



Agrecalc Report - Agricultural Resource Efficiency

Farm: Harper Adams University Farm (ID: 4201)

Report reference: Harper Adams University Farm report 2023 (ID: 32360)

Sectors: Beef, Sheep, Dairy, Pigs, Oilseed Rape

Region: West Midlands

Year calculation relates: End Dec 2023

Reporting date: 30th Apr 2024

Resource use and Emissions

A summary of emissions from carbon dioxide, methane and nitrous oxide for the whole farm and per enterprise is presented below. Total emissions are also expressed per unit of output, per hectare and per livestock unit equivalent to allow comparisons to be made. Per unit of output is the most common way to express emissions associated with the production of food products.

Examples of practical measures to improve efficiency and reduce emissions are shown after the table.

		Whole Farm	Beef	Sheep	Dairy	Pigs	Oilseed rape
		kg CO ₂ e	kg CO ₂ e	kg CO ₂ e	kg CO ₂ e	kg CO ₂ e	kg CO ₂ e
CARBON DIOXIDE							
Direct Emissions	Diesel ⁽¹⁾	223,479	37,375	23,542	142,376	2,359	17,826
	Electricity ⁽¹⁾	162,822	0	0	79,464	83,358	0
	Other fuels ⁽¹⁾	19,363	591	9,869	8,513	0	390
	Renewable electricity ⁽¹⁾	0	0	0	0	0	0
	Renewable heat ⁽¹⁾	0	0	0	0	0	0
	Direct CO₂	405,664	37,967	33,412	230,353	85,717	18,216
Direct & Indirect emissions (embedded in purchased inputs)	Fertiliser	113,919	4,353	11,111	70,382	0	28,072
	Lime	0	0	0	0	0	0
	Feed	2,451,912	77,645	32,424	1,048,360	1,293,483	0
	Bedding	162,973	1,612	0	132,321	29,040	0
	Pesticides	205	27	0	93	0	84
	Waste plastic / packaging	1,630	331	34	1,185	77	3
	Disposal of carcasses	12,700	153	1,325	4,543	6,679	0
	Transport	0	0	0	0	0	0
	Indirect CO₂	2,743,339	84,122	44,894	1,256,884	1,329,279	28,160
	Total CO₂ from energy & waste	3,149,003	122,089	78,306	1,487,237	1,414,996	46,376
METHANE							
Enteric	Fermentation (feed digestion)	2,704,825	66,007	288,636	2,218,065	132,117	0
	Manure mgmt	1,331,937	2,259	6,058	489,481	834,139	0
	Total CO_{2e} from methane	4,036,762	68,266	294,695	2,707,546	966,256	0
NITROUS OXIDE							
Volatilisation, leaching & run-off	Inorganic and imported organic manure input to soil	111,316	7,147	4,950	74,868	0	24,352
	Grazing deposition, manure management and organic manure input to soil	499,932	8,770	87,646	266,989	136,526	0
Vegetation, stubble & roots	Crop N residues	158,308	5,516	3,330	146,848	0	2,602
	Total CO_{2e} from nitrous oxide	769,556	21,433	95,926	488,705	136,526	26,954
CARBON SEQUESTRATION - Hedges							
Sequestration by hedges (allocated by land area)	(kg CO_{2e})	-15,222	-520	-4,739	-8,994	0	-850
Total CO_{2e} emissions from farming		7,940,100	211,267	464,187	4,674,494	2,517,778	72,480
Sequestration by forestry	(kg CO_{2e})	417,740					
Net emissions from land use		7,522,360					
Whole farm CO₂e emissions per kg of farm output	(KgCO₂e/kg output) ⁽²⁾	1.51					

