Reducing dairy's greenhouse gas emissions

Value and cost efficiency of emission reduction on dairy farms

Fact sheet 1 of 6

The Australian dairy industry is fortunate to have many options to help it reduce the greenhouse emissions generated on-farm during the process of producing milk and meat.

And as technology develops, more options will become available. But like anything on farm, options need to be considered in the context of the individual farm circumstances. Not every option is suitable. Some don't make financial sense – they cost too much for the end result. Others simply aren't practical to implement on a busy dairy farm. Then there are those that don't achieve the desired result. Options also need to be considered in the context of the specific circumstances of each individual farm.

Understanding the effectiveness and value-for-money of any investment is crucial to ensure money and time is spent appropriately within a business. But understanding the value of emissions reduction strategies isn't simple.

Dairy Australia commissioned a study to identify key emissions reduction opportunities on Australian dairy farms. The study drew upon information from a variety of sources to estimate the costs and effectiveness of greenhouse gas (GHG) interventions. The best way to predict the results of different emissions reduction options for an entire industry is to model the outcomes using a marginal abatement cost curve (MACC). The analysis, completed late in 2022, updates work from 2019.

KEY POINTS

A marginal abatement cost curve (MACC) is an economic tool that estimates the costs and effectiveness of different greenhouse gas reduction strategies

Modelling has been completed for the Australian dairy farming industry as a whole to estimate the carbon price required to cover the cost of, or make a profit from, various emission reduction activities, and to understand the impact on industry emission

This fact sheet will help you to understand what Dairy Australia is doing to look at emissions reduction across the industry to meet the industry goal of reducing emissions intensity by 30% by 2030. It will also provide a summary of what each strategy is, the pros, cons, costs and where the knowledge gaps are. It is not an evaluation of whether a specific strategy will pay off for your individual farm business, but it is a helpful step

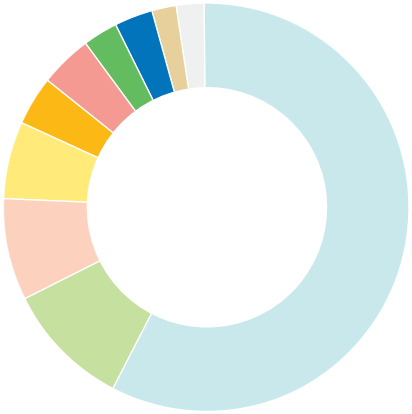
Reducing dairy's emissions

The Australian dairy industry has committed to reducing its greenhouse gas emissions intensity by 30 per cent by 2030 compared to a 2015 baseline.

The **2021 Australian Dairy Industry Sustainability Report** found 94 per cent of Australian dairy farmers have implemented practices on their farms to reduce or offset their greenhouse gas emissions. Dairy manufacturers reduced their greenhouse gas emissions by 23.5 per cent in the decade prior, according to the report.

DELIVERING for DAIRY

Figure 1 Analysis of dairy farm's GHG emissions data



Enteric methane	58%	N_2O nitrogen fertiliser direct	4%
Waste methane	10%	N_2O manure spread inc direct	3%
Concentrates	8%	Fertiliser	3%
Electricity	6%	Fodder	2%
N_2O direct voided onto pasture	4%	Diesel	2%

Source: Christie, K. 2020, DairyBase

Estimated pre-farmgate Australian dairy emissions are 9.8 million tonnes of carbon dioxide equivalent (CO_2e) per year, with enteric methane contributing 58 per cent of this (see Figure 1 above).

There are two ways to decrease emissions on a dairy farm. The first is decreasing the total emissions and the second is reducing the emission intensity – decreasing the amount of carbon emitted relative to milk production.

All countries with more than 4,000 litres fat and protein corrected milk (FPCM) per cow per year have emissions intensity less than 2kg CO_2e/L FPCM. Australia is one of the few countries to have emissions intensity of about 1kg CO_2e/ litre FPCM. But there is still room to improve efficiency and reduce emissions and achieve the industry target.

Marginal abatement cost curve

The marginal abatement cost curve (MACC) generates a cost per unit of emissions reduction expressed as dollars per tonne CO_2e.

This unit enables accurate comparisons between different emissions reduction strategies with different costs, effectiveness and applicability.

The 2022 Dairy MACC considered options for reducing greenhouse gas emissions on-farm across a 10-year timeframe (see Table 1).

The main values required for this MACC were:

- The rates of adoption of the emissions reduction strategies.
- The chances of these actions reducing emissions – mitigation potential.
- The cost, or potential savings, associated with implementing these measures.

