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BEACON FARM NETWORK

Dairy Farm Carbon Footprint Benchmarking Report

Booklet prepared from case studies completed by:

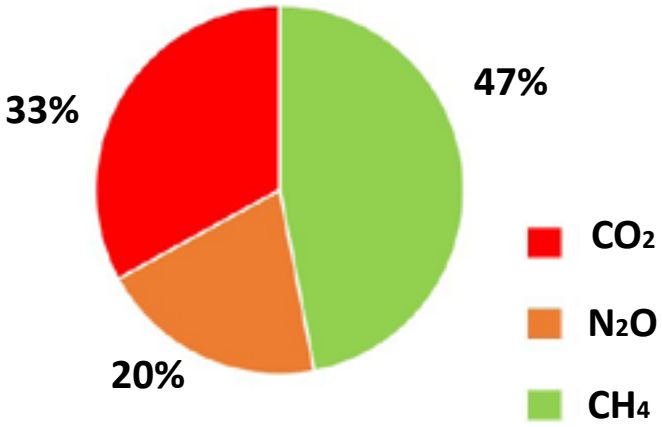
agrecalc

SAC CONSULTING

Introduction

Dairy farmers within the Beacon Farm Network were benchmarked using the Agrecalc system using enterprise production data, fertiliser usage, fuel and electricity usage, as well as land and quality data. From this, it was possible to determine the total emissions produced by each farm. As seen in the pie chart below, it is possible to break down the emission quantities into the respective Greenhouse Gases produced as an equivalent to Carbon Dioxide.

Dairy GHG Emissions on a CO2e basis



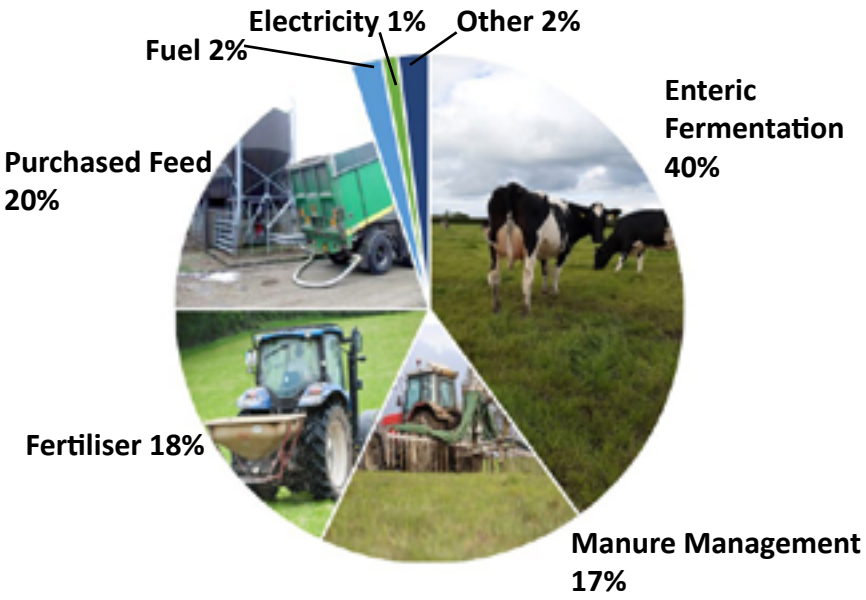
Carbon Dioxide (CO_2) is often considered as the main contributor to climate change and is the most prevalent Greenhouse Gas. Production on farm is often related to fuel and electricity usage as part of routine dairy farm activities such as milking, feeding, lighting etc.

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 Dairy 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 the pie chart opposite, 40% of emissions from the sampled dairy farms were attributed to enteric fermentation in ruminants, followed by 20% of emissions coming from purchased feed, 17% from manure management, 18% from fertiliser emissions, and 5% from other sources such as electricity and fuel.



Of the dairy farms sampled from the Beacon Farm Network, the members performed well in terms of gross and net emissions, as can be seen in Table below. Emissions offset by soils on farm was found to be 33.3%, which in turn resulted in net emissions of 0.87kg CO_2e/kg product produced. This also resulted in a Net Total Emissions average of 1,454t CO_2e across the whole farm per year.