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		Whole Farm	Beef	Sheep	Dairy	Pigs	Oilseed rape
Product CO₂e emissions							
Meat	Total KgCO₂e		211,267	446,148	179,344	2,517,778	
	(KgCO ₂ e/kg lwt)		5.84	7.89	2.31	3.03	
	(KgCO ₂ e/kg dwt)		11.02	17.54	4.37	4.09	
Wool	Total KgCO₂e			18,039			
	(KgCO ₂ e/kg wool)			7.56			
Milk	Total KgCO₂e				4,495,150		
	(KgCO ₂ e/kg FPC milk) ⁽³⁾				1.03		
Eggs	Total KgCO₂e						
	(KgCO ₂ e/kg eggs)						
Forage, grain, seeds, roots	Total KgCO₂e						59,432
	(KgCO ₂ e/kg crop)						0.62
Straw	Total KgCO₂e						13,047.78
	(KgCO ₂ e/kg straw)						0.17
Emissions per LU equivalent	(KgCO₂e/LU)	0	14,323	4,446	8,333	0	
Emissions per hectare	(KgCO₂e/ha)	15,405	12,971	3,126	16,589		2,721
Farm and enterprise output	(Kg)	5,253,242	19,163	27,819	4,418,320	615,839	172,100

(1) - Power for farming activity (excludes personal and household demand)

(2) - Beef, sheep, dairy, pig & poultry meat expressed per net kg dwt of cold carcase; milk expressed per kg FPC milk, poultry eggs expressed per kg, crops and straw expressed per kg

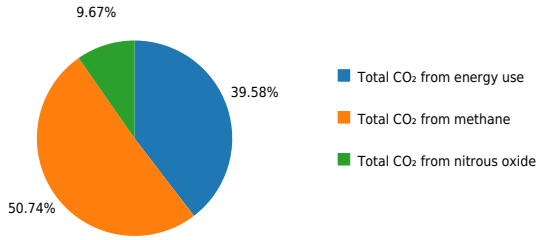
(3) - Fat protein corrected (FPC) milk

Resource use and Emissions Charts

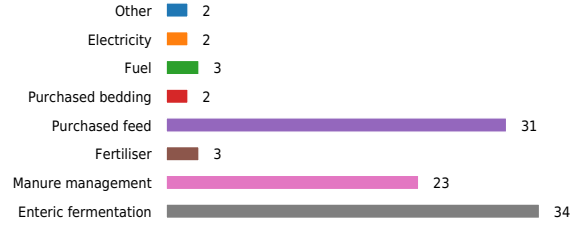
Emissions by gas and by source for the whole farm and per enterprise are presented below.

Harper Adams University Farm report 2023 (Harper Adams University Farm 2023)

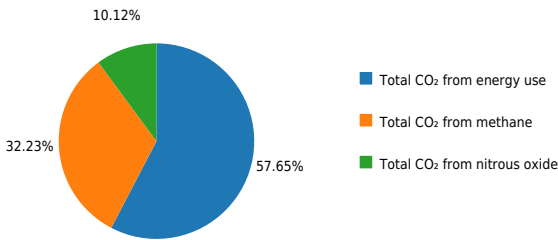
Whole farm emissions by gas (%)



Whole farm emissions by source (%)

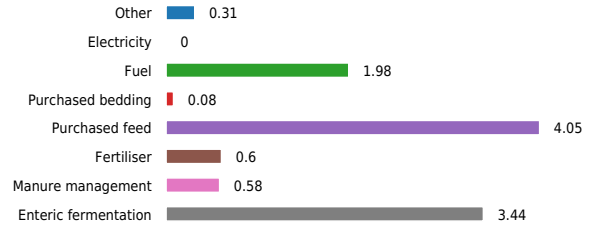


Beef emissions by gas (%)

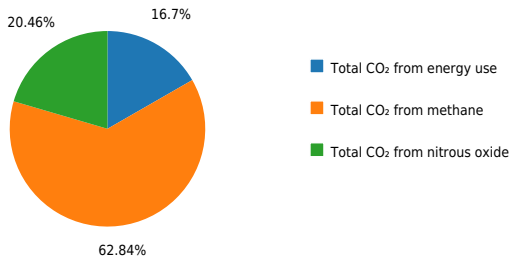


Beef emissions by source

(kg CO₂e/kg dwt)