Three scenarios were investigated for each option – pessimistic, optimistic and moderate.

On-farm application

The accompanying fact sheets in this series provide a starting point for farm businesses considering options for reducing emissions.

Table 1 Options assessed for emissions mitigation or reduction

Enteric methane interventions	
Feed additives	Other
• Agolin® (an essential oil)	• Breeding
• Asparagopsis (red marine algae)	• Early life programming
• Bovaer® (3-NOP)	
Manure methane interventions	
• Effluent additive	• Covered anaerobic ponds
Nitrous oxide interventions	
• Balancing dietary energy : protein	• Reduced fertiliser use
Fossil fuel, CO_2 intervention	
• On-farm renewable energy	• Carbon neutral fertiliser
Carbon sequestration	
• Environmental planting	• Shelter belts
• Timber plantations	

Results

The research identified the actions most likely to reduce emissions on-farm cost effectively. The top three options in the order of value for investment were:

1 Agolin® (an essential oil feed additive): cost savings (profit) of $130 a tonne of CO_2e.

2 On-farm renewable energy: cost savings (profit) of $94/tonne CO_2e.

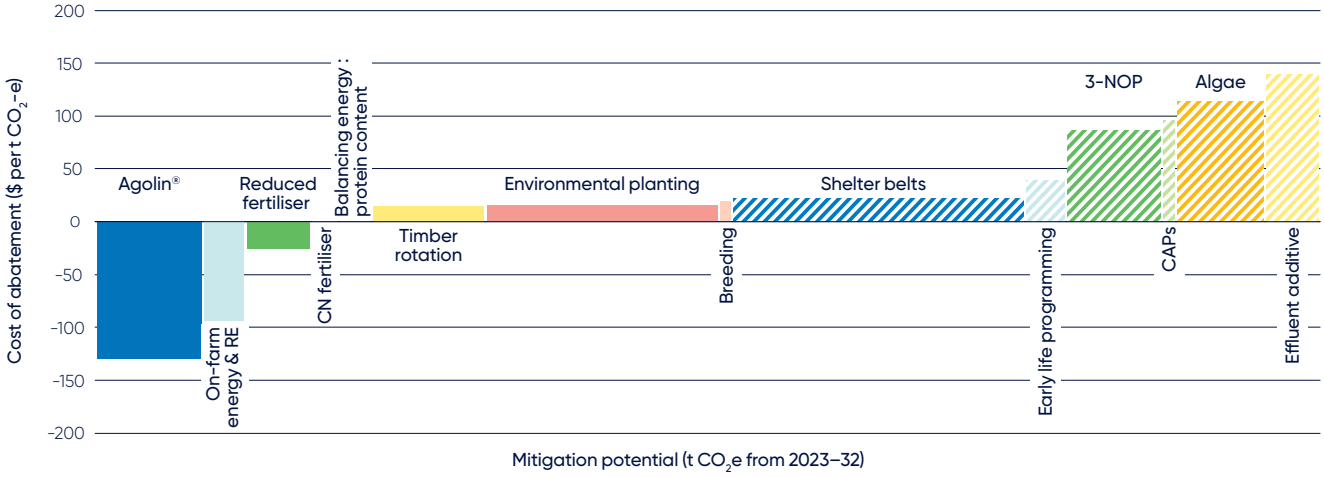
3 Reducing fertiliser use: cost savings (profit) of $25/ tonne CO_2e.

The most expensive way to reduce greenhouse gas emissions was using an effluent additive, setting farmers back $139/tonne CO_2e.

The report noted that this modelling was according to the medium cost, effectiveness and adoption assumptions and the cost per tonne of CO_2e was most heavily determined by the effectiveness of the option in reducing emissions, its cost and financial benefits.

Options with longer timeframes to commercialisation have less time to mitigate and accumulate emissions reductions by 2032, potentially leading to a higher cost per tonne of CO_2e.

Figure 2 Results for the medium assumptions for emissions mitigation potential, adoption and costs



Negative values denote financial benefit (revenue/savings)

In the diagram above, emission reduction strategies with negative values (below the $0 line) indicate that these are likely to represent an overall cost saving (increased profit) to a farm business (Agolin, on-farm renewable energy and reduced fertiliser). Strategies above the line indicate an estimated cost to a farm business per ton of greenhouse gas emissions reduced. The highest values, on the right side of the graph, indicate the greatest estimate cost per ton of reduced emissions, based on the situation at the end of 2022 and noting that these may come down significantly over time.

