, de, 2000; Jongerden &amp; Ruivenkamp, 2008; Oerlemans &amp; Assouline, 2004; Wiskerke, 1995, 2003; Wiskerke &amp; Oerlemans, 2004</td>
<td>The Netherlands</td>
<td>Initiative for sustainable production and marketing of baking wheat</td>
<td>Subnational (province)</td>
<td>1.84</td>
<td>2.5</td>
</tr>
<tr>
<td>Allmende Kontor Tempelhof</td>
<td>Münchnich, 2014; Wunder, 2013</td>
<td>Germany</td>
<td>Community garden</td>
<td>Sub-municipality</td>
<td>3.25</td>
<td>1</td>
</tr>
</tbody>
</table>
Results

Results of the correlation analysis
Table 2 shows the correlation coefficients for those variables/factors that have a significant correlation (p<0.1) with either of the two success indicators as well as the kind of relation that literature suggests for these factors with the success of collaborative interventions (see Table A1 in the annex for references for the suggested relations).

Table 2. Influencing factors with significant correlations with degree of goal achievement G(i) or durability of goal achievement D_i

<table>
<thead>
<tr>
<th>Independent variables / influencing factors</th>
<th>Spearman's rho</th>
<th>Relation suggested in the literature between a factor and the success of an intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Achievement of the goals G(i)</td>
<td>Durability of goal achievement D_i</td>
</tr>
<tr>
<td>Characteristics of the group of involved actors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Composition of the group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group heterogeneity (change)</td>
<td>-0.8332**</td>
<td>-0.0328</td>
</tr>
<tr>
<td>Group heterogeneity (end)</td>
<td>0.0123</td>
<td>-0.7847**</td>
</tr>
<tr>
<td>Group size (beginning)</td>
<td>0.2857</td>
<td>-0.7042*</td>
</tr>
<tr>
<td>Social Capital</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-existing relations</td>
<td>0.7619**</td>
<td>0.2156</td>
</tr>
<tr>
<td>Shared norms (beginning)</td>
<td>-0.2561</td>
<td>0.7565**</td>
</tr>
<tr>
<td>Factors related to the management of the intervention</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rules and objectives</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explicit and defined objectives</td>
<td>-0.0137</td>
<td>-0.6298*</td>
</tr>
<tr>
<td>Compatibility of the objectives with the livelihoods and/or usual activities of the involved actors</td>
<td>0.0275</td>
<td>0.8202**</td>
</tr>
<tr>
<td>Complexity of the objectives</td>
<td>-0.1788</td>
<td>-0.7415**</td>
</tr>
</tbody>
</table>
Incentive for the involved actors to pursue the objectives of the intervention 0.2156 0.6351* +
Incentive for the involved actors to collaborate 0.6274* 0.0145 +
Internal rules of the intervention can be changed by the involved actors -0.6547* 0.1598 +

Communication and decision-making
Dialogue (two-way information exchange) in the process of reaching decisions 0.6923* -0.8738** +
Mode of participation in decision-making allows the involved actors to contribute all of their relevant skills and expertise 0.1455 -0.7171* +
Influence of the involved actors on decisions 0.2648 -0.8442** +

Other management factors
Clear criteria for eligibility to become a member of the intervention 0.2061 0.6394* +
Inclusiveness of the intervention 0.7350** -0.5007 +/-
Monitoring 0.2245 0.7573* +
Intervention includes efforts to enhance capacities of involved actors -0.4122 -0.7039* +
Existence of a core group -0.1690 -0.7204** +
Achievement of self-sustenance of the intervention 0.2171 0.7075** +

*p < 0.1, **p<0.05

Some of these results suggest relations between influencing factor and success of an intervention that are in line with the relations proposed in the literature, some results sharply contradict the literature. As these correlations are based on a rather low number of cases, it is questionable whether they are mere artefacts or are indeed backed-up by causal relations. Therefore, their primary use is to indicate the factors for which a more detailed qualitative analysis for causal relations is probably worthwhile. The following section presents such qualitative insights for four of these factors that have a significant correlation with one of the two success indicators: level or norms shared at the outset of an intervention, level of pre-
existing relations among the involved actors, level of capacity-building during the intervention, and the level of dialogue in decision-making.

**Results of the qualitative analysis of causal relations**

**Relation between initial shared norms and the durability of achievements of an intervention**

Correlation analysis indicates a positive relationship between the level of norms shared among the actively involved actors at the outset of a CIMSA and the durability of its achievements (Figure 1). In the cases included in this analysis, two types of mechanisms through which a high level of shared norms at the outset of an intervention may contribute to long-lasting achievements could be identified. First, by being present at the outset of an initiative, the common norms of the involved actors shaped structures and other features of the intervention. Through this process of the intervention epitomising the norms important to a great part of the involved actors, the intervention itself became important to the actors, which incited their commitment and adherence to the intervention. Second, a high degree of shared norms generated a sense of mutual dependence among the involved actors. Thus, initially shared norms tied the actors both to the intervention and to each other.

**Figure 1. Scatterplot showing the relation of initial shared values and the durability of achievements.** (The data points of Graig Farm Network and BioPlus Berlin-Brandenburg are in the same place as the data point of Tradice Bílých Karpat. There was no data available for initial level of shared norms for Gailtal Alp Cheese).

Both of these mechanisms are present in the cases of Tradice Bílých Karpat and BioPlus Berlin-Brandenburg. The intervention of Tradice Bílých Karpat (TBK) started in the early 1990s in the region of the White Carpathians in the Czech Republic with old local fruit growers and environmental NGOs. Their idea was to protect old local apple varieties and sustain local traditions. In the first years, the intervention was rather informal and was then formalised in 1998 in order to be able to receive a grant from a foundation. However, the old orchard owners did not join this new, formal TBK. Apart from this moment, a later value conflict between the idealistic world view of the members of the environmental NGOs and the more realistic stance of the (new) involved organic farmers threatened the continuance of the intervention. Yet, despite a high proportion of the original, founding members having dropped out of the initiative,
and the later emerging value conflict, the original shared norms still formed the heart of the intervention as “[t]he structure of the TBK o.s. collective [was] rooted in the special worldview: living in harmony with nature” (Kučerová et al., 2007, p. 10). Not only had the intervention come to mirror the norms that were still important to many of the involved actors, the common initial value basis also led to a feeling of mutual dependence, which held the involved actors together: “I feel we need each other because we make common things” (Kučerová et al., 2007, p. 12).

In the case of BioPlus Berlin-Brandenburg, a regional branch of an organic farming association in the States of Berlin and Brandenburg, Germany, the main shared norm in the beginning and also later on was one of mutual support in order to be able to farm organically. The norm of mutual support per se created a mutual dependence of the involved actors, which generated cohesion among them. The embodiment of the norm of mutual support in the intervention happened because mutual help in the form of a non-market exchange of resources and services came to be the central form of collaboration of BioPlus Berlin-Brandenburg (Segert & Zierke, 2004b).

Relation between pre-existing relations and the level of achievement of the goals of an intervention

![Figure 2. Scatterplot showing the relation of pre-existing relations and the level of goal achievement](image)

The results of the correlation analysis suggest that a high level of pre-existing relations among the involved actors makes it more likely that a CIMSA achieves its goals (Figure 2). In the analysed cases this was the case, especially if the pre-existing relationships among involved actors included relations to actors in crucial positions. This was most apparent in the cases of the Allmende Kontor Tempelhof and Gaittal Alp Cheese.

In the case of the Allmende Kontor Tempelhof, a community garden established on the area of the former airport Tempelhof in Berlin, a couple of the founding members were especially well-connected to a diversity of actors in Berlin. Through their relations they were able to get
local authorities and an NGO involved in the intervention. Only through these actors did the intervention get access to resources that were necessary to fulfil its goals. For example, these existing relations allowed the Allmende Kontor Tempelhof to formally become part of the registered association “Workstation Ideenwerkstatt e.V.”. This step was necessary as one requirement for proposals for pioneer projects on the former Tempelhof airport area was that they be organised in registered associations. Becoming a registered association itself would have been too time-intensive, which is why the “Workstation Ideenwerkstatt” became the project executing organisation. Only in this way was the Allmende Kontor Tempelhof able to get access to an area for the establishment of a community garden (Wunder, 2013).

The case of Gailtal Alp Cheese was a state-led initiative in the Gailtal valley in Austria to apply for a Protected Denomination of Origin (PDO) for the local traditional cheese. Here, an already existing network among national government and regional authorities and organisations allowed the bringing together of necessary skills and resources and was “among the reasons why the project is often cited as an example of best practice at the national and international levels” (Borg & Gratzer, 2013, p. 31).

**Relation between presence of capacity-building efforts in an intervention and the durability of its achievements**

Surprisingly, correlation analysis suggests that including efforts to increase the capacities of the involved actors of a CIMSA makes the achievements of the intervention less long lasting (Figure 3).

![Figure 3. Scatterplot showing the relation of presence of capacity-building efforts in an intervention and the durability of achievements of the intervention (the numbers in the graphic stand for the following cases: 1 BioPlus Berlin-Brandenburg, 2 Graig Farm Network).](attachment:image)

In the investigated cases, two types of relevant capacities were apparent: technical capacities, such as knowledge and skills for agricultural production; and networking skills, which allowed the involved actors to hold involved as well as associated actors together and keep the intervention going. Furthermore, there were two ways through which the necessary capacities
were made available to the intervention: either the intervention included efforts to increase the capacities of the involved actors (Zeeuwse Vlegel, Graig Farm, Tradice Bílých Karpat); or actors that already possessed the necessary capacities became part of the intervention (Gailtal Alp Cheese, Upländer Farmer Dairy).

