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BEACON FARM NETWORK

Beef and Sheep Carbon Footprint Benchmarking Report

Booklet prepared from case studies completed by:

agrecalc

SAC CONSULTING

Introduction

Beef and sheep farmers within the Beacon Farm Network were benchmarked using Agrecalc, a carbon benchmarking program used by SAC Consulting, that uses enterprise production data, fertiliser usage, fuel and electricity usage, as well as land and crop data to develop an individual farm emissions profile. 34 beef enterprises and 17 sheep enterprises were benchmarked as part of the project. From this, it was possible to determine the total emissions produced by each farm. As seen in Figure 1, it is possible to break down the emission quantities into the respective Greenhouse Gases produced as an equivalent to Carbon Dioxide.

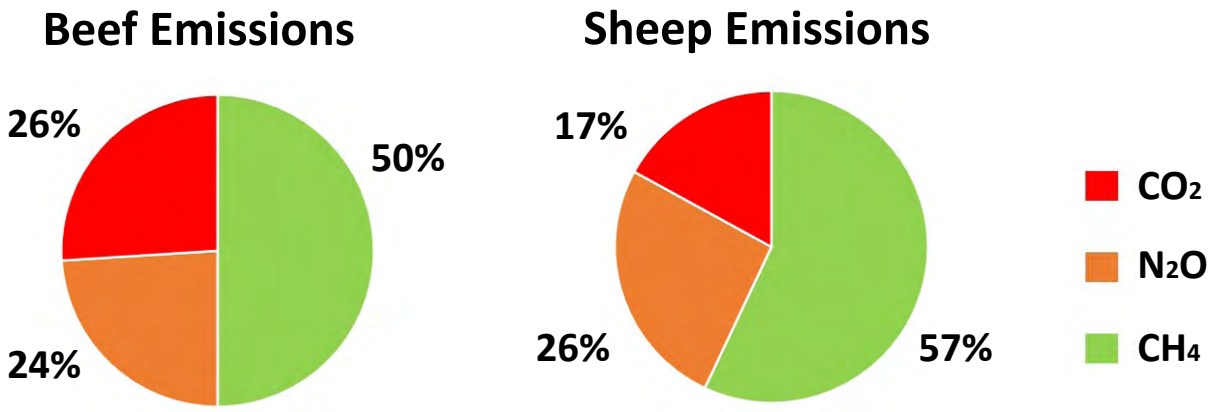


Figure 1 - Beef and sheep GHG Emissions on a CO2e basis

Carbon Dioxide (CO_2) is often considered as the main contributor to climate change and is the most available Greenhouse Gas. Production on farm is often related to fuel and electricity usage as part of routine farm activities such as feeding and lighting etc.