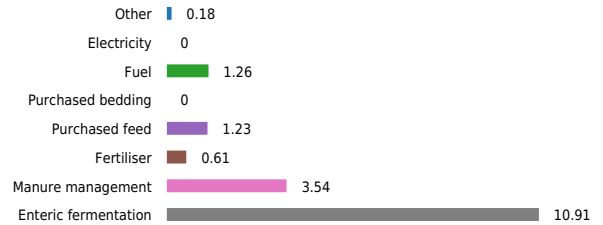


Sheep emissions by gas (%)

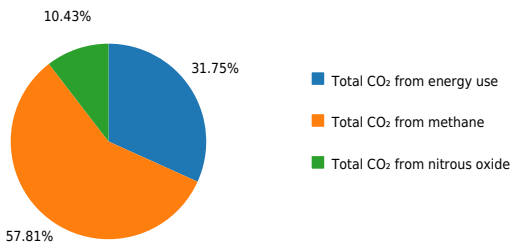


Sheep emissions by source

(kg CO₂e/kg dwt)

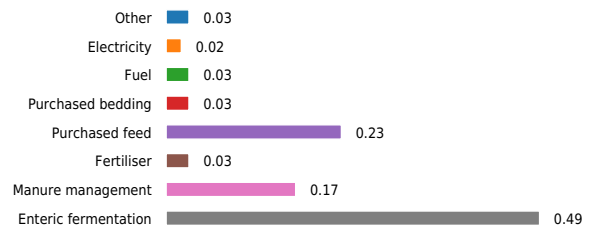


Dairy emissions by gas (%)

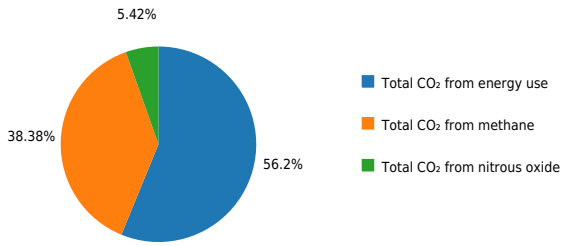


Dairy emissions by source

(kg CO₂e/kg FPC milk)

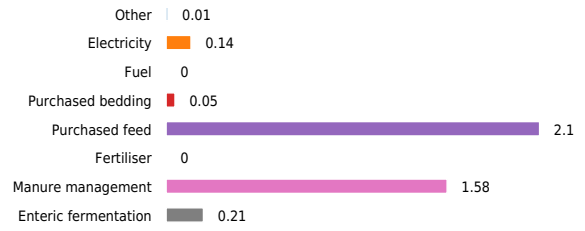


Pigs emissions by gas (%)

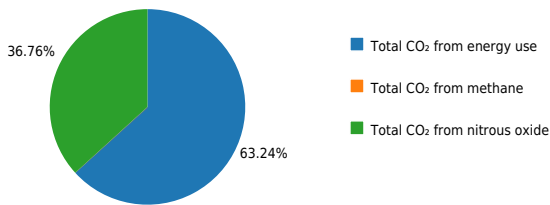


Pigs emissions by source

(kg CO₂e/kg dwt)

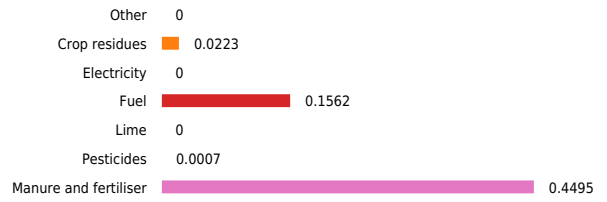


Oilseed rape emissions (%)



Oilseed rape emissions by source

(kg CO₂e/kg oilseed)