A general mechanism through which capacity-building may impair the durability of the achievements of a CIMSA could not be detected in the investigated case studies. Only the case of the Zeeuwse Vlegel provided one example of conditions under which capacity-building efforts can impair the durability of an intervention or its achievements. This case received a medium score for capacity building because the involved actors focused on the enhancement of one capacity type (technical capacities) while the other capacity type (networking capacities) was neglected. Technical capacity building played a central role by enabling the involved actors to grow high quality baking wheat in an environmentally friendly way. Therefore, technical capacity building was indispensable to achieve some of the goals of the intervention. However, “the learning process was focused too much on the technical aspects of sustainable baking-wheat cultivation. Learning about the management of network relations and network building was largely neglected.” (Wiskerke, 2003, p. 445) Together with sales lagging behind expectations, this neglect of network building led to a deterioration of the commitment and sense of collectivity among members, which made many members think that the Zeeuwse Vlegel had “had its day and [was] bound to fade away” (Wiskerke & Oerlemans, 2004, p. 248)

However, it seems that an emphasis on technical capacity building is not necessarily detrimental to the durability of the achievements of a CIMSA as long as networking capacities are not neglected. Also in the other cases that included capacity building efforts, the focus was on technical capacity building. Yet, in these cases also networking capacities were developed. A very good example for this is the case of the Allmende Kontor Tempelhof. Here, the two types of capacities were enhanced jointly. Members were encouraged to form working groups dedicated to specific topics and motivate people to take over responsibility for these working groups (Wunder, 2013). Consequently, members involved in these sub-projects simultaneously obtained technical knowledge and skills related to the topic of the working group and at the same time learned how to manage a group or network of different actors working towards a common goal. (Note: The very low durability score of the Allmende Kontor Tempelhof (Figure 3) is mainly attributable to the limited time the area on the Tempelhof site was made available to pioneer projects such as the Allmende Kontor.) Thus, when it comes to capacity building efforts, what may impair the durability of a CIMSA and with that also the durability of its achievements is not so much an emphasis on but the neglect of one capacity type.

As for the effect the way in which capacities are brought into an intervention has - whether through actors with the necessary capacities or through capacity building efforts for the involved actors - it is hard to see clear patterns. Nevertheless, the case of Gailtal Alp Cheese shows that the model of making the necessary capacities available does not unavoidably leave the broad range of involved actors incapable and dependent on the actors who have important capacities. In the case of Gailtal Alp Cheese, the contrary happened. This intervention was initiated and led by state actors who had the necessary networking and management capacities. However, after some years, state actors were able to withdraw and hand over all responsibilities to the local actors (Rytkönen & Gratzer, 2010). Thus, the local actors had obtained the ability to manage and continue the activities of the intervention.
Relation between the level of dialogue in decision-making and both the degree of goal achievement and durability of the achievements

For the level of dialogue in decision-making, in the sense of two-way exchange among the involved actors, correlation analysis indicates a relation with both success indicators, yet with opposite directions: CIMSA where decision-making includes a high level of dialogue supposedly achieve their goals better (Figure 4a), but are less long-lasting (Figure 4b).

![Figure 4. Scatterplots showing the relation of the degree of dialogue among involved actors in decision-making with a) the degree of the achievement of the goals of an intervention and b) the durability of the achievements (the data points of the cases Tradice Bílých Karpat and Graig Farm Network are in the same place as the data point of BioPlus Berlin-Brandenburg; no data was available for Gailtal Alp Cheese).](image)

In the investigated cases, two ways were found in which dialogic decision-making may contribute to a higher degree of goal achievement. One type was identified in the case of the Allmende Kontor Tempelhof: This intervention saw involvement, engagement and communication not only as a means but as an end in itself. Therefore, making decisions in a dialogic way already fulfilled a part of the objectives of the initiative.

The other type of relationship was found in the case of the Zeeuwse Vlegel. This intervention mainly fell short on the achievement of its economic goals because it was not able to sell as much Zeeuwse Vlegel bread as the involved actors would have liked. More dialogue between the board and the remaining involved actors could possibly have led to decisions that could have increased sales. In the beginning of the intervention, there was a rather high degree of dialogue: “In the design phase of the Zeeuwse Vlegel the bakers were actively involved in the design of the project, in particular in the construction of the bread concept. The product that emerged was the outcome of negotiations between farmers, bakers and environmentalists.” (Wiskerke & Oerlemans, 2004, p. 258) However, in later stages the management board became less open towards suggestions from the actors who were not part of the board. Thus, the bread concept remained the same although changes to the concept could have boosted its sales as there were good ideas of how the bread could have been better sold, especially on the part of the bakers. Furthermore, the lack of openness of the board also impaired the
commitment and satisfaction of the involved actors. On another occasion the closed decision-making of the board resulted in both an impairment of the sales and an increasing resentment of the actors: by ignoring the voices of the broad range of involved actors, the board decided to sell the Zeeuwse Vlegel bread not only through bakeries but also through supermarkets; this in turn lead to a refusal of the bakers in two large cities to sell the bread, which meant a great setback for the sales (Wiskerke & Oerlemans, 2004). The continuance of a two-way exchange between the board and the remaining involved actors could, on the one hand, have allowed the initiative to build on a broader set of insights to further develop and improve its products. On the other hand, more dialogue could have made sure that all interests were considered in major decisions so that they would have been acceptable to all involved actors.

While there is some evidence as to how dialogue in decision-making helps CIMSAs to achieve their goals, no mechanisms underlying a negative causal relationship between dialogue in decision-making and the durability of the achievements could be found.

Discussion
The discussion of the results is structured around the following two questions:

- What role does social capital play in cooperation for innovation for sustainable agriculture?
- How can innovation networks for sustainable agriculture be managed and which learning processes are taking place?

The role of social capital in cooperation for innovation for sustainable agriculture
It has been stated that cooperation for sustainability innovations in land management is confronted with a dilemma: on the one hand there is the need to build social capital - especially trust - which takes time; on the other hand such initiatives are supposed to foster rapid innovation cycles for economic purposes in order to compete in a dynamic competition. The question then is how to cope with this dilemma (Schäfer & Nölting, 2015).

Trust is the first thing one thinks of when hearing ‘social capital’. Yet social capital also includes other kinds of relational resources. The analysis conducted in this work identified two other kinds of social capital to support the success of CIMSAs: pre-existing relations; and norms shared by the involved actors. A high degree of shared norms contributed to success by increasing the durability of an intervention and therefore of its achievements, especially if it occurred in the early phases of the intervention.

To avoid the above described dilemma, one possibility could thus be to build on these two types of social capital. This would of course require bringing together the ‘right’ actors, meaning that the intervention would have to involve from the start actors whose norms show a great overlap and among whom some relations exist already. Under these preconditions, which are not easily met in practice, these types of social capital would already be available from the beginning of an intervention and would not have to be built first. Additionally, if actors share the same norms and values, they trust each other more easily (Siegrist et al., 2000). Thus, apart from directly supporting the success of an intervention, shared norms and pre-existing relations also have the potential to catalyse the formation of trust among the involved actors.
Management of and learning processes in innovation networks for sustainable agriculture

The correlation analysis indicates that there is a range of different management-related factors that may have an influence on the success of a CIMSA. For two of these factors - capacity-building efforts and dialogue in decision-making - it was assessed in more detail in which ways they might affect the success of such interventions.

Especially in CIMSAs, technical capacities for agricultural production often play an important role. However, our findings show that while no harm seems to come from focusing on technical capacities, it can be detrimental if there are efforts to enhance technical capacities alone while networking capacities are completely neglected. A good way to ensure that both capacities are enhanced is to develop them in an integrated way, as happened in the case of the Allmende Kontor Tempelhof where the involved actors formed self-organising working groups on specific, often technical topics. These working groups resembled what are called "communities of practice". Communities of practice share three characteristics: they have a shared domain of interest; they engage in joint activities and discussions; and they develop a shared repertoire of resources such as experiences, tools, way of addressing problems etc. (Wenger, 2006). Thus, encouraging self-organising communities of practice within CIMSAs can help to increase both technical and networking capacities at the same time.

Two further ways in which necessary capacities can be brought into a collaborative intervention were also identified: either the intervention included efforts to increase the capacities of the involved actors; or actors that already possess the necessary capacities become part of the intervention. Here, no clear pattern could be detected as to which of these two ways would be more beneficial. However, one case showed that bringing in actors that already have important capacities may lead to a transfer of these capacities to other involved actors. This may happen through peer-to-peer learning in practical situations that are relevant to the actors involved in a CIMSA. Thus, engaging 'capable actors' in the intervention and having them use their capacities in the context of the intervention can be a way of capacity-building that is an alternative or supplementary to the usual capacity-building efforts such as training.

A high level of dialogue in internal decision-making processes can support CIMSAs to achieve their goals and therefore be more successful. On the one hand dialogue can be a means of obtaining important insights and information from the involved actors. With such an improved information base more appropriate decisions can be taken (Newig, 2007). On the other hand a dialogic way of taking decisions in a collaborative intervention can help to first get to know and then consider all interests in major decisions: in this way decisions are likely to be more acceptable to the involved actors. It is suggested that involvement in decision-making processes that are fair and based on mutual communication increases acceptance even if the final decision does not correspond to actors’ expectations (Newig, 2007). A greater acceptance of decisions taken within CIMSAs will likely keep those involved more satisfied and motivated to continue to contribute to the intervention.

