Department of
Primary Industries and
Regional Development

GOVERNMENT OF
WESTERN AUSTRALIA

28 October 2022

Carbon Calculators – Western Australian Dairy farm example

Agricultural practices and farming systems produce greenhouse gases (GHG) emissions. These emissions are mainly in the forms of methane and nitrous oxides. Baselining carbon accounts for individual farms will give total GHG emissions for the farm and the carbon intensity of crops and livestock produced. Farm baseline accounts include all emissions on farm, emissions from purchases and inputs such as fertiliser, feed, and electricity. These are classified as Scope 1, 2 and 3.

- **Scope 1:** All emissions on-farm from agricultural activity
- **Scope 2:** Emissions from the production of purchased electricity
- **Scope 3:** All emissions associated with producing inputs such as fertilisers, herbicides, veterinary services etc.

It is best for individual farmers or consultants to go through the process of developing a baseline carbon account for their own individual farms to tailor the inputs to that specific enterprise. The quality of the results is dependent on the quality and detail of the data used, so accurate farm records are important.

The calculator used for these examples is the Greenhouse Accounting Framework (GAF). Using the Cropping GHG Accounting Framework (G-GAF), the Sheep & Beef GHG Accounting Framework (SB-GAF), and the Dairy GHG Accounting Framework (D-GAF). These tools were developed and maintained by Primary Industries Climate Challenge Centre and the University of Melbourne.

These calculators use MS Excel spreadsheets and are freely available to download. The tools also align with the Australian National Greenhouse Gas Inventory (NGGI) method. They are simple, intuitive to use and utilise data that should be readily available for a farmer. These tools provide a snapshot of a single years GHG emissions, they report the emissions as carbon equivalents (CO_2e) of Carbon Dioxide (CO_2), Methane (CH_4) and Nitrous Oxide (N_2O).

For mixed farms the spreadsheets do require combining the livestock and cropping calculators results outside of the calculators themselves.

The tools are freely available to run your own farm here.

Contact

Ashleigh Lydon
Development Officer
t +61 (0)8 9892 8462 **|** **e** ashleigh.lydon@dpird.wa.gov.au

Summary

A carbon account of an example Western Australian dairy farm was established using the D-GAF tool to assess the emissions from this farm. The data for this example was established from industry professional consultation. The example dairy farm is a 415 milking cow operation, producing on average 22 L/day/head. This is a non-irrigated production system, with 350 ha of improved pasture. Fertiliser applications included a total of 89 tonnes of Urea, and a total of 141 kg N/ha applied. 175 tonnes of lime was also applied.

Table 1 – Livestock numbers, weights and milk production

	Milking Cows	Heifers >1	Heifers <1	Dairy Bulls>1	Dairy Bulls<1	
Livestock Numbers	415	60	120	0	5	head
Liveweight	600	420	180	0	750	kg/head
Milk Production	22.3	NA	NA	NA	NA	L/day/head

Carbon Account Results

The largest percentage of CO_2e produced was from enteric methane (60%), followed by the collective pre-farm scope 3 emissions (15%) then manure (12%). The emissions intensity for milk solids was 13.87 t CO2-e/t MS/farm/year. The lowest contributing factors included electricity, fuel, herbicides and pesticides, and atmospheric deposition (1-2%) (figure 1). Most emissions emitted were methane, followed by carbon dioxide and nitrous oxide. The methane and nitrous oxide were predominantly produced from scope 1 emissions, where the carbon dioxide emissions were mainly produced from scope 3 emissions (figure 2).

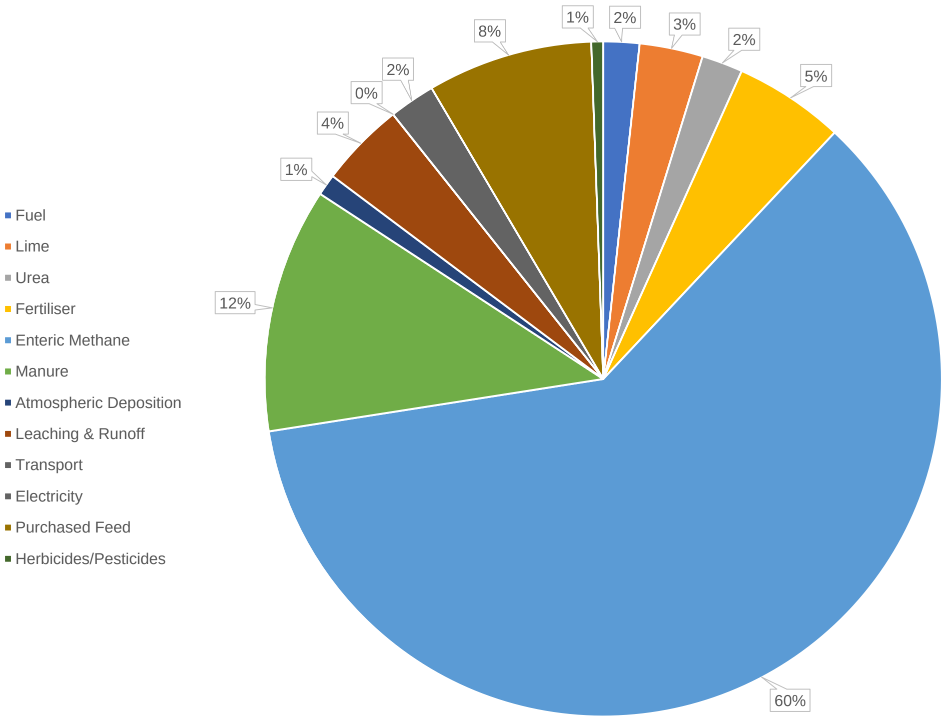

Figure 1 – South West Dairy Example Farm emissions breakdown (% tCO2e/farm)

