Appendix 11: Australian dairy farm greenhouse gas emissions

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Livestock account for around 11 per cent of Australia's greenhouse gas emissions and researchers are working hard to develop practical on-farm options to reduce emissions without compromising farm productivity. Karen Christie, Project Officer from the Tasmanian Institute of Agricultural Research, was tasked with estimating the greenhouse gas (GHG) emissions of the 44 dairy farms to value-add to the Accounting for Nutrients (A4N) on Australian Dairy Farms project.

The A4N project involved collecting detailed data on nutrient imports, exports and within-farm nutrient flows from 44 dairy farms, on a quarterly basis. The study took place between February 2008 and February 2009 and the farms were located in the eight dairying regions of Australia (Figure 1). These farms represented the diversity of the industry in terms of herd size, farm size, level of milk production per cow, grain and forage feeding, fertiliser usage and reliance on irrigation.

While the A4N project was never intended to be used as a source of farm data for estimating on farm GHG emissions, it was clear that the dataset was an invaluable source of farm data that could be used to examine this. Of the 44 farms, 41 farms had sufficient data to estimate each farms' GHG emissions, using the Dairy Greenhouse gas Abatement Strategies (DGAS) calculator (version 1.3). DGAS estimates four sources of GHG emissions; carbon dioxide from the consumption of electricity and fuel, methane from enteric fermentation and management of animal waste, nitrous oxide from management of animal waste and nitrogen fertilisers and a pre-farm embedded emission incorporating the carbon dioxide emitted with the production of grains/concentrates, hay, silage and fertilisers that are brought onto the farm.

The average total farm GHG emissions across the 41 farms was estimated to be 2,255 tonnes of carbon dioxide equivalents (t CO_2e), but varied between 411 and 9,416 t CO_2e. To compare farms within and across dairying regions, total farm GHG emissions were divided by annual milk production (milk solids), milking herd size and total farm area (including runoff/outblock areas in addition to milking platform), to calculate a milk GHG emissions intensity (t CO_2e/ t MS), cow GHG emissions intensity (t CO_2e/cow) and area GHG emissions intensity (t CO_2e/ha). Karen found that there was a strong linear relationship between total farm GHG emissions and either milk production (Figure 2a) or milking herd size (Figure 2b), but not between total farm GHG emissions and farm size (Figure 2c).

Overall, the average milk GHG emissions intensity was 14.7 kg CO_2e/kg MS across all regions (Table 1). The average milk GHG emission for Tasmania was significantly ($P<0.05$) higher than all other regions, with the exception of Queensland, at 18.1 kg CO_2e/kg MS. The four Tasmanian dairy farms were predominantly pasture based with zero or very low levels of grain/concentrate feeding per cow and low milk production per cow at an average of 340 kg MS/cow. Previous research has shown that milk production per cow has a strong influence on the GHG emission intensity of milk production and these abovementioned points contributed to the higher mean GHG emissions intensity of milk production for Tasmania compared to all other regions.

The estimated average GHG emissions per cow was 6.3 t CO_2e/cow, with little variation between regions (Table 1), indicating that regional mean GHG emissions per cow were relatively consistent, irrespective of farm location. However, there was still quite some variation between farms within and across regions. The average GHG emissions per hectare was 7.7 t CO_2e/ha (Table 1), with noticeable variation between regions. Tasmania and to a lesser extent, south eastern Victoria, on average, had a higher GHG emissions per hectare than the other regions as a result of these two regions generally possessing a higher stocking rate (cows/ha). Given the consistent GHG emissions per cow, this increased stocking rate resulted in greater GHG emissions per unit of land. The reverse was the case for regions with lower stocking rates (e.g. New South Wales, Queensland and Western Australia).

A stepwise linear regression analysis of key farm variables identified milk production per cow as a key farm variable driver influencing the GHG emissions intensity of milk production. Increasing in milk production per cow resulted in reductions in the GHG emission intensity of milk production (kg CO_2e/kg MS) and GHG emissions per hectare (t CO2e/ha). Increasing milk production per hectare and increasing the application rate of nitrogen fertilisers (kg N/ha) were key farm variables that increased the GHG emissions per hectare. Identifying and adopting approaches that improve milk production per cow and/or improve nitrogen fertiliser efficiency are key areas to consider for GHG emissions mitigation, although it is very important that these strategies do not result in lowering farm profitability.

It is also important to note that the estimates of GHG emissions are derived by following the International Panel on Climate Change and Australian GHG inventory methodologies. It is currently not practically possible to directly measure the GHG emissions on all farms due to the significant amount of cost and technology required. Although the methodology used to estimate GHG emissions incorporates the most recent of scientific knowledge, there is still a significant amount of research being undertaken to provide a greater level of accuracy to GHG accounting on-farm.

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Contact: For more information on the A4N project, contact Dr Cameron Gourley on (03) 5624 2222 or Cameron.Gourley@dpi.vic.gov.au. For more information on this study, contact Karen Christie on (03) 6430 4921 or Karen.Christie@utas.edu.au or to view the DGAS calculator, visit the Dairying for Tomorrow website http://www.dairyingfortomorrow.com.au/index.php?id=47

Table 1. Regional means and ranges of milk greenhouse gas emissions intensity (t CO_2e/t MS), cow greenhouse gas emissions intensity (t CO_2e/cow) and farm area greenhouse gas emissions intensity (t CO_2e/ha).