Conclusions

This work provides very preliminary results based on an analysis of the first eight investigated cases studies of a larger case survey. Through statistical analysis of data generated by coding eight case studies, this work identified a range of factors related to characteristics of the group of involved actors and factors of organisation and management of CIMSAs that possibly have
an influence on the success of these interventions in terms of the degree to which the interventions achieved their goals and the durability of these achievements. For some of these factors (shared norms, pre-existing relations, capacity-building and dialogue in decision-making), qualitative analysis revealed a range of mechanisms through which these factors may influence the success of such interventions. This helped shed some light firstly on the role of social capital in cooperation for sustainable agriculture and secondly on the management of and learning processes in innovation networks for sustainable agriculture. Despite the preliminary nature of these results they call attention to issues that should be considered in initiating and managing future co-operations seeking innovative and sustainable solutions to challenges in agriculture in order to help these efforts to lead to long-lasting success.

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References


### Annex

**Table A1. References for the relations between influencing factors and success of an intervention suggested in the literature**

<table>
<thead>
<tr>
<th>Influencing factor</th>
<th>Type of suggested relation</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group heterogeneity</td>
<td>+</td>
<td>Agrawal, 2001; Dyer et al., 2013; Markelova &amp; Mwangi, 2010; Newman &amp; Dale, 2007; Totin et al., 2014</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>Azadi, Hoseininia, Zarafshani, Heydari, &amp; Witlox, 2010; Ramdwar, Ganpat, &amp; Bridgemohan, 2013</td>
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<tr>
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<td>-</td>
<td>Agrawal, 2001; Ayer, 1997; Mills et al., 2011; Prager, 2015; Ramdwar et al., 2013; Schlager, 1995; Shiferaw et al., 2011</td>
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<tr>
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<tr>
<td></td>
<td>-</td>
<td>Prager, 2015</td>
</tr>
<tr>
<td>Shared Norms</td>
<td>+</td>
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</tr>
<tr>
<td>Explicit and defined objectives</td>
<td>+</td>
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</tr>
<tr>
<td>Compatibility of the objectives with the livelihoods and/or usual activities of the involved actors</td>
<td>+</td>
<td>Measham &amp; Lumbasi, 2013</td>
</tr>
<tr>
<td>Incentive for the involved actors to pursue the objectives of the intervention</td>
<td>+</td>
<td>Measham &amp; Lumbasi, 2013; Prager, 2015</td>
</tr>
<tr>
<td>Incentive for the involved actors to collaborate</td>
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<td>Ayer, 1997; Burandt, Lang, Schrader, &amp; Thiem, 2013; Dyer et al., 2013; Ingram et al., 2008; Newman &amp; Dale, 2007; Prager, 2015; Schlager, 1995; Shiferaw et al., 2011</td>
</tr>
<tr>
<td>Internal rules of the intervention can be changed by the involved actors</td>
<td>+</td>
<td>Oerlemans &amp; Assouline, 2004; Ramdwar et al., 2013</td>
</tr>
<tr>
<td>Dialogue (two-way information exchange) in the process of reaching decisions</td>
<td>+</td>
<td>Mburu &amp; Wale, 2006; Newman &amp; Dale, 2007; Oerlemans &amp; Assouline, 2004; Schlager, 1995; Shiferaw et al., 2011</td>
</tr>
<tr>
<td>Mode of participation in decision allows the involved actors to</td>
<td>+</td>
<td>Dyer et al., 2013</td>
</tr>
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</table>
Contribute all of their relevant skills and expertise

<table>
<thead>
<tr>
<th>Factor</th>
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<tr>
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<td>Clear criteria for eligibility to become a member of the intervention</td>
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<td>Agrawal, 2001</td>
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<td>Dyer et al., 2013; Shiferaw et al., 2011</td>
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<td>Monitoring</td>
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<td>Oerlemans &amp; Assouline, 2004; Prager, 2015; Schlager, 1995; Shiferaw et al., 2011</td>
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<td>Intervention includes efforts to enhance capacities of involved actors</td>
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<td>Burandt et al., 2013; Dyer et al., 2013; Gyau, Takoutsing, &amp; Franzel, 2012; Measham &amp; Lumbasi, 2013; Prager, 2015; Shiferaw et al., 2011</td>
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<td>Existence of a core group</td>
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<td>Ayer, 1997; Clark, 2006; Mills et al., 2011</td>
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<td>Achievement of self-sustenance of the intervention</td>
<td></td>
<td>Ramdwar et al., 2013</td>
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</table>
Elaborating hypotheses on motivations for participation in cooperation initiatives for sustainable farming.

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Abstract: Farmers can be motivated in different ways to participate in initiatives aiming to stimulate farmers towards sustainable farming. The dynamic interaction between an initiative’s design, farmer motivation to participate and their motivations to contribute to sustainable farming, makes research on farmer motivations to participate in sustainable farming initiatives (SFI) very interesting for SFI organisers. To grasp this dynamic relationship between motivations and an initiative’s design, 9 hypotheses were developed, using Self-determination theory (SDT). Based on these hypotheses we constructed a methodology to test them in SFI cases.

Keywords: Farmer motivations, farmer participation, self-determination theory, sustainable farming initiatives

Introduction

During the last decade, a variety of initiatives aiming to stimulate farmers towards sustainable farming were initiated. These sustainable farming initiatives (SFIs) are very diverse, and can in literature be referred to as innovation networks (e.g. Hermans et al., 2011; Klerkx et al., 2010; Kroma, 2008; Spielman et al., 2010), communities of practice (e.g. O’Kane et al., 2008; Oreszczyn et al., 2010), learning initiatives (e.g. Keen & Mahanty, 2006; Lankester, 2013; Restrepo et al., 2013), advisory services (e.g. Faure et al., 2012), farmer field schools (e.g. Butt et al., 2015; Charatsari et al., 2015; Vaarst et al., 2007), agri-environmental initiatives (e.g. Smithers & Furman, 2003), agro-environmental schemes (Atari et al., 2009; Wilson & Hart, 2001; Wilson, 1997), conservation covenanting programmes (Kabii & Horwitz, 2006), or agri-environmental policies (Defrancesco et al., 2008; Siebert et al., 2006; Stobbelaar et al., 2009).

The common goal of SFIs is encouraging farmers to adopt sustainable farming practices¹. SFIs are based on cooperation between farmers and other agro-food system actors (e.g. farmer’s union, food processors, NGO’s, government), as described in the definition of Learning and Innovation Networks for Sustainable Agriculture (LINSA) (www.solinsa.org). Depending on the SFI, sustainable practices can be differently defined e.g. one might focus on the adoption of practices favouring soil fertility, while others focus on sustainable management decisions at farm level. Despite their common goal, i.e. encouraging sustainable development within the agri-food chain, SFIs vary in their rate of success. Some initiatives are very successful in motivating farmers and other agri-food chain actors to participate and

¹ “A practice” is described by C. Blackmore et al. (2012) as “a generally accepted and shared habitual, taken for granted ways of performing an activity, with its attendant values, understandings, communications and cooperative routines”. An example of a sustainable farming practice is no till farming.
realise growing public recognition. Other initiatives encounter difficulties in motivating actors to participate and eventually disappear.

In this paper, we scrutinize the ways in which farmers can be motivated to participate in SFIs (Wilson & Hart, 2000). Some initiatives offer direct financial rewards or penalties, such as subsidies and fines e.g. agro-environmental schemes (Atari et al., 2009; Wilson & Hart, 2001; Wilson, 1997), conservation covenanting programmes (Kabii & Horwitz, 2006), agri-environmental policies (Defrancesco et al., 2008; Siebert et al., 2006; Stobbelaar et al., 2009). In these initiatives financial drivers are often the primary motivation for farmers to participate (Wilson & Hart, 2000). But, as in other initiatives which lack these direct financial rewards or penalties, other and even multiple motivations can be at play (Wilson & Hart, 2000), e.g. improving the economic performance of one’s farm or seeking social contacts.

Research has been performed on the influencing factors for farmer participation in SFIs, e.g. in agro-environmental schemes (e.g. Atari et al., 2009), conservation covenanting programmes (e.g. Kabii & Horwitz, 2006), agri-environmental policies (e.g. Defrancesco et al., 2008), farm-level agri-environmental management and planning (Smithers & Furman, 2003) and farmer field schools (Charatsiri et al., 2015).

Reported influencing factors for participation are: (i) farmer characteristics (e.g. age, education, dependency of farmer’s income); (ii) farm and farming system characteristics (e.g. farm size, production); (iii) the SFI characteristics (e.g. SFI design and objective, actors involved, tools used, rules for participation); and (iv) context factors (e.g. agricultural policies, vicinity of natural parks). Although these factors offer interesting information for SFI initiators and organisers, they do not give insights into farmers’ psychological motivations to participate. Despite its recognised importance (Wilson, 1997), limited research has been done on this topic so far (Charatsari et al., 2015). A reason for this research gap might be that SFIs are often studied within specific research domains such as innovation, social learning or advisory and extension. Because of these specific foci, we suppose that researchers do not scrutinize the motivations to participate, as researchers automatically link farmer motivation to the specific research foci (i.e. innovation, learning, advice). However, a farmer can, for example, participate in a social learning initiative mainly because he/she is seeking social interaction and not because he/she wants to learn about sustainability.