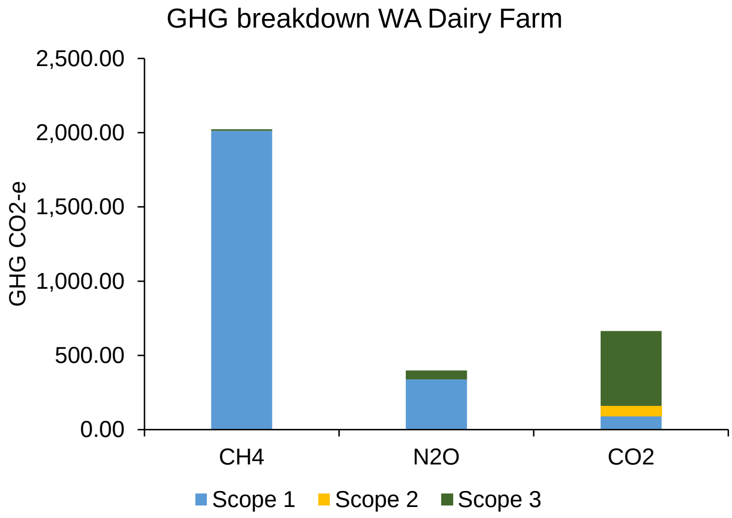

Figure 2 – South West Dairy Example Farm greenhouse gas breakdown between gas type and scope

Enteric methane was the largest contributor to total farm emissions (60%). The largest factor influencing the production of methane is animal numbers, as numbers increase, particularly milking cows, the enteric methane will also increase. The amount of feed consumed influences the methane produced. Milking cows produced the largest daily methane yield (0.412-0.444 kg CH_4/head/day), followed by the dairy bulls <1 year (0.236 kg CH_4/head/day). The increase in methane produced by the milking cows, also aligned with the increase in feed consumption and milk production seen in spring. As liveweight increases there is also an increase methane produced by the animal.

Carbon sources of emissions such as lime, fuel and urea were reasonably small contributors to total emissions. Lime contributed 3% to the overall emissions, currently a small contributor due to the quantity of lime applied (figure 1). If the amount of lime needed increased, this would also be reflected in the emissions. Fuel and urea contributed to 2% of emissions independently. 7% of emissions emitted were due to fertiliser applications, including both nitrogen fertilisers and urea (figure 1). However, of the scope 1 fertiliser emission outputs, urea CO_2 contributed 20% more t CO_2e/farm compared to direct fertiliser N_2O emissions.

Two of the key influences on emissions from agricultural soils include leaching and runoff, and urine and dug deposited during grazing. Leaching and runoff contributed to 4% of the total emissions (figure 1). This is the leaching of organic nitrogen, and subsequent denitrification in rivers and estuaries. Leaching of nitrogen in soils includes both leaching of nitrogen from manure and fertiliser. In this example the emissions have been produced predominantly from fertilisers.

Manure represents 12% of the total emissions produced. Most of these emissions are present as methane from manure management strategies. While the anaerobic lagoon contributed to a smaller fraction of the manure management strategies implemented (table 2), the methane produced was much higher compared to the other manure management strategies. Urine and dung nitrous oxide emissions which were deposited during grazing contributed to almost a quarter of the total t CO_2e/farm manure emissions.

Table 2 – Manure management

	Pasture	Anaerobic Lagoon	Sump and Dispersal	Drain to Paddocks	Solid Storage	
Manure management for milking cows	87.5	7.5	2.5	0	2.5	% of all excreta
Manure management for other dairy cows	100	0	0	0	0	% of all excreta

Options to reduce emissions in Dairy:

The largest challenge now is reducing the enteric methane emitted from the animal directly. The key ways to do this currently include improving livestock efficiencies, and reducing the emissions intensity. Other options such as feed supplements are potentially effective ways to reduce methane emitted by the animal, however these are not currently on the market, and will require extra expense for the farmer.

Animal genetics are the longest lasting and permanent options for reducing enteric methane. Changing genetics requires further research and it will take longer time periods to achieve.

The other large on farm emission is around manure management. These emissions are primarily from methane, but also include nitrous oxide. Measures to reduce GHG emissions from manure include stockpile aeration and composting which reducing methane emissions or adding urease inhibitors to manure stockpiles can reduce nitrous oxide emissions; urease inhibitors are chemical additives that stop or reduce the rate that urea is converted to nitrous oxide.

To reduce emissions from livestock urine some options include breeding for improved nitrogen efficiency, using forages with higher energy-to-protein ratios, and balancing high protein forages with high energy supplements.

There are a few other options to reduce, sequester or mitigate carbon emissions. These include, but are not limited to:

Sequester carbon by planting trees or encouraging remnant vegetation regrowth

Shift to renewable alternative energy sources

Reduce inputs

Improve livestock efficiencies by changing feed regimes, feed efficiencies such as increasing the improving the use of legumes in the system.

Use improved genetics to produce less methane,

Feed animals supplements that will mitigate methane mitigation

Prevent soil erosion by wind and water, and general improvement of soil characteristics (claying and liming)

References, links and other DPIRD web pages

How to calculate the carbon emissions from your own farm business

Livestock and Carbon

Carbon farming: reducing methane emissions from cattle using feed additives

Carbon farming: managing pastures to reduce methane emissions from cattle