Small productivity benefits at the cow level can have a substantial positive impact on the cost per unit of emissions reduction. But options associated with any decline in production would be costly.

Limitations

The MACC is a useful tool to predict the results of different emissions reduction options for an entire industry. However, the dollar values in the diagram above do not apply to individual farm businesses. This is because the model involves complex assumptions for each option in terms of mitigation potential, expected costs, potential returns and forecast adoption rates.

There were three additional limitations to the 2022 Dairy MACC study.

Firstly, this MACC reflects current research only; the possibility of future technological and knowledge development hasn't been considered in the modelling. It's based on mid-2022 published literature and expert opinion.

Secondly, a timeframe of 10 years was applied to assumptions including the rate of adoption of emissions reduction strategies, costs, national on-farm emissions as well as the usefulness of each strategy. As a result of this 10-year forecast, this MACC included speculation. The report authors acknowledged that the effectiveness and costs of each strategy could change during the next 10 years, and this wasn't reflected in the analysis.

Similarly, employing an emission reduction strategy with a large capital investment is considered more expensive per unit of abatement than if a longer period was considered over which to spread the upfront costs.

Thirdly, each emission reduction option was modelled as an independent choice without consideration to co-benefits such as the ability to harvest timber from plantations. For example, the impact of reduced fertiliser use on the benefit of the carbon neutral fertiliser option wasn't included. Also, the adoption of some options could make other options less practical or effective. To account for these limitations, report authors ranked each mitigation option based on the 'uncertainty of assumptions' which were rated as either low, moderate or high.

Development

The Dairy MACC drew upon:

- A review of literature of the latest information about commercial solutions to greenhouse gas emissions reduction and their reduction potential.
- The expertise of a panel of technical specialists, industry representatives and service providers who discussed research gaps, policy implications and challenges in meeting industry emissions reduction targets.

What farmers can do now

The first step for any farm business is to understand your own farm emissions. You can do this with the Australian Dairy Carbon Calculator (ADCC) – a free, industry standard, levy-funded tool developed by experts, accepted across the supply chain and in line with Australian and international carbon accounting methods.

The ADCC is available through **DairyBase** or as a standalone **spreadsheet**. Both use the same calculations.

Once you know your carbon number, you can use these fact sheets to start looking at profitable ways to reduce your emissions and contribute to achievement of the industry target.

Available now
and cost effective

- Agolin feed additive ★★★
- On farm renewable energy ★★
- Reduced fertiliser use ★
- Balancing energy : protein ratio ≈

Net return on investment check

★★★ >$100 return/t of CO_2e reduced
★★ >$90
★ >$25
≈ Cost neutral

Available now
but needs to work for your business

- Environmental planting $
- Timber plantation $
- Shelter belts $
- Breeding $

Net return on investment

$ >$10–20/t

Approach with caution
high cost and/or more research needed

- 3-NOP feed additive $$$
- Effluent additive $$$$
- Asparagposis $$$$
- Carbon neutral fertiliser ≈
- Early life programming $$
- Covered anaerobic ponds $$$

Net return on investment

$$ >$20/t
$$$ >$80/t
$$$$ >$100/t
≈ Cost neutral

Calculating the value of emission reduction strategies

- A review commissioned by Dairy Australia has estimated the costs and effectiveness of different greenhouse gas emission reduction strategies across the Australian dairy farm industry as a whole, based on the most recent information available.
- Each strategy was analysed for its ability to reduce the total greenhouse gas emissions (mitigation potential). The cost of this action was calculated per tonne of carbon dioxide equivalent or CO_2e and modelled into a marginal abatement cost curve.
- Combining the mitigation potential and the cost of the reduction paints a picture of the value for money that each strategy could deliver.
- This information will be used to guide research and investment decisions.
- This fact sheet and others in the series provide a summary of the information from research most relevant to individual farmers. They provide a useful starting point for farm businesses looking to understand their options. Farm businesses will need to do further analysis to figure out which option(s) are appropriate for their own business.

FURTHER INFORMATION

This fact sheet is one of a series:

1 **Reducing dairy's greenhouse gas emissions**
2 Reducing rumen emissions
3 Reducing manure emissions
4 Reducing nitrous oxide emissions
5 Reducing fossil fuel emissions
6 Storing more carbon.

You can find these on the Dairy Australia **website**.

Definitions

Abatement, mitigation reducing.

Abatement cost the cost of reducing the volume or intensity of greenhouse gas emissions.

Marginal cost the cost of reducing an additional unit of CO_2e.

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