Comparative analysis of greenhouse gas emissions and abatement strategies for agricultural enterprises dairy, sheep and grains

Agriculture produces approximately 10-12% of total global anthropogenic greenhouse gas emissions. At 16%, it is the second largest contributor to Australia's total emissions, and will therefore be expected to be part of strategies to reduce national emissions.

The main sources of greenhouse gases from agriculture include methane (CH_4) lost during enteric rumen digestion and nitrous oxide (N_2O) released from nitrogen fertilisers, animal excreta and soils.
A recent study aimed to identify the sources and quantity of greenhouse gas emissions for three farms in Victoria, and to explore and compare abatement options for emissions. Emissions and abatement options were compared for a dairy farm in Longwarry, a sheep property in Gunbower and a cropping farm in Warracknabeal.

Data analysis for each enterprise was collected using the:

- Dairy Greenhouse Gas Abatement Strategies calculator (DGAS)
- Greenhouse in Agriculture tool (GIA) for the sheep and grain enterprises.
- National Carbon Accounting Toolbox (NCAT) Full Carbon Accounting Model (FullCAM) to measure the offset potential of planting trees to reduce emissions on farm.

To allow comparison of emissions between the enterprises, figures were calculated on a per hectare basis.

Table 1: Comparison of emissions (tonnes of carbon dioxide equivalent per hectare), abatement potential, and suitable tree species/sequestration potential for dairy, sheep and grain case studies

Enterprise	Baseline emissions (t CO2e/ha)	Emissions with abatement/offsets (t CO2e/ha)	Offset potential using trees, FullCAM model (100yr av. rate of carbon sequestration)
Dairy – Longwarry	9	6.8	Environmental plantings 0.63tC/ha/yr or blue gums 1.76tC/ha/yr**
Sheep – Gunbower	0.41	0.31*	Environmental plantings 0.34tC/ha/yr or sugar gums 2.50tC/ha/yr
Grains – Warracknabeal	0.117	0.1	Environmental plantings 0.19tC/ha/yr **

* Reduction in emissions calculated using the Greenhouse in Agriculture (GIA) tool by increasing the environmental plantings to cover 10% of the farming area (increase plantings from 40 ha to 70 ha)
** Maximum carbon storage reached at 2090 for these plantings in these locations. Other plantings reach maximum at 2100.

For the sheep and dairy farms, the main source of emissions is enteric methane from rumen fermentation, contributing 73% and 54% of total emissions respectively. For the cropping farm in Warracknabeal, the main source of emissions is N_2O derived from crop residues, fertilisers, leaching and indirect ammonia.

Planting trees to offset total net emissions for the dairy farm is practically impossible, as an area of land greater than the total farm area (150 ha) would be required to totally offset emissions from the dairy system (until 2090). However, for the sheep farm in Gunbower, increasing plantings may be a suitable option to offset a portion of the farm's emissions, given the larger number of hectares available for planting (these values were calculated using the Greenhouse in Agriculture calculator, and therefore differ slightly from the FullCAM output). The sequestration potential of trees is finite. Using the FullCAM model, plantings would reach maximum carbon storage between 2090 and 2100, whereas farm emissions are potentially infinite. Nevertheless, the integration of trees on farming land should not be disregarded, as tree plantings offer a number of other benefits aside from their carbon sequestration value.

There are a number of abatement options other than carbon sequestration that should be considered, the suitability of which will vary for each enterprise. These include:

Abatement strategies for methane

- Diet manipulation strategies (including addition of dietary oils and tannins, increase in forage quality and level of grain feeding)
- Extended lactation, reducing energy requirements and number of cows, and potentially increasing quality of milk
- Genetic improvement for feed conversion efficiency (long term strategy)
- Development of vaccines to reduce methane production

Abatement strategies for nitrous oxide

- Management of N_2O losses through source, rate and timing of fertiliser application
- Management of tillage, soil compaction and soil aeration
- Use of cover crops during the fallow period to remove residual nitrate from soil
- Use of nitrification inhibitor coated fertilisers
- Use of nitrification inhibitor spray to reduce emissions from animal urine

Methane abatement strategies are numerous and the introduction of dietary oils is a relatively practical option for dairy, but is limited for an extensive sheep farm. Increasing the forage quality and level of grain feeding in the diet may provide more practical options for dairy and sheep, depending on the farm set-up. Nitrification inhibitors, such as coated fertilisers, effectively reduce N_2O loss for cropping, sheep and dairy enterprises. However, the costs of these strategies are currently prohibitive and further research is required before they become commercially available. It is also important to consider each strategy in the context of a farm's full life cycle analysis, to ensure that the efficiency and sustainability of the farm system is maintained.

Websites for carbon tools

DGAS - www.dairyingfortomorrow.com
Greenhouse in Agriculture tools -
www.greenhouse.unimelb.edu.au/Tools.htm
NCAT & FullCAM -
www.climatechange.gov.au/government/initiatives/ncat.aspx

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