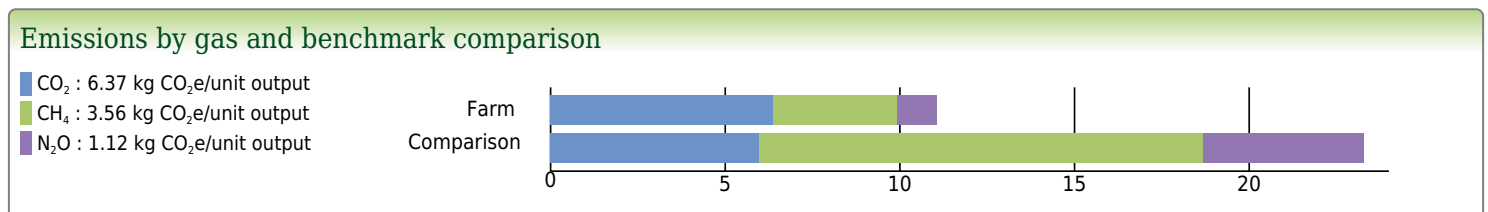
Agrecalc Report - Beef

Sector: Beef
 Enterprise type: Finishing of dairy - beef cross calves
 System: Finisher
 Group:
 Producer:
 Farm: Harper Adams University Farm

Region: West Midlands
 Year calc relates: End Dec 2023
 Reporting date: 30th Apr 2024
 Report reference: Harper Adams University Farm report 2023
 Compared to: Beef Enterprises (system specific) 2020 to 2024 (609) reports

Quick glance enterprise emissions				Physical performance of enterprise		
	* kg CO ₂ e/ kg dwt	Opportunity Level	Comparison		Value	Comparison
Enteric fermentation	3.44	Low	11.87	Area of land utilised (ha)	16	82
Manure management	0.58	Low	3.70	Female breeding stock (no)	0	2
Fertiliser	0.60	Low	2.89	Heifer sale weight (kg lwt/head)	535	536
Purchased feed	4.05	High	2.93	Steer sale weight (kg lwt/head)	631	570
Purchased bedding	0.08	Low	0.50	Young bulls sale weight (kg lwt)	0	532
Fuel	1.98	High	0.77	Purchased feed use (kg/head)	1,358	935
Electricity	0	Low	0.05	Homegrown fodder use (kg/head)	5,147	5,837
Other	0.31	Low	0.56	Live weight gain (kg/day)	1.29	0.95
Total emissions **	11.05	Low	23.21	Mortality (%)	5	3
<i>Other: crop residues, lime, transport and waste</i>				Calving percentage (%)	0	9
				Cow cull rate (%)	0	6
				Enterprise net output (kgs)	19,163	45,777

Whole farm sustainability indicators					
Nitrogen Use	27.98	kg/ha	Water use	19,541,000.00	litres
Phosphate Use	0.53	kg/ha	Stocking density	1.55	LU/ha
Potash Use	12.00	kg/ha	Sequestration	417.74	tCO ₂ e
Waste	9,705.00	kg	Renewable energy used	439,995.00	kWh



* Your carbon footprint is expressed in units of CO₂ equivalents (CO₂e) per unit of output e.g. kg CO₂e per kg dwt of cold carcass. This allows the efficiency of the enterprise to be compared. The main greenhouse gases emitted by agriculture are CH₄ = Methane (Predominantly from animal digestion); N₂O = Nitrous oxide (Predominantly from manure and fertiliser); CO₂ = Carbon dioxide (Predominantly from burning of fossil fuels).

** Total emissions may differ due to rounding. Emissions may be skewed on a year to year basis due to timing of sales therefore results are best monitored over a three year (minimum) period.

Agrecalc Report - Sheep

Sector: Sheep
 Enterprise type: Early lambing ewe flock
 System: Store/finisher
 Group:
 Producer:
 Farm: Harper Adams University Farm

Region: West Midlands
 Year calc relates: End Dec 2023
 Reporting date: 30th Apr 2024
 Report reference: Harper Adams University Farm report 2023
 Compared to: Sheep Enterprises (system specific) 2020 to 2024 (263) reports

Quick glance enterprise emissions

	* kg CO ₂ e/ kg dwt	Opportunity Level	Comparison
Enteric fermentation	10.91	Low	18.08
Manure management	3.54	Low	5.14
Fertiliser	0.61	Low	3.61
Purchased feed	1.23	Low	2.39
Purchased bedding	0	Low	0.19
Fuel	1.26	Medium	1.18
Electricity	0	Low	0.06
Other	0.18	Low	0.83
Total emissions **	17.72	Low	31.35