Carbon Emissions and Sequestration Benchmarking from 18 Beacon Farm Network Dairy Farms

	Minimum Benchmark Figure	Average of BFN Dairy Farms	Maximum Benchmark Figure
Kg CO_2e/kg product (without sequestration) Tier 2	1.08	1.29	1.45
Kg CO_2e/kg product (with sequestration)	0.69	0.87	1.09
Emissions/Ha (Kg CO_2e)	5,617	13,200	29,131
Net Total Emissions (t/CO_2e) [Whole Farm]	313	1,454	5,513
Emissions offset (soil) Tier 1	13.20%	33.30%	49.50%
Emissions offset (forestry)	0%	0.60%	4.50%

Case Studies

As part of the Beacon Farm Network project, 3 dairy farms were selected to complete further case studies to fully outline Carbon emission sources, and develop practical measures that could be implemented on farm in order to help mitigate Carbon emissions. These farms ranged from a highly automated dairy farm operating robotic milking, a large autumn calving herd, as well as a spring calving herd.

Farm 1

A year round calving herd of 125 cows, producing 9,400 litres/cow at 4.19% butterfat and 3.29% protein, operating a robotic milking system.

This farm was found to emit 1,775,203kg CO_2e from farm operations, which is 10% below the Agrecalc average. Of this, 48% of CO_2e emissions were from methane, related to enteric fermentation and manure management. Purchased feed and fertiliser were also found to be have a large effect on Carbon emissions on farm and 39.5% of the CO_2e emitted was related to energy use. When soil and woodland sequestration were factored in, a net Carbon emission figure of 1,518,152kg CO_2e was calculated.

Current carbon management on farm included:

- Taking 3 quality cuts of silage to increase milk from forage,
- Regular soil analysis every 3 years and lime applications where required
- Good grassland management with regular reseeding
- Solar panels on farm to produce 4.4% of energy requirements, with a wind turbine being considered also.

Recommendations to reduce CO_2e emissions to improve business performance

- Improving silage quality and increasing performance, through taking up to 5 cuts of silage and stopping zero grazing to reduce fluctuations in milk yield, and feeding a more consistent TMR.
- Improving grassland management through use of a platemeter to measure grass covers
- Introducing red and white clover into grassland swards to reduce fertiliser usage
- Improving slurry management through use of a trailing shoe, as well as possibly considering slurry separation to improve manure consistency for spreading
- Increasing woodland area and hedgerows on farm for carbon sequestration by around 0.89ha.

These recommendations would have a significant impact on the Carbon emissions produced. By improving silage quality >11ME, 105,288 extra litres per year could be produced by the milking herd, reducing the kg CO_2e/kg FPC milk by 7%, from the current figure of 1.17 to 1.09.

Introducing clover to up to 20% in grassland swards could decrease fertiliser usage by to 28 tonnes of 27% N fertiliser. This could reduce the overall farm footprint by 54t CO_2e, or 3.2%.

Using a trailing shoe LESSE applicator will reduce ammonia emissions to the atmosphere by 60% compared to a splash plate, and can mitigate the need for 2.9 tonnes of 27% N fertiliser, saving 5.74t CO_2e, or 0.32%.

By increasing woodland area, it will be possible to sequester 9.7t CO_2e per year (0.5% of farm's emissions), through strategic planting of another 2km of hedgerows, it is possible to sequester another 8t CO_2e, or 0.45% of total farm's emissions.

Farm 2

An autumn calving herd of 275 cows, producing around 8,500l/cow at 4.06% butterfat and 3.36% protein.

This farm was found to emit 3,391,330kg CO_2e from all farming operations, or 1.35kg/CO_2e FPC milk from the dairy enterprise, which was 5% above the Agrecalc average. Of the total farm emissions, 37% was the result of methane related to enteric fermentation, with other main emissions sources including purchased feed at 25%, fertiliser at 17%, and manure management at 16%. Once soil carbon sequestration was accounted for, Net carbon emissions from land use reduced to 2,572,158kg, resulting in a whole farm carbon footprint of 0.71kg CO_2e/kg output.

Current carbon management on farm included:

- Reducing the calving period from 9 to 6 months
- Focus on high quality silage – 4 cuts targeted
- Genomic testing of heifers for selection of replacements
- Effective use of sexed semen early in the breeding season
- Age at first calving around 24-25 months - aim to reduce to 23 months
- Regular soil sampling and lime application
- Slurry separation to target manure application
- GPS application of fertiliser using urea or DAP if required
- Reseeding plan in place - all swards <7 years old within 5 years
- Solar panels produce 2.6% of farm's electricity needs.
- Variable speed vacuum pump, plate cooler, and heat recovery unit all reduce electricity requirement.