We discern two motivational processes regarding farmer participation in SFIs: the motivation to participate in an SFI and the motivation to contribute to sustainable farming. Both motivations are dynamically linked to each other and the SFI design. Indeed, farmer motivations to participate can influence both their commitment to the SFI and their attitude towards sustainable farming. Therefore, the interaction between their motivation to participate and the SFI design aiming to foster sustainable farming, can offer valuable information for SFI organisers. For example, farmers can initially decide to participate for reasons other than sustainable farming and during their participation their attitudes towards sustainable farming may change.

In this paper we take farmer motivations as the core subject of our study and in doing this we want to contribute to an in depth understanding of farmer participation in SFIs. We use self-determination theory (SDT), a theory of human motivations that provides a framework to investigate the motives of human behaviour, in our case participation in SFIs. The theory is grounded in the humanistic psychological theoretical perspective stating that human beings
have an inherent need to develop, grow and reach their full potential when conditions are favourable (Schacter et al., 2012). SDT provides a frame for investigating the particular conditions of SFIs that foster or undermine these positive human potentials (Ryan & Deci, 2000).

The aim of this paper is to refine our research objectives by formulating hypotheses on farmer motivations to participate in SFIs using SDT. We first discuss some basic principles of SDT and illustrate them with the subject of our study: motivations to participate in SFIs. Then, we develop hypotheses based on SDT. Finally, we elaborate on a methodology to test our hypotheses.

**Self-determination theory**

Self-determination theory (SDT) focuses on the extent to which an individual’s behaviour is self-motivated and self-determined (Ryan & Deci, 2004). It is a theory of human motivation, emotion and personality that has been under development for over 40 years (Vansteenkiste et al., 2010). It is widely used in several research domains such as education, organisations, sport and physical activity, and health and medicine (Vansteenkiste et al., 2010). To our knowledge SDT has been used rarely in agricultural contexts: Stobbelaar et al. (2009) researched the internalisation of agri-environmental policies and the role of institutions; Zhu and Yang (2012) investigated farmer motivations for participation in publicly funded training programmes in China; and Zepeda et al. (2013) studied CSA membership and psychological needs fulfilment using SDT. These few examples of SDT used in agricultural contexts show the innovative character of our research.

SDT consists of five mini-theories and different concepts (Vansteenkiste et al., 2010). For the purpose of our paper we will focus on only three closely linked basic concepts of SDT: the self-determination continuum; internalisation; and basic needs. These are explained in the following paragraphs, using fictional examples of our study object (farmer participation in SFIs).

**Motivations**

Motivations to participate in SFIs can be very diverse or even multiple. Farmers may engage in SFIs because they value specific characteristics in an SFI, e.g. social contact, working on sustainable development, business opportunities. In our paper we call these motivation themes.

Besides the motivation theme, motivations can be further distinguished by the motivation type. Motivations are often subdivided into intrinsic and extrinsic motivations. When intrinsically motivated, people perform an activity or engage in behaviour because they enjoy what they are doing. The activity itself, not the outcomes, act as an incentive (Barbuto & Scholl, 1998) and therefore people engage in autonomous and self-determined behaviour. For example, a farmer decides to participate in an SFI because he enjoys exchanging ideas with colleagues.

However, the majority of behaviours in which people engage are not inherently interesting or enjoyable (Ryan & Deci, 2000). In this case the performance of the activity itself does not give satisfaction (i.e. intrinsic behaviour), and therefore behavioural engagement requires external forces to motivate behaviour (Vansteenkiste et al., 2010; Zepeda et al., 2013). This is called extrinsic motivation.
Extrinsic motivation is a main focus of SDT, and SDT developed a framework for nuanced investigation of extrinsic motivation, comprising: (i) a continuum distinguishing different extrinsic motivation types; and (ii) a frame for investigation of the impact of context factors on these extrinsic motivation types.

**Self-determination continuum**

According to SDT, extrinsic motivation can vary significantly in its relative autonomy (Ryan & Deci, 2000). For example (based on Ryan & Deci, 2000), farmers can participate in an SFI because they personally endorse the value of sustainable farming or because they feel their consumers want them to work sustainably. Both are examples of external motivation because the outcome of their behaviour (in this case participation) is pursued. However, the first is accompanied by higher relative autonomy than the latter. So extrinsic motivation will be experienced as autonomous and volitional when people concur with the reason for their behaviour (e.g. participation in an SFI) and have fully endorsed the personal value and significance of the behaviour (Vansteenkiste et al., 2010). To specify these differences in the degree of relative autonomy, a self-determination continuum with different types of extrinsic motivation was developed (Figure 1) (Ryan & Deci, 2000).

In Figure 1, these nuances between motivation types are organised according to the degree to which motivations originate from the self. From left to right motivations are perceived as more autonomous (Ryan & Deci, 2000):

- **Amotivation**: a state of lacking the intention to act. People either do not act at all or act without intent and just go through the motions (Deci & Ryan, 2000).
- **External motivation** (Vansteenkiste et al., 2010):
  - **External regulation**: people are motivated to obtain a reward or to avoid punishment. The value of the behaviour has not been internalised and problems with maintenance and transfer of the behaviour to other settings occur. E.g. farmers participate in an SFI because they are promised better prices for their products.
  - **Introjected regulation**: people are motivated to comply with a partially internalised possibility to gain pride and self-esteem, or to avoid feelings of guilt and shame. This second type of extrinsic motivation only predicts short term persistence of the activity. E.g. farmers participate in an SFI because they feel their neighbours expect them to do so.
  - **Identified regulation**: people understand and endorse the personal value and significance of specific behaviour and, as a result, experience a sense of freedom in doing it. This third type of extrinsic motivation is guided by personal values and self-endorsed commitments. E.g. farmers participate in an SFI because they understand the importance of sustainable farming.
  - **Integrated regulation**: involves the assimilation of identified values and goals and the alignment of those identifications with other aspects of the self. This process requires considerable effort, reflection and self-awareness. Integrated regulation does not become intrinsic motivation, but is still considered extrinsic motivation because the motivation is characterised not by the person being interested in the activity but rather by the activity being instrumentally important for personal goals (Gagné & Deci, 2005). E.g. farmers participate in an SFI because they have been interested in sustainability since they were young.
Intrinsic motivation: people are motivated to perform work or engage in behaviour because they enjoy it (Barbuto & Scholl, 1998). According to Deci & Ryan (2000) intrinsic motivation is the prototypic manifestation of human learning and creativity. E.g. farmers participate in an SFI because they enjoy working on sustainable farming.

In this theory an important distinction is made between autonomous and controlled motivation. Motivational types are attributed to autonomous motivation when behaviour is accompanied with feelings of volition and psychological freedom. In this case people stand behind their behaviour because of their interests and values (Ryan & Deci, 2000). They perceive internal reasons for their behaviour (i.e. internal locus of causality) and endorse the values of their behaviour. Besides intrinsic motivation, which is inherently autonomous, identified and integrated regulation can also be categorised as autonomous motivation. Contrary to this, controlled motivations are accompanied by feelings of pressure to think, feel or behave in particular ways. In this case people act for reasons external to the self (external locus of causality) (Ryan & Deci, 2000). In the SDT continuum, external regulation and introjected regulation are both forms of controlled motivation (Vansteenkiste et al. 2010).

The interesting thing about this distinction is that SDT associates more autonomous motivation with greater persistence, performance, social functioning and physical and psychological wellness compared to controlled motivation (Vansteenkiste et al., 2010). SDT also states that controlling factors might influence autonomous motivation negatively, in such a way that controlling external events (e.g. threat of punishment, deadlines, evaluation, competition, and surveillance) can even undermine intrinsic motivation (Vansteenkiste et al., 2010). These

Figure 1. Self-determination continuum (Adapted from: Gagné & Deci, 2005; Ryan & Deci, 2000; Vansteenkiste et al., 2010)

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controlling factors contribute to less cognitive flexibility, more shallow learning, less creativity and less positive emotional tone (Vansteenkiste et al., 2010). These important findings will be used to unravel the dynamics between farmer motivations to participate and a SFI’s design to foster sustainability. For example, a farmer might primarily have an integrated motivation to participate in an SFI, but if an initiative imposes too stringent rules for participation this might negatively affect this farmer’s motivation to participate.

**Internalisation**
A crucial process within SDT is internalisation. The four types of extrinsic motivation reflect different degrees to which the value or regulation of a requested behaviour is incorporated or internalised. So, internalisation refers to the incorporation of a value or regulation (Ryan & Deci, 2000). Subsequent integration is the personal transformation of this incorporated value or regulation, in a way that a person perceives as originating from him or herself. So, when people internalise and integrate regulations and values of an extrinsically motivated behaviour they will experience their behaviour as being more autonomous (Ryan & Deci, 2000). This is also shown in Figure 1. Interestingly SDT attributes an important role to this internalisation process for successful socialisation, in which socially important behaviours, that are not intrinsically motivated, are self-initiated and maintained. This means that when someone personally endorses societal norms and rules, it is more likely that he will follow them freely, even when controlling factors are absent (Vansteenkiste et al., 2010). Transposed to our research topic, this means that farmers will be more likely to engage in sustainable farming when they personally endorse the value of sustainable farming.

**Basic Needs**
Previous paragraphs showed the importance of autonomy for personal growth and optimal functioning. Across the years, SDT researchers have identified three universal (across age, gender and culture) innate psychological basic needs that have to be fulfilled for optimal functioning and personal growth (Deci & Ryan, 2000). Contexts that satisfy participant’s basic needs stimulate self-determinated motivations. Hence, fulfilment of the basic needs is required for intrinsic motivation and has a positive influence on the internalisation process (Vansteenkiste et al., 2010).