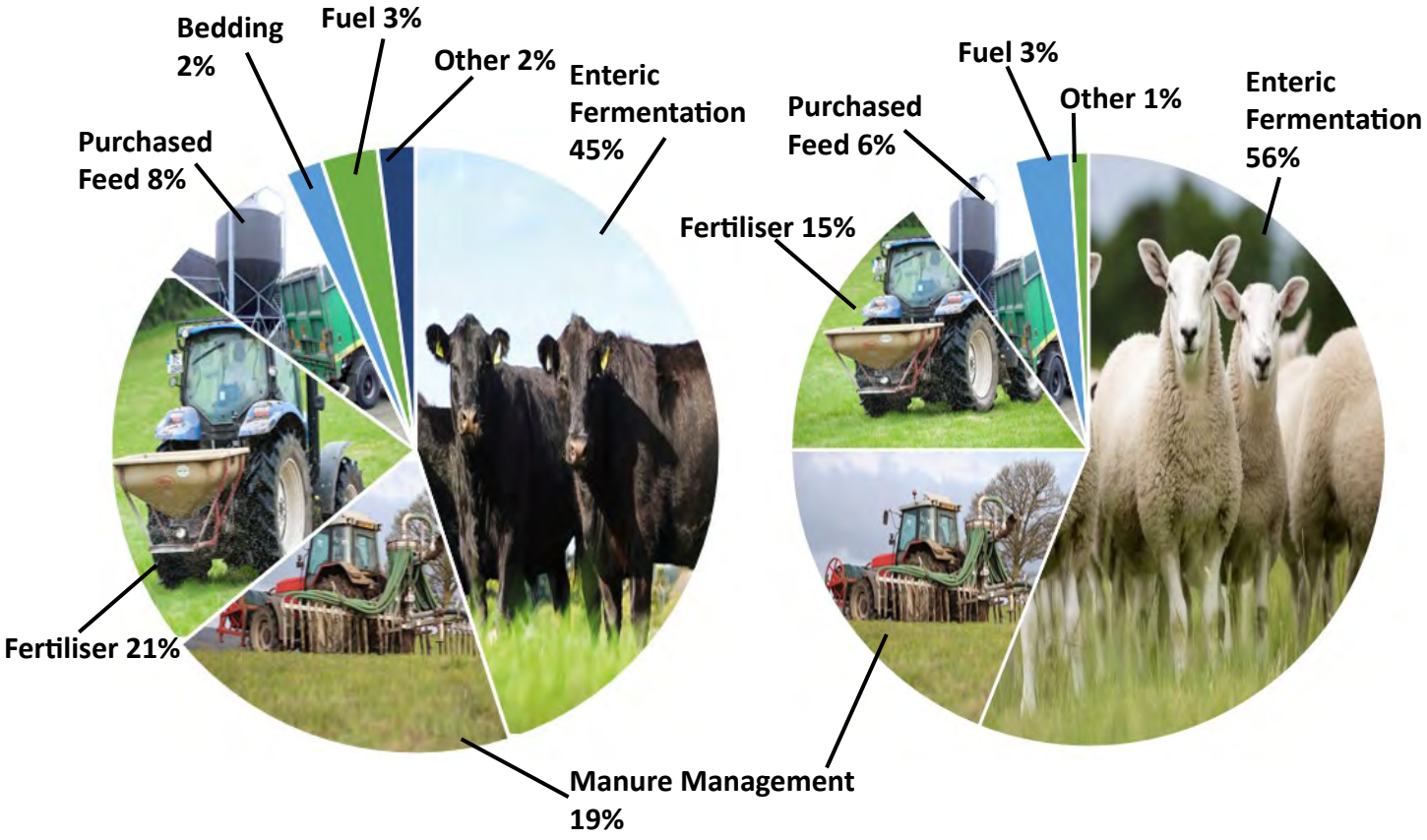
Nitrous Oxide (N_2O) emissions production on farm is related to emissions from the application of manufactured fertilisers to land for grassland and crop production, as the fertiliser is broken down and is taken up by the soil through mineralisation. Nitrous Oxide release can also take place in waterlogged soils through the action of denitrifying bacteria, reducing the availability of soil nitrate.

Methane (CH_4) is related to the enteric fermentation that takes place in ruminants as symbiotic bacteria in the rumen ferment grass and silage to break down complex sugars into an available form that can be absorbed by the animal's digestive system. Some Methane emissions can also be related to manure management on farm.

Beacon Farm Network Emissions by Source

As part of the Agrecalc calculations, it is possible to attribute the total emissions to specific areas within the business. As seen in Figure 2, 45% of emissions in the Beacon Farm Network beef systems assessed were attributed to enteric fermentation, compared to 56% in sheep systems. Emissions from fertiliser application resulted in producing 21% of the total emissions in beef systems and 15% in sheep systems. 19% of the total emissions in beef and sheep systems were produced by manure management. Purchased feed only made up 8% of emissions from beef farms and 6% in sheep farms.