	Milk GHG emissions intensity (t CO_2e/t MS)		**Cow GHG emissions intensity (t CO_2e/cow)**		**Area GHG emissions intensity (t CO_2e/ha)**	
	Mean	Range	Mean	Range	Mean	Range
NSW	14.9^{b}	12.0 – 18.7	6.8^{a}	5.3 – 8.6	6.0^{c}	1.4 – 16.2
QLD	15.7^{ab}	13.6 – 19.2	6.2^{a}	4.8 – 7.0	4.8^{c}	1.5 – 7.0
SA	13.8^{b}	12.1 – 15.0	6.8^{a}	5.9 – 7.4	8.2^{abc}	2.2 – 15.4
TAS	18.1^{a}	14.4 – 22.7	6.0^{a}	5.5 – 6.3	11.1^{a}	9.0 – 12.6
Nth VIC	13.2^{b}	12.6 – 13.6	6.4^{a}	5.8 – 6.7	8.8^{abc}	5.0 – 11.0
SE VIC	14.0^{b}	10.6 – 16.4	6.3^{a}	5.8 – 7.5	10.4^{ab}	5.0 – 18.0
SW VIC	13.0^{b}	11.0 – 14.6	5.8^{a}	5.3 – 6.3	6.4^{abc}	4.2 – 8.8
WA	14.5^{b}	13.1 – 15.4	6.1^{a}	5.5 – 6.4	5.2^{c}	2.1 – 6.8
Overall	14.7	10.6 – 22.7	6.3	4.8 – 8.6	7.9	1.4 – 18.0

Superscript letters which differ indicate a significant ($P<0.05$) difference in greenhouse gas emissions intensity

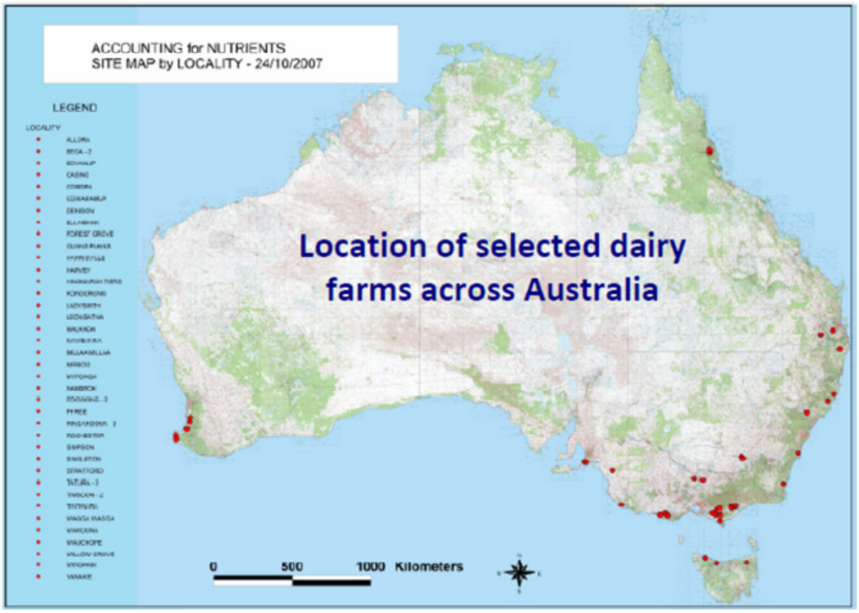

Figure 1. Location of the 44 farms involved in the Accounting for Nutrients project.

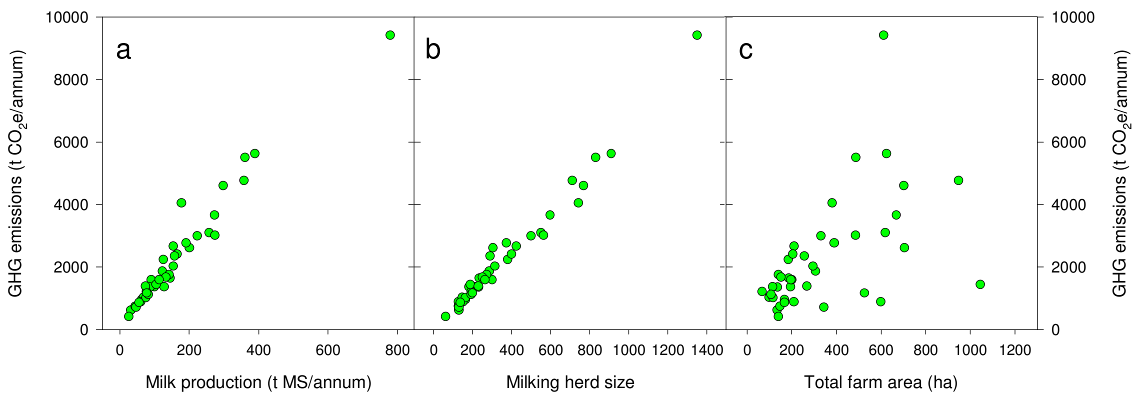

Figure 2. Linear relationship between total farm greenhouse gas emissions (t CO_2e/annum) and milk production (a; t MS/annum), milking herd size (b) and farm area (c; ha).