Other: crop residues, lime, transport and waste

Physical performance of enterprise

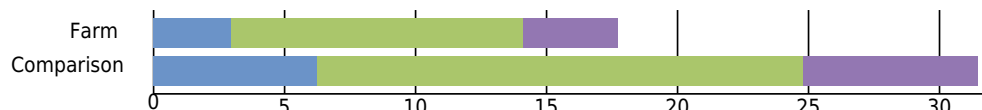
	Value	Comparison
Area of land utilised (ha)	148	57
Female breeding stock (no)	680	347
Lamb sale weight (kg lwt/head)	43.70	42.63
Lamb sale weight (kg dwt/head)	19.67	19.51
Wool sales (kg)	2,387	782
Purchased feed use (kg/ewe)	133	103
Homegrown feed use (kg/ewe)	72	964
Mortality (%)	9	6
Lambing percentage (%)	151	160
Ewe cull rate (%)	42	30
Enterprise net output (kgs)	27,819	11,777

Whole farm sustainability indicators

Nitrogen Use	27.98	kg/ha	Water use	19,541,000.00	litres
Phosphate Use	0.53	kg/ha	Stocking density	1.55	LU/ha
Potash Use	12.00	kg/ha	Sequestration	417.74	tCO ₂ e
Waste	9,705.00	kg	Renewable energy used	439,995.00	kWh

Emissions by gas and benchmark comparison

CO₂ : 2.96 kg CO₂e/unit output
 CH₄ : 11.14 kg CO₂e/unit output
 N₂O : 3.63 kg CO₂e/unit output



* Your carbon footprint is expressed in units of CO₂ equivalents (CO₂e) per unit of output e.g. kg CO₂e per kg dwt of cold carcase. This allows the efficiency of the enterprise to be compared. The main greenhouse gases emitted by agriculture are CH₄ = Methane (Predominantly from animal digestion); N₂O = Nitrous oxide (Predominantly from manure and fertiliser); CO₂ = Carbon dioxide (Predominantly from burning of fossil fuels).

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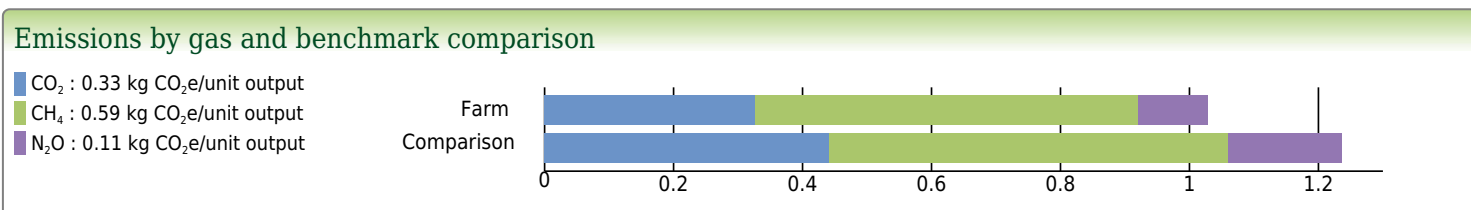
Agrecalc Report - Dairy

Sector: Dairy
 Enterprise type: All year round calving, 9,500l typical annual yield
 System: not specified
 Group:
 Producer:
 Farm: Harper Adams University Farm

Region: West Midlands
 Year calc relates: End Dec 2023
 Reporting date: 30th Apr 2024
 Report reference: Harper Adams University Farm report 2023
 Compared to: Dairy Enterprises (system specific) 2020 to 2024 (349) reports