Beacon Farm Network Beef and Sheep Emissions by Source



Carbon Emissions and Sequestration Benchmarking

Of the beef and sheep farms assessed in the Beacon Farm Network, members performed well in terms of gross and net emissions, as can be seen in Table 1a and 1b below. The average emissions offset through soil carbon sequestration were found to be 43.8% for beef systems and 47.7% for sheep systems. This meant that an overall average emissions/ha of 6,963kg CO_2e for beef farms, compared to 5,877kg CO_2e for sheep farms. Average Net Total Emissions for the whole farm for beef systems resulted in 789t CO_2e produced, compared to 579t CO_2e produced in sheep systems.

Table 1a - Carbon Emissions and Sequestration Benchmarking from Beacon Farm Network Beef enterprises

	Minimum Benchmark Figure	Average of BFN Beef Enterprises	Maximum Benchmark Figure
Kg CO_2e/kg product (without sequestration) Tier 2	7.99	34.82	107.62
Kg CO_2e/kg product (with sequestration)	-12.75	15.72	49.78
Emissions/Ha (Kg CO_2e)	-562	6,963	26,167
Net Total Emissions (t/CO_2e) [Whole Farm]	-93	789	4,372
Emissions offset (soil) Tier 1	-20.30%	43.78%	108.00%
Emissions offset (forestry)	0%	4.12%	33.20%

Table 1b - Carbon Emissions and Sequestration Benchmarking from Beacon Farm Network Sheep enterprises

	Minimum Benchmark Figure	Average of BFN Sheep Enterprises	Maximum Benchmark Figure
Kg CO_2e/kg product (without sequestration) Tier 2	15.16	34.2	88.19
Kg CO_2e/kg product (with sequestration)	-2.4	18.92	63.87
Emissions/Ha (Kg CO_2e)	-656	5,877	39,569
Net Total Emissions (t/CO_2e) [Whole Farm]	-93	579	2,558
Emissions offset (soil) Tier 1	-20.30%	43.78%	108.00%
Emissions offset (forestry)	0%	6.06%	33.20%

Case Studies

As part of the Beacon Farm Network project, 4 beef and sheep farms were selected to complete further case studies to fully explore emission sources, and develop practical measures that could be implemented on farm in order to help mitigate emissions. These farms were selected to be representative of the whole group and ranged from a beef and arable system, a beef only system, a beef and sheep upland farm, and a majority sheep enterprise.

Farm 1

A grass-based beef system with an arable enterprise covering 67ha, with 60 spring calving Limousin cross suckler cows and calves taken through to finishing at 21-23 months.

The whole farm was found to emit 620,070kg CO_2e, which is 14% lower than typical farms with similar enterprises that have been benchmarked across the UK. Over 60% of the gross emissions produced on farm were attributed to methane production from livestock and manure management, with 25% being attributed nitrous oxide emissions from fertiliser. Soil carbon sequestration was estimated to offset 52% of the farm's total emissions, resulting in Net Whole Farm carbon emissions of 294,427kg CO_2e from land use.

Current carbon management on farm included:

- 3 day rotational grazing system
- Up to 20% clover in paddocks
- 2.4ha of herbal leys being trialled
- Regular soil sampling with all fields above pH 6.0
- Pelvic measuring of purchased heifers, with bottom 25% sold, to minimise calving issues
- Slurry applied with a trailing shoe

Recommendations to reduce CO_2e emissions to improve business performance

- Measuring grass using a plate meter to aid and improve grass utilisation
- Maximising nutrient application through slurry analysis and using soil sampling results to tailor fertiliser and slurry application to each field as necessary
- Utilising clover in swards by increasing the level of clover across all paddocks to a target of 30%
- Increasing silage quality by trying to boost Crude Protein content in silage and cutting slightly earlier – incorporating higher levels of clover into swards
- Purchase protein in the form of concentrate – improving growth rates and reducing days to slaughter will help to cut enteric fermentation emissions
- Incorporate home grown proteins into the arable enterprise on farm
- Reduce the level of tillage on farm to reduce to conserve and build carbon stocks in soil

These recommendations if implemented would significantly reduce GHG emissions on farm. By incorporating more clover and tailoring nutrient applications as required, the resulting reductions in fertiliser applications could decrease GHG emissions from fertiliser application by 27%.