- The first need is autonomy. Autonomy satisfaction concurs with the experience of volition and psychological freedom, in which one experiences choice in and ownership of a behaviour (Vansteenkiste et al., 2010): the behaviour is perceived as emanating from the self. For example, an SFI participant experiences choice and freedom in the activities he engages in. In contrast, “Autonomy frustration involves feeling controlled through externally enforced or self-imposed pressures” (Chen et al., 2015).
- The second need is competence. Competence satisfaction “refers to feeling effective in one’s ongoing interactions with the social environment and experiencing opportunities to exercise and express one’s capacities” (Ryan & Deci, 2002). For example, an SFI participant experiences his ability to fulfil the initiative’s expectations. Competence frustration comes with “feelings of failure and doubts about one’s efficacy” (Chen et al., 2015).
- The third need is relatedness. Relatedness satisfaction concurs with experiences of reciprocal care and concern for important others (Vansteenkiste et al., 2010), and a sense of belongingness with individuals and one’s community (Ryan & Deci, 2002). For example, a SFI participant experiences a close connectedness with other
participants he values in the SFI. “Relatedness frustration involves the experience of relational exclusion and loneliness” (Chen et al., 2015).

These needs can be satisfied independently from each other, e.g. a farmer can feel free in his decisions while participating in an SFI (autonomy satisfaction), but can lack a feeling of reciprocal understanding with other participants (e.g. because the other participants have other beliefs and neglect his beliefs) (relatedness frustration).

Due to the importance of basic needs fulfilment for optimal functioning, presence of a basic need fulfilling context is a necessary prerequisite for self-determined motivations. Vansteenkiste et al. (2010) posit that “full internalisation is most likely to occur in social contexts that are autonomy-supportive (rather than controlling), competence supportive (rather than chaotic and demeaning), and relatedness supportive (rather than rejecting and withholding).” So analysis of SFIs regarding these characteristics allows us to elicit the dynamics that promote or hinder ‘high-quality’ motivation (i.e. more autonomous motivation) (Vansteenkiste et al., 2010).

**SDT and initiatives for sustainable farming: building hypotheses**

Based on these theoretical insights, we develop hypotheses about farmer motivations to participate in SFIs. We discern three main topics: the first concerns the reason for participation - why do farmers decide to participate?; the second concerns the persistence of one’s participation - does the motivation influence farmers’ participation persistence and how?; the third concerns the results of one’s participation in an SFI. The initiatives’ goal is to encourage farmers to adopt more sustainable farming practices. Does the motivation influence the outcomes regarding this goal?

**Reason for participation**

Although SFIs all serve the same goal, i.e. farmer’s adoption of sustainable farming practices, their means of accomplishing this can differ widely. Initiatives offer a variety of activities such as social learning groups with farmers, sustainability assessment tools or experience and knowledge exchange via field trips. Because of this variety, farmers can be motivated to participate in an SFI for a number of reasons (motivation themes), other than merely working on farm sustainability. Because a person’s behaviour can be affected by multiple motivation themes (De Young, 2000), farmers can participate in an initiative for multiple reasons.

**H1. Farmers can have multiple motivations to participate in an initiative.**

Previous studies with SDT have shown that people are more likely to engage in a behaviour if they perceive their motivation as more autonomous (Osbaldiston & Sheldon, 2003; Vansteenkiste et al., 2010). An autonomous motivation, contrary to external pressure, is also needed to stimulate people to take responsibility for their behaviour and the environmental health of the planet (Osbaldiston & Sheldon, 2003). Therefore we hypothesise that farmers who participate in SFIs for reasons that can be considered socially important, such as sustainability or environmental responsibility, will be autonomously motivated. Otherwise, we consider how more ego-centric reasons, such as benefits for their business or a craving for new knowledge, are related to autonomous or controlled motivations (Figure 2).

**H2. Farmers who primarily participate in initiatives because of sustainability, will be autonomously motivated.**
Participation persistence

Persistent farmer participation is important for an initiative’s success. The longer farmers participate, the more an initiative can contribute to their learning on sustainable farming. According to SDT, participation will be more persistent when a farmer’s decision to participate is perceived as more autonomous, provided that the initiative creates a context that supports the basic needs. Thus, an initiative will have greater growing opportunities, making it more successful, when a basic needs supportive environment is created (Figure 3). This also means that persistent farmer participation is likely to occur when the initiative provides the information and guidance needed for a farmer to pursue his farming goals.

H3. Autonomous motivations to participate are positively related to fulfilment of the basic needs.

H4. Fulfilment of the farmer’s basic needs results in more persistent farmer participation.

To accomplish a good functioning and trustworthy results, SFIs develop rules that have to be met by their participants. The less participants perceive the rules as a burden, the less likely they are to give up participation. Not all participants accept these rules easily and some struggle to meet them. We hypothesise that participants who are autonomously motivated to participate in an SFI, will show a higher acceptance of these rules (Figure 3).

H5. A more autonomous motivation results in higher acceptance of an initiative’s participation rules.
Participation results
Farmers initially might have motivations other than sustainable farming to participate in SFIs. However, the initiative’s goal in favour of sustainable farming presumes that participant motivations to work on sustainable farming will become more internalised with longer participation. To accomplish this, according to SDT, the initiative should provide a context that supports the basic needs (Figure 4).

H6. Internalisation with respect to sustainable development occurs when participants participate in the initiative for a longer time.
H7. Fulfilment of the basic needs results in an internalisation process with respect to sustainable development.
To achieve more sustainable behaviours by its participants, learning should be an essential element of SFIs (Loeber et al., 2007). To realise sustainable development in agriculture, transformative learning is necessary to change a farmer’s vision, strategy and farming practices (Lankester, 2013). The transformative learning theory differentiates domains of learning and reflection processes (Lankester, 2013): instrumental learning (task oriented, problem-solving actions to improve performance of current activities); communicative learning (ability of individuals to examine and reinterpolate meanings, intentions and values associated with actions and activities of others); and emancipatory learning (involves critical self-reflection and is often transformative, thus achieving change in meaning structures and perspectives (Blackmore, 2007)). To come to transformative learning, we posit that the motivation to work on sustainability has to be internalised. Since basic need satisfaction has a positive influence on the internalisation process (Vansteenkiste et al., 2010), and thus more autonomous motivations to participate, we argue that basic need satisfaction has a positive influence on communicative and transformative learning (Figure 5).

H8. A more autonomous motivation to participate for sustainability results in more communicative and transformative learning (on sustainability).

H9. Fulfilment of the basic needs are more likely to result in communicative and transformative learning (on sustainability).
Overview
Based on the formulated hypotheses, different concepts need to be measured. Table 1 gives an overview of the relevant concepts per hypothesis group, the relations between them and the sign that can be attributed to them.
Table 1. Overview of the hypothesis groups.

<table>
<thead>
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<th>Hypothesis group</th>
<th>Concepts</th>
<th>Relations</th>
<th>Sign</th>
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<td>Participation motive</td>
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<td>Socially important motive &gt; autonomous initial motivation +</td>
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<td>Socially important motive &gt; controlled initial motivation -</td>
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<td>Ego-centric intended goal &gt; autonomous initial motivation ?</td>
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<td></td>
<td>Ego-centric intended goal &gt; controlled initial motivation ?</td>
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</tr>
<tr>
<td>Participation persistence</td>
<td>Initial motivation type (autonomous vs. controlled) Basic needs fulfilment Rules acceptance Period of participation</td>
<td>Needs fulfilment &gt; period of participation +</td>
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<tr>
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<td></td>
<td>Needs fulfilment &gt; autonomous current motivation +</td>
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<td></td>
<td></td>
<td>Needs fulfilment &gt; controlled current motivation -</td>
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<tr>
<td></td>
<td></td>
<td>No needs fulfilment &gt; period of participation -</td>
<td></td>
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<td></td>
<td></td>
<td>No needs fulfilment &gt; controlled current motivation +</td>
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<td></td>
<td>No needs fulfilment &gt; autonomous current motivation -</td>
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<td></td>
<td></td>
<td>Autonomous current motivation &gt; rules are no burden &gt; period of participation +</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Controlled current motivation &gt; rules are burden &gt; period of participation +</td>
<td></td>
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<tr>
<td>Participation results – Internalisation</td>
<td>Initial motivation type (autonomous vs. controlled) Current motivation type (autonomous vs. controlled) Internalisation (more autonomous current motivation) Basic needs fulfilment Period of participation</td>
<td>Autonomous initial motivation &gt; more autonomous current motivation ?</td>
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<td></td>
<td>Controlled initial motivation &gt; autonomous current motivation ?</td>
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<td>Period of participation &gt; internalisation +</td>
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<td>Participation results – Learning on sustainability</td>
<td>Current motivation type (autonomous vs. controlled)</td>
<td>Autonomous motivation &gt; instrumental, communicative and emancipatory learning</td>
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<td>Implementation of sustainable practices</td>
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Methodology to test the hypotheses

In the following paragraphs we propose a mixed methods approach to test the hypotheses. The approach can be used in any or multiple SFIs. In our qual-QUAN design (Creswell, 2003; Teddlie & Tashakkori, 2009), we first use qualitative research to test our first hypothesis H1. These results are used as input for the quantitative research step, in which the other hypotheses will be tested.

Qualitative research step

The first step encompasses a qualitative research approach to gain insights into farmer motivations to participate in SFIs (H1). For data acquisition, several sources such as interviews with participants and SFI organisers, field notes, reports and scientific literature can be used. Coding of these sources on the reported motivations for participation is twofold: first, reported motivations should be coded according to motivation themes e.g. working on sustainable development, knowledge exchange; and second, they should be coded according to the motivation types of the SDT continuum.

