School of **Sustainable Food and Farming**

Project title: Nitrogen removal and recovery from animal slurries for fertiliser application

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Project overview:

The application of animal slurries to land is facing ever increasing regulatory constraints, with the aim to reduce the oversupply of nutrients to crops that can then leach into watercourses (nitrates (NO_3^-)) or be released into the atmosphere (ammonia (NH_3) and nitrous oxide (N_2O)). Up to 29% of the ammoniacal nitrogen (NH_3-N) of slurry is lost to the environment during soil application, which can contribute to soil acidification, reduced soil quality and eutrophication of waterways. To reduce these nitrogen losses, nitrogen can be extracted from slurry in a more concentrated form to improve the efficiency of slurry application for crop nutrient provision.

Biochar is a by-product produced from the pyrolysis process and previous research has shown some biochars to be effective filters at removing nutrients from wastewaters. The nutrient-rich biochar could then be applied to the soil to provide crop nutrients. Alternatively, reverse osmosis (RO) is a process of membrane filtration, separating nutrients into one fraction and producing a second water fraction from the slurry. However, the high solids content of the slurry can block the membranes and have limited their use.

This short feasibility study investigated the use of filters to allow for the selective removal of nitrogen from slurries at farm-scale, using technology that could be retrofitted to existing slurries systems. This project compared the efficacy of nitrogen removal and recovery of using different biochar types and filter membranes to remove nitrogen.

Research outcomes:

Four experiments were undertaken with cattle slurry previously treated with Elentec Ltd's electrocoagulation technology to remove phosphorous from the slurry. The resulting low phosphorous slurry was then used to recover nitrogen from this slurry. Overall, the results from the biochar filter trials were variable at retaining total nitrogen within the biochar filter, with results varying from 10-52% sorption of total nitrogen from the slurry into the biochar filter.

The RO technology was effective at extracting water from the slurry and concentrating the total nitrogen within the nutrient-rich fraction that could be used for land application to provide nitrogen to growing crops. Sub-samples of the nutrient-rich fraction and extracted water fraction were taken at set timepoints of the experiment when 20%, 40%, 60% and 80% volume of water had been extracted from the slurry. The nutrient-rich and extracted water fractions at the different sampling timepoints are shown in Figures 1 and 2. Total nitrogen extraction varied across the different timepoint samples. The highest total nitrogen reduction from the slurry occurred when 20% of the water volume was extracted from the slurry, reducing the total nitrogen concentration of the water was reduced by 98.7%. This total nitrogen was retained within the nutrient-rich fraction of the slurry that could be used for crop application.

Practical application / Sector use:

Both biochar and RO processes recovered varying degrees of total nitrogen from cattle slurry. Further research is required to develop these approaches; to identify optimum biochars types to increase total nitrogen sorption rates and greater quantification of the RO water fraction to determine possible further uses for this water. Both biochar and RO processes offer different cost opportunities for farmers to incorporate both phosphorous removal using Elentec's electrocoagulation technology, followed by total nitrogen removal with biochar or RO processes. This approach could generate separate phosphorous and nitrogen fractions from slurry for precision

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application to growing crops, whilst reducing the overall volume of slurry for storage and land application.

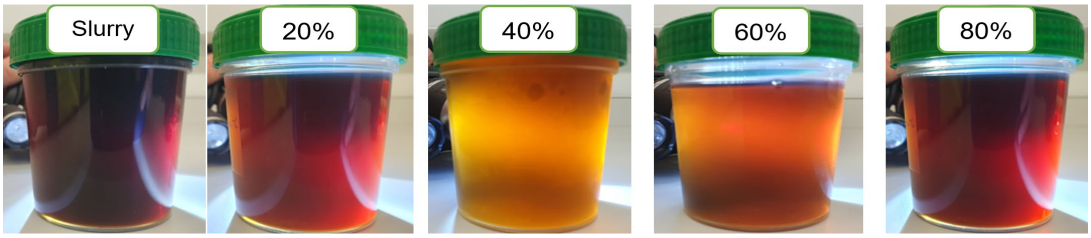

Figure 1 – Reverse osmosis concentrated, nutrient-rich fraction samples produced from cattle slurry (from left to right: original cattle slurry (untreated), 20%, 40%, 60% and 80% volume of water fraction removed from the cattle slurry using reverse osmosis)

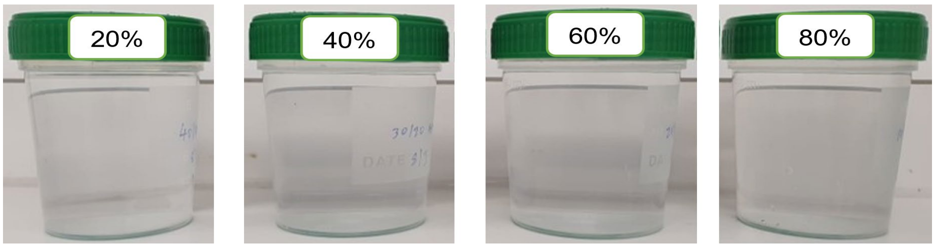

Figure 2 – Reverse osmosis water fraction samples extracted from cattle slurry (from left to right: 20%, 40%, 60% and 80% volume of water extracted from the cattle slurry using reverse osmosis)