Quick glance enterprise emissions				Physical performance of enterprise		
	* kg CO ₂ e/ kg FPC milk	Opportunity Level	Comparison		Value	Comparison
Enteric fermentation	0.49	Low	0.51	Area of land utilised (ha)	282	164
Manure management	0.17	Low	0.20	Female breeding stock (no)	418	257
Fertiliser	0.03	Low	0.13	Cattle sales (kg lwt/head)	280	382
Purchased feed	0.23	Low	0.32	Milk production (l/cow)	10,244	9,687
Purchased bedding	0.03	High	0.01	Purchased feed use (kg/cow)	4,627	4,665
Fuel	0.03	Low	0.03	Homegrown fodder (kg/cow)	23,842	15,068
Electricity	0.02	High	0.01	Electricity use (kWh/cow)	2,036	491
Other	0.03	High	0.02	Red diesel use (l/cow)	126	123
Total emissions **	1.03	Low	1.24	Mortality (%)	5	5
<i>Other: crop residues, lime, transport and waste</i>				Calving percentage (%)	69	92
				Cow cull rate (%)	28	31
				Enterprise net output (kgs)	4,418,320	2,682,606

Whole farm sustainability indicators					
Nitrogen Use	27.98	kg/ha	Water use	19,541,000.00	litres
Phosphate Use	0.53	kg/ha	Stocking density	1.55	LU/ha
Potash Use	12.00	kg/ha	Sequestration	417.74	tCO ₂ e
Waste	9,705.00	kg	Renewable energy used	439,995.00	kWh



* Your carbon footprint is expressed in units of CO₂ equivalents (CO₂e) per unit of output e.g. kg CO₂e per kg fat protein corrected milk. This allows the efficiency of the enterprise to be compared. The main greenhouse gases emitted by agriculture are CH₄ = Methane (Predominantly from animal digestion); N₂O = Nitrous oxide (Predominantly from manure and fertiliser); CO₂ = Carbon dioxide (Predominantly from burning of fossil fuels).

** Total emissions may differ due to rounding. Emissions may be skewed on a year to year basis due to timing of sales therefore results are best monitored over a three year (minimum) period.

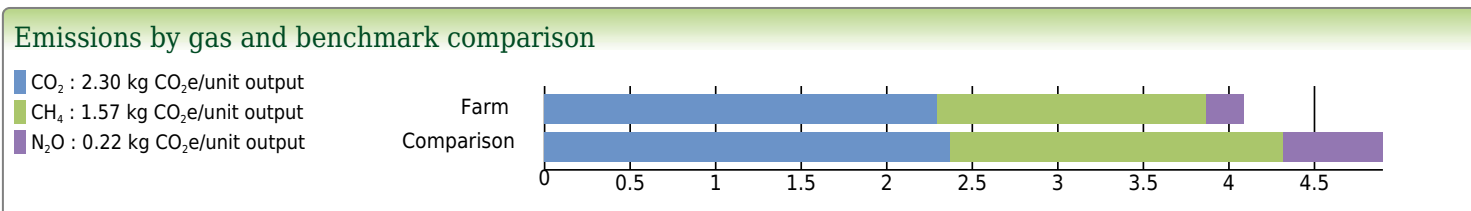
Agrecalc Report - Pigs

Sector: Pigs
 Enterprise type: Indoor breeding/finishing
 System: not specified
 Group:
 Producer:
 Farm: Harper Adams University Farm

Region: West Midlands
 Year calc relates: End Dec 2023
 Reporting date: 30th Apr 2024
 Report reference: Harper Adams University Farm report 2023
 Compared to: Pigs Enterprises (system specific) 2020 to 2024 (36) reports

Quick glance enterprise emissions				Physical performance of enterprise		
	* kg CO ₂ e/ kg dwt	Opportunity Level	Comparison		Value	Comparison
Enteric fermentation	0.21	Low	0.28	Area of land utilised (ha)	0	76
Manure management	1.58	Low	2.05	Female breeding stock (no)	284	364
Fertiliser	0	Low	0.30	Weaner sale weight (kg lwt/head)	0	40.60
Purchased feed	2.10	Medium	1.92	Grower sale weight (kg lwt/head)	0	49.17
Purchased bedding	0.05	Medium	0.05	Finisher sale weight (kg lwt/head)	115.00	109.71
Fuel	0.00	Low	0.15	Growers % of sales	0	3
Electricity	0.14	High	0.05	Finishers % of sales	96	89
Other	0.01	Low	0.10	Purchased feed use (kg/head)	308	237
Total emissions **	4.09	Low	4.90	Enterprise net output (kgs)	615,839	567,380
<i>Other: crop residues, lime, transport and waste</i>						