Quantitative research step

Testing the other hypotheses (H2 – H9) includes the distribution of a survey amongst participating farmers in an SFI. Based on the concepts used in our hypotheses, the survey consists of five main parts:

A first part gathers information about the farmer’s participation in an SFI (e.g. since when has he participated?);

A second part asks about their motivations for initial and current participation. Based on the input of the qualitative research step, several Likert type items can be constructed testing both motivation themes and types. To obtain data about possible internalisation processes, farmers should answer how much they agree with the items, regarding both their initial decision to participate and their current decision to stay participating;

A third part, asks participants about their experiences with the initiative - who they value most, what they have learned since their participation (based on the distinction between instrumental, communicative and emancipated learning as described by Lankester (2013)), if they have already implemented new knowledge and skills on their farms, and how they perceive the initiative’s participation rules;

A fourth part tests the farmers' basic needs fulfilment in the SFI using twenty Likert type items. The items of the “Basic psychological needs and frustration scale for physical education” developed by Haerens et al. (2015) can be adjusted to the SFI context;

The fifth part of the survey can be used to ask general questions about the respondent, such as their residence, education, birth year, membership of other study groups etc.

Statistical analysis of the survey results will test our hypotheses.

Case: Foundation Skylark

We distributed a survey amongst all farmers participating in the SFI “Foundation Skylark”. It is a successful Dutch knowledge exchange network of arable farmers and their supply chain partners that started in 2002. Their aim is to establish on-farm sustainable development and
facilitate the development of sustainable arable food chains. Currently, more than 400 farmers, 25 chain partners and 15 advisory firms are involved. So far we have retrieved answers from 96 respondents, of which 74 completed the whole survey. The results will be used to test our hypotheses.

**Conclusion**

Literature on factors influencing participation in SFIs lack insight into farmers' psychological motivations to participate. However, research on the dynamic interaction between an initiative’s design, farmer motivations to participate and farmer motivations to contribute to sustainable farming can offer valuable information for organisers of SFIs. To grasp these dynamics, nine hypotheses were developed using self-determination theory (SDT). Three basic concepts of SDT (SDT continuum, internalisation and basic needs) proved to be valuable to focus our research. Based on our hypotheses, we developed a methodology to test them in SFI cases. However, this methodology has yet to be tested on case studies to prove its usefulness.
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Cooperation between farmers in feed production and use of manure

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Abstract: The objective of the research project was to explain the benefits or advantages of cooperation in manure management and feed production from the point of view of the agricultural entrepreneur and also describe the (strategic) significance/relevance of these cooperation forms for the whole farm business. The role of risk in land management and various innovative approaches regarding mutual cooperation and the importance of trust and commitment was explored. The theoretical background is based on the theory of strategic management on farms as well as resource based theory. Semi-structured interviews with eight farmers were carried out in the northern Savo region in eastern Finland in March-September 2015. The interview transcripts were categorised by conventional and directed content analysis. The cooperation between crop and animal husbandry farmers could be classified in various categories of looser and closer strategic cooperation. Benefits mentioned were partly clear economic benefits like reduction of costs and savings in labour time, but also a range of benefits not explicitly economic such as guaranteed deposition of produce. Access to organic nutrients as well as access to farm land for manure spreading, better crop yields, better crop rotation and land management were other direct benefits mentioned. Economic benefits could be divided between short-run (one year or less) and long-run (5-10 year) benefits. Farmers mentioned trust in one another and good personal relationships as particular conditions for cooperation, which was also obvious from the lack of written contracts. Cooperation was mainly regarded as reducing risks even though in three cases it was seen as involving risks. Commitments varied from mutual cooperative arrangements to quite concrete short-run practical arrangements which can be categorised according to two axes: organisational bonds and managerial bonds. Themes which clearly emerged from the interviews were long-term goals and understanding of the operational environment as well as the competitive factors arising from farm resources.

Keywords: Cooperation, networks, farms, strategic management, trust, risk, manure, feed

Management and leadership of farms in changing environment

In order to better analyse the operational environment of a farm enterprise, a division is made between internal and external operational environment. The external operational environment consists of forces that “are considering the decision-making and actions of a farm enterprise” (Haapanen et al., 2004). This refers to clients, business partners, competitors and other external factors. The latter includes matters affecting national economy, political decisions, technological improvement, environment and nature. Daft (1997, p. 75) further divides the external operational environment into two: the primary external environment consists of the indirect social, demographical and economical forces affecting the enterprise; and the direct external environment of the competitors, suppliers and clients of an enterprise.
The Common Agricultural Policy (CAP) is part of the external operational environment. The emphasis of CAP is moving from farm support with interventions and restrictions on production to de-coupled subsidies and setting environmental obligations to farmers (Niemi et al., 2014). At the beginning of new Rural Development Policy period the greening element, meaning stricter environmental guidelines as a condition for subsidies, has also gained more importance (ibid). The milk quotas as a restriction of production have ceased to exist from the beginning of 2015 (European Commission 2009). These actions mentioned above can be considered to reduce the restrictions on production and competition and also to liberate the operational environment of farm enterprises.

Society also appears to have an interest in environmental conditions and handling of nutrients in primary production. The Finnish Government has made a commitment to achieve a good environmental state of the Finnish Archipelago Sea and this is carried out by improving the nutrient recycling efficiency by using the tools of the current Rural Development Programme. The aim is to be a model country of nutrient recycling by the year 2020. (Ministry of Agriculture and Forestry, 2015) In recent research of consumer preferences the environmental effects and sustainability of food production have also been noted (Peltoniemi & Yrjölä, 2012; Latvala & Koistinen, 2012; Heikkurinen et al., 2012).

The increasing market dependency and removing the control mechanisms of production can be seen as a challenge for Finnish agriculture. The external operational environment has become more unpredictable. A recent example of this development is the crisis in Ukraine and the harsh effect of Russian counter sanctions on the Finnish food industry market, and especially on milk production: the producer price of milk in October 2015 was 14 percent lower than in October 2014 (Luke, 2015).

The Finnish food market is part of the international food markets. An individual farm enterprise is a price taker, i.e. it cannot determine the price of its product (Sipiläinen et al., 2012), but it can try to modify the cost structure of production techniques and business partners on the horizontal level (Laitila et al., 2014). Direct business to consumer marketing changes the position an individual company has regarding the price levels, but it is still rare in the Finnish food market (Luke, 2014).

**Strategic management and resource-based view**

"Strategy is not a detailed plan or program of instructions; it is a unifying theme that gives coherence and direction to the actions and decisions of an individual or an organisation." Although Grant (2002, p.4) above considers that strategy is not a detailed instruction programme, it can be described in a certain framework. The cornerstones of a strategy are long-term, mutually agreed-on goals, in-depth understanding of operational environment and competitors, and analysis of resources in use. A successful strategy is always put into practice (Grant, 2002 p.4). Strategy tells us which way is chosen and how value is being created. (Miles & Snow, 2005). The concept of strategy is not unequivocal: according to Mintzberg (1987) strategy can be described as a plan, ploy, pattern, position and perspective.

Out of Mintzberg’s (1987) classifications in particular, strategy as a position is useful for our purpose. Position is a company’s place in its environment, so strategic positioning is the linkage between internal and external operational environment (Mintzberg, 1987, ref. Hofer & Schendel, 1978 p.4). In the farm enterprise case, strategy is crystallised by combining the
production factors in an economically optimal (most profitable) way. This assumption is rooted in the fact that the fixed production factors used in agricultural production cannot be acquired quickly and with low cost. If a farm does not possess all production factors it needs for profitable production, it will most likely try to get access to them on its own or with business partners.

Resource can refer to anything which can be a strength or weakness to a firm (Wernerfelt, 1984). Tangible objects such as land and production facilities are resources as are also intangible information-based concepts like know-how and organisational culture (Itami & Roehl, 1991). The resource-based view can be thought of as strategic resources scattered unequally to firms, which can reach competitive advantage by following a strategy exploiting internal strengths and avoiding internal weaknesses and external threats (Barney, 1991).

Understanding the meaning of resources and exploiting earlier unconscious resources are challenges for management and leadership. Itami and Roehl (1991, pp.12-13) describe intangible resources as a true source of competitive advantage and ability to adapt. Intangible resources are mostly difficult to access, they can be used for many purposes simultaneously and they can be both inputs and outputs in production processes.

Controlling intangible resources as the competitive advantage’s starting point is the base of a resource-based view (Barney, 1991). In the case of farm enterprises the use of resource-based theory in monitoring strategic choices of entrepreneurs can be based on the non-transformable and unmoving nature of such basic elements of internal operational environment as fields, other land and their location. The form of tangible resources is unique in every farm. The internal infrastructure of a farm in the form of field locations in relation to buildings, routes and water resources can either give good possibilities to operate as a single farm or push the farm to exploit its networks and to co-operate with other farms to control machinery costs. Also Inderhees and Theuvsen (2009, p. 256) look at strategy from this viewpoint. Although the tangible resources are easily noticed, the intangible resources also play their role in the operational environment. The know-how the entrepreneur and the paid workers have and their way of communicating and operating are also the base of the strategy work a farm enterprise is executing. One long-term strategy can be co-operating with other entrepreneurs to control or reach competitive advantage relative to other farm entrepreneurs operating in the same area.