The farm relies on all home grown feed with no concentrates purchased, however, if concentrates or home grown protein are incorporated to shorten livestock growing period by 2 months, on farm CO_2e emissions would drop by 11% per kg of output.

By reducing tillage on the 7ha area of barley grown, it is possible to reduce total farm emissions by 2%, or up to 3% if direct drilling is used.

Case Studies

Farm 2

A an upland beef and sheep system extending to 105ha, comprising of 60 head of suckler cows, with half calving in spring and the other half calving in autumn. Spring born calves are sold at 9-10 months, with autumn calves sold in February. 70 Texel lambs lamb inside on a straw bedded system. The whole farm was found to emit 401,087kg CO_2e, which was 57% more than UK farms with similar enterprises benchmarked by Agrecalc. Of this, 90% of the emissions came from the beef enterprise, while 10% came from the sheep enterprise. Soil carbon and woodland sequestration was able to offset 75% of the farm's emissions, resulting in Net Whole Farm carbon emissions of 104,386kg CO_2e. 56.63% of the farm emissions were as a result of methane from enteric fermentation and manure management. 21.5% of the emissions were as a result of nitrous oxide emissions from fertiliser applications.

Current carbon management on farm included:

- Good grassland management – paddock grazing system used with regular reseeding being practiced
- Focus on making high quality silage with 2 cuts taken to try and reduce reliance on purchased feed
- Maximising slurry usage for silage production
- Heifers have a pre-breeding check for pelvic width to prevent problematic heifers being bulled

Recommendations to reduce CO_2e emissions to improve business performance

- Slurry analysis carried out twice a year to help tailor slurry applications to crop requirements
- Applying slurry with a trailing shoe to cut down on ammonia emissions produced and increase nutrient availability
- Increasing clover content within recently sown grass swards and including in the reseeding programme
- Selecting sires for breeding with positive Direct Calving Ease EBV's to reduce calving injuries and caesarean sections required.
- Choosing sires with positive 200 day and 400 day growth EBVs can improve calf growth rates if calves are born smaller.
- Carrying out silage analysis to tailor the feed ration to ensure in calf cows are reaching the optimal Body Condition Score and to reduce waste of silage and purchased feed

From these findings, it would be possible to reduce the overall farm carbon footprint through small changes to herd and land management by making informed decisions to tailor nutrient applications, feed rations, and livestock breeding to suit individual fields, or animals.

Case Studies

Farm 3

A mainly sheep enterprise, consisting of 700 commercial Aberfield and Belclare ewes, with a further 40 spring born dairy heifers being reared from 6-8 months up to 500kg when they return to their home dairy farm. The farm consists of 73ha, with 50ha of permanent pasture, 6ha of spring barley for home feed, 15ha for biomass production, and a further 10ha rented out for seasonal grazing.

The whole farm carbon footprint was found to be 565,323kg CO_2e, which is 30% less than UK farms benchmarked with similar enterprises. When soil carbon and woodland sequestration were accounted for, the Net Whole Farm carbon footprint was 391,435kg CO_2e. The main sources of carbon emissions on farm are enteric fermentation which made up 48%, fertiliser which made up 33%, and manure management which made up 13% of total farm emissions.

Current carbon management on farm included:

- Grass is measured weekly and grass quality is monitored, which allows for very good management of grassland
- Focus on making 2 high quality cuts of silage to reduce reliance on purchased feed
- A winter forage crop of kale is grown on 6.7ha which further reduces reliance on purchased feed
- Use of slurry is maximised for silage production
- Regular soil sampling and lime applications take place to ensure soil pH is above 6.2, allowing for most efficient use of fertiliser.