Whole farm sustainability indicators					
Nitrogen Use	0	kg/ha	Water use	19,541,000.00	litres
Phosphate Use	0	kg/ha	Stocking density	1.55	LU/ha
Potash Use	0	kg/ha	Sequestration	417.74	tCO ₂ e
Waste	9,705.00	kg	Renewable energy used	439,995.00	kWh



* Your carbon footprint is expressed in units of CO₂ equivalents (CO₂e) per unit of output e.g. kg CO₂e per kg dwt of cold carcass. This allows the efficiency of the enterprise to be compared. The main greenhouse gases emitted by agriculture are CH₄ = Methane (Predominantly from animal digestion); N₂O = Nitrous oxide (Predominantly from manure and fertiliser); CO₂ = Carbon dioxide (Predominantly from burning of fossil fuels).

** Other: crop residues, lime, transport and waste

*** Total emissions may differ due to rounding. Emissions may be skewed on a year to year basis due to timing of sales therefore results are best monitored over a three year (minimum) period.

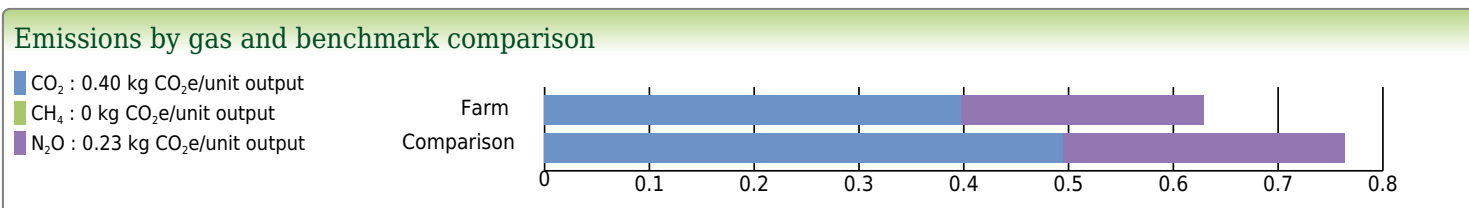
Agrecalc Report - Oilseed rape

Sector: Oilseeds
 Crop: Oilseed rape
 Group:
 Producer:
 Farm: Harper Adams University Farm

Region: West Midlands
 Year calc relates: End Dec 2023
 Reporting date: 30th Apr 2024
 Report reference: Harper Adams University Farm report 2023
 Compared to: Combinable Crops Enterprises (Oilseed rape specific) 2020 to 2024 (678) reports

Quick glance enterprise emissions				Physical performance of enterprise		
	* kg CO ₂ e/ kg oilseed	Opportunity Level	Comparison		Value	Comparison
Manure and fertiliser	0.45	Low	0.59	Area of oilseed rape sold (ha)	26.64	46.03
Pesticides	0.001	Low	0.001	Seed yield (t/ha)	3.59	4.01
Lime	0	Low	0.05	Straw yield (t/ha)	2.87	0.51
Fuel	0.16	High	0.10	Fertiliser use (t per t seed)	0.12	0.17
Electricity	0	Low	0.00	Fertiliser use (t per ha)	0.44	0.64
Crop residues	0.02	Low	0.03	Electricity use (kWh per t seed)	0	0
Other	0.00	Low	0.00	Red diesel use (l per t seed)	69.06	31.55
Total emissions **	0.63	Low	0.76	Red diesel use (l per ha)	247.94	116.26
<i>Other: transport, waste</i>						