Minimising costs while being mostly price taker in product selling is the basis for fitting farm enterprises into cost leadership strategy followers. When a farm enterprise is producing and selling special niche products to consumers (or retailing) it can be described as a differentiating strategy (Laitila et al., 2014). Fulfilling the demand for quality of the food industry is the unavoidable basis for a farm producing unspecified milk, meat or grain products. The scale of enterprise is also smaller than that of an ordinary industry company aiming towards cost minimisation. Without creating a comprehensive definition of cost efficiency (for example Harju & Koivukoski, 2014; Laitila et al., 2012; Mäkijärvi, 2012), it is said to be better applicable to farm enterprises when compared to pure cost minimising strategy (Vihtonen, 2007 p.11).
Classification systems for networks from earlier research

Farms that are cooperating with each other can be classified in many different ways. Laitila et al. (2014) classify the farm according to Figure 1.

According to Ryhänen and Laitila (2014) the cooperation can be classified on a scale of increasing cooperation from help and learning from neighbours to common property, exchange of work, mutual contract work, outsourcing, common shares of a unit and a common unit.

Vesalainen and Asikainen (1993) classify the firms in the SME sector according to a purchaser-buyer relation, agreement (e.g. agency, licence, franchising or outsourcing), exchange of resources, common use of resources, joint venture and acquisition or fusion of firms.

Varamäki (2001) and Varamäki and Vesalainen (2003) as well as Hakanen et al. (2007) use the classification presented in Figure 2.

A development ring as presented in Figure 2 is a free forum for exchanges of information and interaction. A cooperation ring is a further development of the development ring where a
common resource has been acquired and to which the members have a right of use. The aim of a project group is to improve the strategical comparative advantage of the members or to reduce transaction costs. A common enterprise is a further integration of cooperation where a common business has been developed while members maintain their own business strategy. A common unit finally merges the business strategies of the members.

A common strategy can also be evaluated with the evaluation criteria (elements and ties) developed by Vesalainen (2002) presented in Figure 3.

![Figure 3. Elements in relations between firms](Adapted after Vesalainen (2002))

The organisational ties in Figure 3 are both structural and social. Thus, in the criteria used by Vesalainen the social commitment is also observed. Business ties and commitment divides into exchange of good and services on the one hand and strategical significance on the other. Strategic ties may be based on specialisation and complementary skills while the strategical goals are the same according to Vesalainen. The development from a market-based relationship to a partnership is illustrated in Figure 4.
Market-based relationships are based on physical exchange of goods. Relationships based on increasing interaction differ in that the dependence based on social ties and trust are more developed. The deepest form of cooperation is based on ties where all core functions and work have become common for the cooperating parts.

**Aim of the present study**

The aim of this study was to understand cooperation between farmers from the point of the entrepreneur and to find some regularities in the forms of cooperation between farmers. A specific aim was to investigate what significance the particular co-operation had for each farm size and what kind of costs and benefits arise from this cooperation. This aim was realised through a set of more specific questions:

- What is the history and current state of cooperation at the moment?
- Which are the main goals of the farmers for cooperation?
- What kind of management means do the interviewed farmers mention?
- How do the farmers experience their benefit from cooperation?
- What has been agreed on and how do farmers explain commitment to cooperation as well as the risks arising from it?
- What kind of pricing models and models for cost distribution and practical division of tasks do the farmers mention?
- What is the strategical significance of cooperation?
What kind of future plans, plans for development and needs have been created through cooperation networks and how has the cooperation evolved?

Outline of the study
This qualitative study was carried out as a multi-case study through eight theme interviews. The interviews were all carried out in North Savo region, Eastern Finland. Regional restriction was made to ensure an equal environment of activities for all interviewed entrepreneurs.

The study was supported by local rural consultant organisation, ProAgria North Savo. Support was given in the form of a list of names of potential entrepreneurs. Contact was made by the researcher. The interviewed entrepreneurs were chosen purely by the cooperation form they were practising, not by the economical or physical size of farms or by the intensity of their production. The interviews were iterated by exact words except when some family members interjected. The interviews gave saturation (i.e. same observations started repeating themselves) (Hirsjärvi, 1997 p.171). The number of investigated networks was six whereas eight interviews were carried out.

The material has been classified into tables partly based on the repetition of observations, partly based on earlier theory. Both conventional and directed content analysis was applied according to the definition of Hsieh and Shannon (2005)

Ways of leadership, types of cooperation and agreements have been based on earlier investigations. The depth of cooperation is based on scales developed by Laitila et al. (2014), Hakanen et al. (2007) and Vesalainen (2002).

The eight interviews were not carried out with farmers participating in similar forms of cooperation. A deeper examination of cooperation could have been possible if the study had been limited to partners of only one network

Results

The current situation of the cooperation
The ongoing cooperation form was for five interviewees cooperation between a cattle and a grain farm. This kind of cooperation included selling grain, smashed grain, hay or silage, and also using cattle manure for the grain farm’s fields. Two interviewed entrepreneurs also had plans concerning cooperation in manure use but currently cooperated only by buying feed for cattle from a grain farm. One interviewed entrepreneur had recently reduced the intensity of cooperation and it included only selling grain and renting fields to a cattle farm.

The common nominator for all eight interviewed entrepreneurs was the complex network of cooperation relationships. The most important cooperation form included also paying work with work, buying labour or selling it to a cooperation partner. Cooperation was also practised with other, less important partners. Four entrepreneurs had machinery or buildings owned together with other farmers. All interviewed had also former experience with cooperation but the importance of the former cooperation form varied.

The initiative for cooperation between farms was taken in four cases from a cattle farm. The other four entrepreneurs did not clearly indicate the initiative. The need for additional resources for the cattle farm such as more fields to use cattle manure or to ensure feeding
when production was expanded was the reason for the initiative. Two more entrepreneurs had also sought cooperation relationship because of lack of labour resources.

The duration of cooperation relationship was under three years in five cases, which included both feed production and manure use. The duration of the cooperation for the other three interviewed entrepreneurs was over three years, and in one of these cases the parents of the current owner were already practising some kind of cooperation with the same partner. The distance between cooperative farms was most commonly under 15 kilometres.

The goals of the activities according to the farmers

The interviewed entrepreneurs named from one to three main goals of their business. Both economical and non-economic goals were named by three entrepreneurs, two entrepreneurs named only economical goals to their business and the last two named only non-economical, production orientated goals.

Five of eight interviewed entrepreneurs named economic success or improving their financial situation as a main goal for their business. Economic success was sited for example as: a goal to achieve an adequate level of income for two adult persons; a goal to make profit; or as efficiency goals, which result in increasing profits or decreasing costs. An efficiency goal was for example lower feeding costs compared to other possibilities of acquiring feed. Most of the farm enterprises claiming economic goals were practising animal husbandry.

Five interviewed entrepreneurs named developing crop production as the main goal for their business. Goals in this category were named as a product with good quality, high yield, and diversification of land use and taking care of the environment. It is possible and perhaps even likely that economic goals can be set behind these production-oriented goals, but in this study economic goals were only directly named as economic by the interviewed person (see Figure 5).

Figure 5. Main goal of the farm enterprise according to the farmer
The data in this study supported the assumption of former research: farm enterprises having both economic and non-economic goals. The latter category would for example cover situations where the main reason for practising agriculture is the chance to have a rural lifestyle or work without given working hours, not to make economic profit. In this study the goals varied slightly according to the cattle or non-cattle status of the farm.

**Leading and managing the business**

The interviewed entrepreneurs were asked to describe their financial management practices. Making calculations and analysing them especially when the company is in the investing phase has in some earlier research been connected to the economic success or efficiency of the farm enterprise (Puig-Junoy & Argiles, 2004). Thorough control of the economic state of the farm has been seen as being useful for the entrepreneur (Harrison, 2006). Personality and competencies of an individual entrepreneur have also been weighted, when exploring the connection between the practices of financial management in use and the economic success (Mäkinen, 2013; Öhlmer & Lönnstedt, 2004; Tarabla & Dodd, 1990).

In the interviews of this study, the practices of financial management were not listed for the interviewed entrepreneurs: they named and described them autonomously. This style of questioning could have led to a situation in which the interviewed person did not list all the actual practices, if some of them were completely intuitive and non-conscious and therefore difficult to describe.

The interviewed entrepreneurs named spontaneously from one to five practices or tools for financial management. Altogether nine tools or practices were named. Three from nine named practices were actually announcements which were demanded from the entrepreneur by the officials: bookkeeping, applying for monetary subsidies for agriculture and making the annual tax return. These practices could not be considered purely as activities carried out of free will. Despite this, planning the application for subsidies and taxation can have concrete results in terms of turnover and economic success of a farm.

Other mentioned practices of financial management were budgeting, analysing the last year from an economic perspective, following the actions in the farm’s bank account, payback methods and margin calculation. Analysing the last complete year, competing tax returns, creating a long-term cash-flow sheet and applying for subsidies were most commonly bought in as services from a consultant.

Earlier research has concluded that the entrepreneur’s view of the economic situation of the farm enterprise is more optimistic than the common key ratios used in research and that the assumptions are based on short-term cash-flow projections (Mäkinen et al., 2009). Three of the eight entrepreneurs in this study named only practices of short-term financial management and five of the eight named both short-term and long-term practices. From these five, four entrepreneurs also mentioned long-term or medium-term economic planning, and discussion from a production-based point of view was included in which the cooperation activities were included. Four out of five interviewed who named long-term financial management practices had also named economic success as a main goal for their enterprise. From these four entrepreneurs one had only crop production. Analysing the last full year from an economic perspective, payback time calculations, long-term cash-flow projections and applying for monetary agricultural subsidies were classified as long term practices or tools in this study.
The last one was counted as a long-term practice because in the beginning of the new Rural Programme season entrepreneurs make decisions which cover the whole five-year programme period.

