Reducing nitrous oxide emissions

Nitrous oxide (N_2O) is a greenhouse gas emitted from organic-rich soils such as fertilised pastures or paddocks where livestock have deposited urine or manure. Reducing N_2O can decrease a dairy farm's total greenhouse gas emissions.

It's possible to reduce nitrous oxide emissions by reducing the farm inputs that contribute to N_2O emissions, or to reduce those emissions through the application of specially designed products.

The direct and indirect N_2O emissions attributed to fertiliser contribute to three per cent of dairy farm emissions; animal waste N_2O equates to about eight per cent of emissions.

The term nitrous oxide interventions refers to products and strategies that are used to reduce the N_2O emitted from dairy farm soils. Two nitrous oxide interventions currently available include:

- Nutrition.
- Reducing fertiliser use.

Nutritional intervention

This involves balancing the ratio of energy to protein in an animal's diet to improve the nitrogen efficiency of a dairy cow's digestive processes. When the proportion of crude protein in the diet is high, there's an increase in the nitrogen excreted in urine. For example, using grain as a feed supplement can boost the energy content of a cow's diet to counteract the seasonal rises in crude protein.

KEY POINTS

- N_2O is a greenhouse gas which contributes to about 11% of dairy farm emissions
- On farm, N_2O is emitted from organic-rich soil, such as fertilised pastures or paddocks where livestock have deposited urine or manure
- The direct and indirect N_2O emissions attributed to fertiliser contribute to 3% of dairy farm emissions, while animal waste N_2O equates to 8% of emissions
- Urine N_2O emissions can be reduced by adjusting the diet, particularly by balancing the protein and energy content and the use of urine patch inhibitors
- Reducing fertiliser use and applying fertiliser inhibitors can also mitigate N_2O emissions, although more information is needed about inhibitors
- Reducing fertiliser applications by targeting specific locations to reduce leaching and gas formation (volatilisation) was the most effective way to reduce N_2O emissions
- Modelling suggests applying less fertiliser could deliver a financial benefit, while concentrating on the animal's feed – balancing the energy and protein – may come at a small net cost

Many dairy farmers are already using nutrition – specifically balancing the ratio of energy to protein of their herd's diet – to reduce N_2O emissions for at least three months of the year (spring) when the crude protein levels in pasture rise.

Balancing the ratio of energy and protein in the diet comes with a significant co-benefit: an increase in milk production as a result of supplementing a pasture diet with grain. The net financial cost or benefit of this strategy is likely to be variable, depending on fluctuations in farmgate milk and grain prices.

Balancing the ratio of energy to protein in an animal's diet to reduce N_2O emissions may achieve around 50 per cent reduction in N_2O emissions from urine.

To accurately gauge the amount of N_2O already abated by the dairy industry, more detail is needed about the extent to which farmers balance the ratio of energy to protein in their herd's diet. Further work is needed to understand the potential benefits of using this practice outside of spring.

Reducing/targeting fertiliser use

This involves applying less fertiliser to paddocks, including limiting application to locations that need nitrogen and to times when there will be less nitrogen loss through leaching and gas formation (volatilisation).

Farm use of urea declined between 2015 and 2020, which suggests more people were using less fertiliser and this trend is expected to continue with increases in fertiliser prices.

Reduced fertiliser use delivers the largest reduction in N_2O emissions but can also result in a financial benefit due to cost savings. These come from a decline in the overall use of fertiliser as well as reduced leaching and volatilisation.

Also, the more this intervention is adopted the less need there is for carbon neutral fertilisers and fertiliser inhibitors – the best use of these is to apply the minimum amount of fertiliser required.

Any reduction in fertiliser use will give an approximately equal reduction in N_2O emissions from fertiliser. It also reduces carbon dioxide equivalent, or CO_2e emissions from fertiliser production.

The effectiveness of this intervention is variable and influenced by the characteristics of farms, weather conditions and previous farm management.

Inhibitors

Inhibitors that reduce N_2O emissions can be added to fertiliser or applied to urine patches. They offer an option to reduce emissions from conservative fertiliser application.

However, there are considerable knowledge gaps that need to be addressed such as the variability in effectiveness, determination of the application rates required compared to traditional fertiliser, and confirmation in international markets that milk from farms using these products is acceptable.

There are a lot of questions about inhibitors on urine patches. Trials demonstrated that the use of inhibitors on patches could decrease N_2O emissions by 25–40 per cent, but this hasn't been proven in a commercial setting.

In a commercial setting, it's expected that the inhibitor would be applied to the urine patch well after deposition and this would decrease the effectiveness of the N_2O mitigation. There are also questions about the timing of grazing after the application of the urine patch inhibitor as there are concerns of transmission from the pasture to the milk and meat. The productivity benefits of inhibitors are also uncertain.

It's a similar story for fertiliser inhibitors. It's understood that associated reductions in direct N_2O emissions can lead to increases in indirect N_2O emission from ammonia gas formation (volatilisation), creating uncertainty about the effectiveness of the product. Results vary from a slight increase in emissions through to more than 50 per cent reductions in soil N_2O emission in some studies.

Fertiliser inhibitors may be less effective at temperatures of more than 25–30° Celsius. There's also a need for more evidence of nitrogen savings associated with fertiliser inhibitors as the current cost of this type of fertilisers is $48 more a hectare than traditional fertiliser. This not only adds costs to the dairy business, but it also means fertiliser used with inhibitors could be one of the most expensive greenhouse gas mitigation options.

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.
- 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.