Whole farm sustainability indicators					
Nitrogen Use	27.98	kg/ha	Water use	19,541,000.00	litres
Phosphate Use	0.53	kg/ha	Stocking density	1.55	LU/ha
Potash Use	12.00	kg/ha	Sequestration	417.74	tCO ₂ e
Waste	9,705.00	kg	Renewable energy used	439,995.00	kWh



* Your carbon footprint is expressed in units of CO₂ equivalents (CO₂e) per unit of output e.g. kg CO₂e per kg oilseed sold. This allows the efficiency of the enterprise to be compared. The main greenhouse gases emitted by agriculture are CH₄ = Methane (Predominantly from animal digestion); N₂O = Nitrous oxide (Predominantly from manure and fertiliser); CO₂ = Carbon dioxide (Predominantly from burning of fossil fuels).

** Total emissions may differ due to rounding. Emissions may be skewed on a year to year basis due to timing of sales therefore results are best monitored over a three year (minimum) period.

Improve efficiency and environmental credentials

What does a carbon footprint actually tell you?

There is a strong correlation between efficiency, profitability and low carbon emissions. The lower your carbon footprint the more effective inputs have been at generating saleable product i.e. increased utilisation of costly inputs. Each farm and system have natural limitations but, within this context, the process can identify carbon 'hotspots' on farm and is therefore a steer to improve efficiency and reduce greenhouse gas emissions.

How accurate does the information need to be?

The more accurate the information entered, the more meaningful the output. Where possible on farm records should be used to provide accurate farm-level data.

AgreCalc report guide

A: Quick glance enterprise emissions The 'opportunity level' (high, medium or low) is the likelihood for improvement gauged against other farms in that sector.

B: Physical performance of enterprise It is much easier to relate to performance indicators, actual sales, feeds and other inputs used. This becomes particularly useful when comparing years and for group comparisons.

C. Whole farm sustainability indicators Sustainability is the ability to deliver a product the customer wants year after year without adversely impacting the environment. Carbon is, however, only one part of the wider sustainability 'formula', some wider indicators are shown in this section.

D. Whole farm emissions by gas and benchmarking comparison Carbon footprinting similar farm types allows a business to benchmark environmental performance against a group average.

E. Potential actions to reduce emissions Examples of practical measures that could reduce emissions are shown below. Technical advice should be sought before making any business changes.

Mitigation area	Actions
Energy and fuels	<ul style="list-style-type: none"> • Install smart meter to monitor electricity use - assess efficiency of equipment and activities. Use thermostats, time clocks, motion sensors and low energy bulbs, increase lagging on hot water pipes, reduce number of hot washes in dairy and renew milk pump or other equipment • Record fuel use per tractor and activity - assess efficiency of vehicles and operations. Undertake regular machinery checks and maintenance, use correct tyre pressure, improve journey planning
Renewable energy	<ul style="list-style-type: none"> • Undertake a renewable energy feasibility study. Consider installing a wind turbine, an anaerobic digester, developing farm-scale micro hydro electricity, using a combined heat and power plant, growing trees as biomass fuel, using solar panels, ground source heat pumps or woodchip burners
Fertiliser and manure	<ul style="list-style-type: none"> • Analyse soil and organic manure - ensure efficient use of organic and inorganic fertiliser. Apply nitrogen at optimum rate and timing for crops, maintain clover content of swards, consider covering slurry stores and injecting slurry
Livestock management	<ul style="list-style-type: none"> • Increase livestock productivity. Improve feed conversion efficiency, increase calving or lambing percentage, reduce mortalities, increase weaning percentage, reduce age of calving, regularly review animal health plans, analyse silage or other homegrown forage
Locking carbon into the soil	<ul style="list-style-type: none"> • Create carbon sinks. Protect peatland and moorland from damage by avoiding over grazing, consider reduced tillage and ploughing in stubble and other crop residues, control soil erosion, create wildlife corridors along water margins, field margins and headlands, retain and conserve semi-natural grasslands, manage existing woodlands on farm and create new ones.

Any questions regarding this report or to discuss other financial and carbon efficiency measures please contact your local SRUC office or the Rural Business Unit.

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