How do the farmers perceive benefits of cooperation?
The interviewed entrepreneurs perceived that they received several different advantages through cooperating with other farmers. Three out of eight interviewed persons named at least two different advantages. Direct financial advantage, meaning decreased costs based on increased efficiency, increased profits or time advantage was mentioned altogether by six interviewed entrepreneurs. Time advantage was named by three interviewees, where the labour input of the entrepreneur was not sufficient to fill all the labour demands of the farm enterprise, and the entrepreneur needed to obtain the missing amount of input by outsourcing or cooperation. These experiences of advantage achieved by cooperation were in connection to the earlier study, in which one of the advantage bundles of cooperation were actions which were extremely seasonal (like silage making) and in which the demand for labour input was over the normal level (Laitila et al., 2014).

Another group of advantages included the possibilities for improving crop production. Three entrepreneurs of crop farms named as advantages the positive effect the cattle manure has on soil structure and the abilities the cattle manure has as a supplement for industrially produced fertilisers. One of these three also mentioned the possibilities cooperation provides to improve monoculture on the field as an advantage.

The indirect advantages were discussed by four interviewed entrepreneurs. These advantages were described as remarkable in terms of the direct financial advantage or saved labour input gained through cooperation. One interviewed had difficulties with describing the advantages gained through cooperation at all. Altogether the advantage of cooperation seemed to consist of monetary or temporal share and less perceptible, non-monetary or option-shaped share. The total monetary value of cooperation was therefore not unequivocally represented but could also include possibilities which were not yet exploited.

There was a connection between the economic success and the advantage experienced through cooperation: the three entrepreneurs who named economic success as a main goal for their business also named cost savings or improved efficiency of production as the advantage of cooperation. In this were included the entrepreneurs who named time advantage as an advantage. Besides this, the five entrepreneurs who named quality of the product, high yield, taking care of the environment or avoiding monoculture in crop production as a main goal, described guaranteed market for their product, nutrients in manure or diversifying crop production as advantages gained through cooperation.

Strategic importance of practised cooperation forms
The importance of cooperation form was analysed in this study through paying attention to comments about risk, trust and commitment. Cooperation classifications from Vesalainen and Varamäki were then applied to cooperation forms found in this study.

Three of the eight interviewed entrepreneurs saw that practicing cooperation with other farms included risk. One of these was a cattle farm and two were crop farms. On the other hand, the
other two entrepreneurs of crop farms described the cooperation precisely with this partner as not including risk or including only marginal amounts of risk.

The main conclusion concerning risk is that seven out of eight entrepreneurs described cooperation with other farms as an element reducing the total risk of their business. The risk-decreasing effect of cooperation was, according to the entrepreneurs, based on the increased leeway on land use and optimising crop choices for their own fields. The burden of on-field activities was partly taken by the cooperation partner or the extra land in use through cooperation helped in following the environmental guidelines the entrepreneur was pledged to when applying agricultural subsidies. The existence of networks was also a safety net which secured the farms ability to function normally when abnormal, unpredictable situations occur.

The level of commitment to the cooperation was described by seven out of eight entrepreneurs. The discussion of the meaning of the cooperation also included inconsistency. When asked, the practised cooperation form was described as binding both partners, although there was no written contract of the cooperation or the contract was only made when some officials demanded it. In two cases the interviewed entrepreneur first heavily weighted the independent position of his/her farm and then admitted the importance of the practised cooperation for controlling the farm entity. For example, one entrepreneur first described the non-strategic nature of the cooperation, then underlined the binding nature of an oral contract, and finally reported that actually having cooperation partners was obligatory for him as he could not manage all the labour his farm needed by himself. Another entrepreneur also underlined his independent state, despite the fact that half of the production of one of the most important inputs was in the hands of his cooperation partners. The experiences of risk in cooperation could be affected by the business partners’ commitment to the cooperation form. If commitment is weak, it is easier to describe the total effect of practising cooperation as risk-minimising.

Trust in present cooperation partners as individuals was highlighted. Four entrepreneurs mentioned that in particular with the current partner the cooperation could be done without a written contract, because the partner as a person was reliable. As a basic condition for cooperation all eight interviewed entrepreneurs mentioned the meaning of mutual trust and compatible mind-sets. These prerequisites for successful cooperation are also noticed in earlier research (Laitila et al., 2014).

There was variation in the pricing methods used in inter-partner transactions between eight cases when selling and buying grain or other feed. Five interviewed entrepreneurs reported that they used the current price on the day, one that the price on the day was fixed individually if one partner used others’ storing capacity. In two cases out of these five, grain drying was part of the cooperation, and in these cases the price on the day for drying was also taken into account.

According to other three interviews which covered two separate cooperation forms the regional price on the day was only a starting point. It was the basis for long term price agreement between partners or a value on which all the different deliveries were taken into account and then the actual price was calculated.

Figure 6 represents the description from Vesalainen (2002) of strategic linkages in cooperation. The six arrows are the six cooperation forms discussed in eight interviews in this
study. The perspective of cooperation networks and nature of cooperation Vesalainen has fits when studying farm enterprises. It recognises the typical social linkages and personal ties of small enterprises and also tangible and intangible resources, of which the possibilities of land use in particular are important to farm entrepreneurs.

Figure 6. Types of cooperation in the material according to the discussions with the farmer-entrepreneurs. (Adapted according to Hakanen et al., 2007)

Five interviewed entrepreneurs represented three different cooperation relationships, which all included cooperation both in feed production and manure use. These five interviews included most of the sequences describing interactive business relations. This is illustrated in Figure 6 by the position of three flashes positioned most far away from the origin. These types of cooperation had most interaction based on social ties and trust. More interactive business relations than markets based relations were found in these relations. They included some logistic services in addition to supply of material. Increasing recognition of the mutual benefits of cooperation were found in these relations. Also common systems of measurement, learning and developing together were reinforced in these relationships. The rest of the cooperation relations covered selling or buying of roughage and exchange of labour. They could be called marked-based cooperation relations. Partnership should include risk-taking together as well as some more core functions than existed in the material. Willingness to deepen the forms of cooperation was anyhow recorded. Table 1 expresses this observation.

In three of the interviews there were two relations of cooperation which included clear price definition of the mutual cooperation - individually designed pricing. These three interviewees
expressed their willingness to deepen the cooperation. Typically for them, in addition to the marked-based price for cooperation the farmers also took into account the use of storage or services carried out like drainage. The other three which were not interested in deepening the cooperation only had market prices as a base for their pricing of cooperation.

Table 1. Forms of pricing in relation to willingness to deepen cooperation.

<table>
<thead>
<tr>
<th>Basis of pricing calculation</th>
<th>Future plans for cooperation</th>
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<tbody>
<tr>
<td>Market price (3)</td>
<td>– no notice of deepening current forms of cooperation</td>
</tr>
<tr>
<td>Market price and services (2)</td>
<td>– notice of potential deepening of cooperation</td>
</tr>
<tr>
<td>Individually defined pricing (3)</td>
<td>– clear notice of potential future deepening of cooperation</td>
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</table>

Discussion and conclusions
Long term objectives, understanding of the operating environment and the competitive situation, as well as the resources and goals of the firm, are the basis of strategic planning (Grant, 2002 p. 4). These factors arose as central out of this study in spite of a small sample of interviewed farmers. Because of the small sample no generalisations can be made but some of the themes which were central could form a basis for comparison with earlier studies.

Farmers thought the benefits of cooperation mainly consisted of reduction of production costs or the improvement of production processes. Farmers mentioning a high quality product, a good yield or an improvement of crop rotation as main goals of cooperation were mostly crop production farms. They often saw cooperation as a potential possibility rather than purely a means of cost reduction. The benefits from cooperation and the main goal of the business seem to be consistent. Cooperation is often seen as a way to acquire a missing resource.

The basis of the benefits of cooperation was often said to be cost reduction. This was particularly the case if costs of transport reduced as a result of developing working practices between partners and if external inputs purchased outside cooperation could be reduced and if the cooperation does not increase other costs or decreases the returns. Two animal farms saw the benefits arising from the point of view of crop production farms. However, they also saw some indirect benefits arising like the potentially positive effects of doing things together.

There were some indications of cooperation moving to a more strategic direction. However, there was also an increasing unwillingness to formalise a personal commitment of trust through a written contract. The interviewees saw formalised written contracts as unnecessary. This probably is a consequence of earlier social networks or a personal relationship with the other partner (Gulati, 1998). However, written contracts could be a way to evaluate more carefully the benefits of cooperation. When the benefits and the opportunity costs of one’s own actions are better recognised it should also be clear if one can commit oneself to a formal
written contract (Bogetoft & Ballebye, 2002). If the opportunity costs are unknown an oral agreement may feel like a less risky alternative.

The structural development of agriculture has been forecast to continue. For expanding animal farms new cooperation partners can be found from former animal farms used to using manure as an organic nutrient. While farm size is increasing also the size of the cooperation and the risks connected to this cooperation can be regarded as increasing. A written, formal agreement can be considered one way of controlling such a risk.

In regions dominated by animal production, cooperation with crop husbandry farms will to some degree make it easier to take care of the manure in a more balanced way. Technological change maybe makes it possible in the future to cooperate with farms situated further away. In this case the requirements on cooperation and on the principles defined between cooperating partners will increase in order to make this cooperation economically sensible.

Further research on this area could focus more in depth on all the members in a particular network and their points of view.
References


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