Recommendations to reduce CO_2e emissions to improve business performance

- Carrying out slurry analysis twice a year to tailor slurry applications to crop requirements
- Applying slurry using a trailing shoe to reduce ammonia emissions and utilise more available Nitrogen in slurry
- Stitching in clover to young grass swards to decrease reliance on chemical Nitrogen
- Ensuring all soil has green cover by having a crop planted before winter to prevent sequestered carbon being emitted into the atmosphere.
- Carrying out a carbon audit on woodland and hedgerows on farm to ensure the maximum amount of carbon is being sequestered

By incorporating clover into grass swards cut for silage up to a level of 30%, it would be possible to reduce Nitrogen applications from 211kg/N/ha to 41kg/N/ha, applied in the spring. This would reduce the whole farm carbon footprint by 86 tonnes, or 16% of the whole farm emissions, which would be a great saving to the farm's carbon footprint and reduce the farm inputs required.

By planting 2ha of broad-leaved woodland on farm, it would be possible to sequester a further 21.7 tonnes of carbon, reducing the overall farm's carbon footprint by 3.83%. By planting a further 2 kilometres of hedgerow, it would be possible to sequester 8 tonnes of carbon, reducing the farm's carbon footprint by 1.41%.

Case Studies

Farm 4

A beef only system covering 14 hectares, with 15 pedigree Charolais suckler cows. The spring calving herd produces pedigree offspring for sale. Some calves are sold as weanlings in the autumn, while the rest are sold in February.

The whole farm was found to emit 84,147kg CO_2e, which is 38% below the Agrecalc average for UK farms with similar enterprises. Woodland carbon sequestration on farm was estimated to offset 19% of the farm's total gross emissions. Net Whole Farm carbon emissions from land use was found to be 67,812kg CO_2e. 61% of farm emissions were from methane, relating to enteric fermentation and manure management. 22% of farm emissions were attributed to nitrous oxide emissions from fertiliser application.

Current carbon management on farm included:

- Cattle grazed on 3 week rotation using pad dock grazing
- Regular soil sampling is carried out
- Low electricity and tractor usage

Recommendations to reduce CO_2e emissions to improve business performance

- Improving soil pH by liming fields below pH 6.0 to improve nutrient usage by soil
- Maximising grassland utilisation by measuring grass with a rising plate meter
- Incorporating clover into grass swards
- Applying protected urea to replace 26:0:6 which is normally applied
- Tightening the calving period from all summer down to 12 weeks

From these recommendations, it would be possible to decrease the Whole Farm total emissions of CO_2e per kg output by 3% by tightening the calving interval down to 12 weeks. By incorporating clover into the grass swards on farm, it could be possible to decrease CO2e emissions per kg output by 27%, while better utilisation of grassland could decrease emissions by 2.5%.

Key Messages

Legumes

Overall, many of the recommendations given to farmers serve a dual purpose, to improve technical efficiency and profitability while also reducing the carbon footprint of farming operations. Common recommendations which could be implemented by many beef and sheep farmers include establishing white and red clover into grazing and silage swards.

Grassland Management

Other common recommendations include improving grassland management through measuring grass covers regularly, budgeting grass and making better quality silage, through cutting more regularly. Farmers are also advised to improve manure and fertiliser management through applying slurry using LESSE methods, analysing manure, and moving to applying protected urea instead of CAN or normal urea.

Herd Genetic Gain

It is recommended for beef farmers to focus on maintaining or tightening the calving period to 12 weeks or under, to allow cows the best chance to get back in-calf to maximise their lifetime on farm. To minimise dystocia and aided calving, it is recommended for beef farmers to select sires with positive direct calving ease EBVs, as well as positive 200 and 400 day growth to maximise weight gain at a young age.

Woodland and Hedgerow management

Carrying out a woodland and hedgerow audit can be useful to locate opportunities to increase woodland and hedgerows on farm and ensure that woodland on farm is able to sequester the maximum amount of carbon. This can be done through ensuring woodland is of the correct density and checking hedgerow health.

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