The effectiveness of greenhouse gas abatement strategies for the dairy industry in south-western Victoria, Australia

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Introduction

In Australia, the dairy industry generates 8.9 million tonnes of carbon dioxide equivalents (t CO_2e) per year (Christie *et al.* 2011). Most greenhouse gas (GHG) emissions from the dairy sector are high global warming potential gases such as methane (CH_4) from enteric fermentation and nitrous oxide (N_2O) from cattle urine and nitrogen (N) based fertilizers, contributing to climate change issues. Several GHG abatement options are available to dairy farmers, including increasing diet quality, feeding oils and reducing replacement rates (Eckard *et al.* 2010), but little assessment of their effectiveness has been carried out at a farm system level. The two objectives of this study were: first, to quantify GHG emissions from pasture-based dairy production systems in south-western Victoria; second, to identify GHG abatement strategies and examining their effects on reducing farm emissions.

Methods

The Dairy GHG Abatement Strategies (DGAS) calculator was utilised to model GHG emissions from farms. The DGAS was developed based on the methodologies, algorithms and emission factors of the Intergovernmental Panel on Climate Change and the Australian national inventory (Christie *et al.* 2011). Its global warming potential values for CO_2, CH_4 and N_2O are 1, 21 and 310 respectively. This study focused on the farm system including only emissions from on-farm and pre-farm sources. The farm data required in DGAS was gathered from 2010/11 farm performance reports that were published by Red Sky Agricultural (www.redskyagri.com). These reports cover 39 dairy farms from south-western Victoria. The farms are classified into average and top 10% categories according to their financial performance. The key dairy farm data is shown in Table 1.

DGAS was also used to estimate GHG emissions reductions from simulating potential GHG abatement strategies (Christie *et al.* 2011). The five strategies investigated were: (1) improving the digestibility of pasture from 70% to 75%; (2) increasing feeding of grain/ concentrate by 50%; (3) supplementing 6% of dietary fats and oils in annual feeding components; (4) spraying nitrification inhibitors onto soils in autumn, winter and spring; and (5) decreasing heifer replacement rate from 28% to 15%.

Results

The total GHG emissions of the average and top 10% south-western Victorian farms were 2815 and 3369 t CO_2e respectively (Fig. 1), equivalent to 14 and 16.5 t CO_2e per ha. The emissions intensity of milk solids (MS) production was 14.7 and 14.3 t CO_2e per t MS for average and top 10% farms.

Of the abatement options investigated, decreasing annual heifer replacement rate showed the most significant reduction in GHG emissions (184.5 t CO_2e; 6%), followed by supplementing dietary fats and oils in feeding components (135 t CO_2e; 4.4%), spraying nitrification inhibitors onto soils (110.5 t CO_2e; 3.6%), increasing the amount of grain/concentrate in feeds (53 t CO_2e; 1.7%) and improving the digestibility of pasture (29 t CO_2e; 0.9%). When all five abatement strategies were implemented, the average and top 10% farms had 439 (15.6%) and 528 (15.7%) t CO_2e emissions reductions each, corresponding to 2.3 (15.6%) and 2.2 (15.4%) t CO_2e reductions in emissions intensity of MS production respectively.

Conclusion

These results showed that the top 10% farms generated more GHG emissions per ha but produced milk at lower emissions intensity than the average farms. The dairy

Table 1. Annual key dairy data from the average and top 10% dairy farms in south-western Victoria.

	Area (ha)	Herd size (cows)	Milksolids (t MS/farm)	Electricity (k Wh)	N fertiliser (kg N/ha)	Pasture + silage consumed (t/farm)	Grain/concentrate consumed (t/farm)
Ave	201	398	192.1	129396	157.2	1932.1	648.7
10%	204	471	235.7	176756	202.5	1930.6	715.9

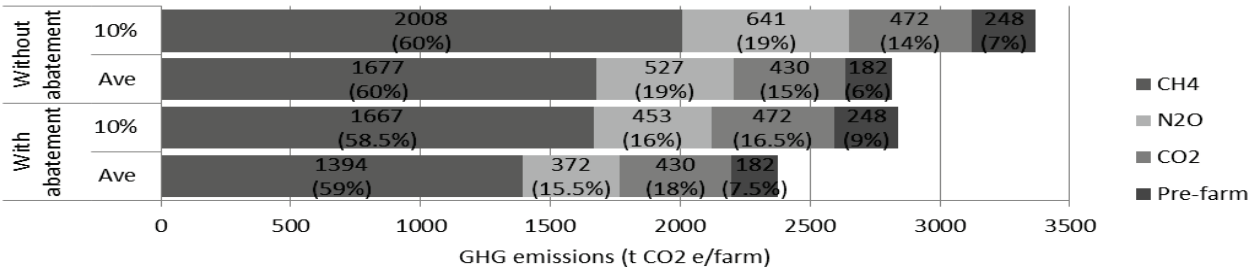

Figure 1. Comparisons of the GHG emissions (t CO_2e) from the average and top 10% dairy farms in south-western Victoria without and with the five abatement strategies implemented. Each bar contains the data of on-farm CH_4, N_2O, CO_2 and pre-farm emissions and their percentages in the total GHG emissions.

farms in south-western Victoria had the potential to reduce GHG emissions or emissions intensity of MS by approximately 15% after applying all the strategies.

Decreasing annual heifer replacement rate was the most effective single option to abate on-farm emissions, as it achieved a 6%reduction in total GHG emissions for both the average and top 10% farms.

Reference

Christie KM, Rawnsley RP, Eckard RJ (2011) A whole farm systems analysis of greenhouse gas emissions of 60 Tasmanian dairy farms. *Animal Feed Science and Technology* **166–167**, 653–662.

Eckard RJ, Grainger G, de Klein CAM (2010) Options for the abatement of methane and nitrous oxide from ruminant production: a review. *Livestock Science* **130**, 47-56.