Recommendations to reduce CO_2e emissions to improve business performance

- Utilise the newly upgraded Moo Monitor system to reduce the calving period from 6 to 4 months
- Select more bulls with higher genetic merit to improve milk output and milk solids
- Improve dry cow management around the transition period to improve milk output and reduce health issues
- Introduce more home grown cereals into the dairy cow ration (barley)
- Review nutrition throughout the housed period with regular forage analysis to ensure purchased protein is kept to a minimum, as well as possibly considering reducing %CP of concentrate from 19% to 17% and dropping to a 14%CP concentrate in the early grazing season
- Introduction of clover as well as herbal leys into the grazing rotation
- Use of a dribble bar for manure application
- Consider moving to protected urea
- Move to a hot wash in the milking parlour every other day to save energy
- Upgrade from the existing 150kWh wind turbine to a more efficient 400kWh wind turbine with connection to the dairy farm

These recommendations would have a significant impact on the carbon emissions. By replacing 2kg/head/day of purchased feed in the dairy cow ration with home grown barley carbon emissions would be reduced by 164 tonnes, around 5% of the total farm carbon emissions. These savings mainly come from a reduction in fertiliser used on grassland with FYM mainly used instead for the barley.

Introducing clover into the 55ha grazing block would reduce urea usage by 14t, saving 55.9t/CO_2e and reducing the farm's overall carbon footprint by 2.8%. Using a dribble bar could result in an extra 15kg N/ha being available to the soil, mitigating the need for 4.89t of urea across the silage and grazing ground. This would save 33.3t of CO_2e and reduce the farm's total carbon footprint by 1%.

Farm 3

A spring calving herd of 95 Jersey x Friesian and Irish Holstein Friesian cows, averaging 5,000l/ year.

This farm was found to emit 698,538kg CO_2e from all farming operations, which was 10.7% higher than the Agrecalc average. This resulted in a whole farm carbon footprint of 1.56kg CO_2e/kg output. The farm dairy enterprise produces 1.43kg CO_2e/ kg FPCM, which was 1.4% higher than similar dairy enterprises in the Agrecalc database. When soil carbon sequestration was accounted for, this number decreased to 0.72kg CO_2e/kg FPCM. Of the total emissions produced on farm, 41% was from enteric fermentation, 25% was related to nitrous oxide emissions from fertiliser usage, 19% was produced from manure management, and 8% was from purchased feed.

Current carbon management on farm included:

- Spring calving herd focussing on milk produced from grass, with calving taking place in a tight 10 week block and excellent fertility with a calving percentage of 100%.
- Very good grassland management on farm, with grass measured using a platemeter and Agrinet software used for grass budgeting. Intensive rotational grazing is used with cows moved to a new paddock every 12 hours.
- Sexed semen is used effectively on farm, being used in the first 3-4 weeks of the breeding season, allowing the remaining season to be used for breeding to beef bulls. Beef calves are sold off farm at 3 weeks to allow for a focus on replacement heifers to calve in at 24 months.
- Analysis of slurry for targeting fertiliser applications in the spring
- Annual soil sampling of half the farm (Whole farm sampled every 2 years) to allow for quick correction of soil pH, P and K requirements

Recommendations to reduce CO_2e emissions to improve business performance

- Increasing the beef output from the dairy herd by keeping beef calves up to 3 months rather than selling at 1-3 weeks
- Analysing slurry and FYM both in January and later in the summer when slurry is more dilute
- Move to spreading protected urea
- Installing a heat recovery unit in the dairy to use heat from milk to preheat water for parlour washing
- Establishing white and red clover into both grazing and silage swards to reduce chemical fertiliser use
- Increasing milk output through improved silage quality, genomic testing of heifer calves, and using sexed semen in better quality heifers
- Audit of woodland and hedgerows on farm to ensure woodland can sequester carbon effectively

These recommendations were made to fine tune an already sustainable farming system. By taking silage cuts earlier and improving silage quality by 0.5MJ/ME, an extra 12,226 litres could be produced from forage and the whole farm's carbon footprint could be reduced from 1.56 to 1.53kg CO_2e.

By establishing white clover into grazing swards and red clover into half of the silage swards in an area covering 28ha, fertiliser usage could be reduced by 9.4t of 46% N urea. This would result in a 58.7t CO_2e emissions reduction for the whole farm, or a 9.2% reduction in the whole farm's carbon footprint.

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 dairy 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

Farmers should also pay close attention to their replacements to ensure heifers are calving at 24 months or earlier and farmers should try to select their best heifers using genomic testing and breeding these heifers to high genetic merit sexed semen to speed up genetic improvement.

Renewables and Energy Efficiency

Farmers can also improve their energy usage by installing renewables to supply energy for the dairy enterprise, as well as ensuring they have energy efficient equipment in the dairy, such as a variable speed vacuum pump, plate cooler, and heat recovery unit.

Innovation Centre
Large Park
Hillsborough
County Down
Northern Ireland
BT26 6DR

T: 028 9268 1539
E: info@agrisearch.org
www.agrisearch.org