Profitable dairy farming: Good business management reduces greenhouse gases

Managing diet and pasture to increase profit and reduce emissions

Key points

- Greenhouse gas emissions are highest per kg of milk solids when cows are fed poor quality diets
- High quality, high digestibility feed will maximise milk production and minimise greenhouse gas emissions per kg of milk solids.

Key recommendations

- Monitor and supplement diets to ensure nutritional requirements are met when pasture quality is low
- Use low protein, high energy supplements when pastures are high in nitrogen to improve milk production efficiency, avoid excessive dietary nitrogen and minimise nitrous oxide emissions
- Include fats and oils as feed supplements to increase milk production if dietary fat levels are below 2-3%, to reduce methane emissions and potentially generate income through the Emissions Reduction Fund.

Why manage emissions through diet and pasture?

Greenhouse gas emissions represent an inefficiency in dairy systems. The loss of methane and nitrous oxide gases into the atmosphere means either that energy and nitrogen which could otherwise be directed towards production are being lost, or that inputs (and costs) are exceeding what the system requires. Some level of emissions is inevitable, but there are many opportunities within a typical dairy system to reduce greenhouse gases and achieve efficiency gains.

The energy lost as enteric methane from a lactating dairy cow is the equivalent to 25 to 40 grazing days per year, or up to 10% of gross energy intake.

Excess nitrogen in the diet leads to nitrogen losses from animal wastes, a small fraction of which is converted to nitrous oxide. In both cases, diet quality has a significant effect on the level of emissions. The most effective mitigation options are those that improve diet quality by matching feed intake with dietary requirements.

Alongside the productivity benefits of reducing emissions, it is possible that farmers will in the future be able to gain income through 'carbon farming'. At this stage feeding oils (as described below) is the only Emissions Reduction Fund methodology related to dietary management. However with the carbon price likely to be low in the short- to medium-term, any ERF income is likely to be only a small percentage of a farm's yearly operating profit. For this reason any changes in diet management must be profitable in their own right, with the emissions reductions and ERF income as additional benefits.

The difference in emissions between various dairy systems highlights the opportunity to reduce this inefficiency. The most efficient dairy systems will minimise greenhouse gas emissions per unit of milk solids. Applying best practice management for cow nutrition will reduce emissions intensity, improve efficiency and increase profitability.

What does the research say?

High quality pasture and forages will reduce energy lost as methane

The rumen microbes responsible for producing methane thrive on high-fibre diets. High fibre, low digestibility feeds – such as hay, mature pasture and C4 grasses – will result in greater methane emissions than forages and pasture with lower fibre and higher soluble carbohydrates – such as less mature pastures, cereal grains, C3 grasses and legumes.

Increasing the grain content of the diet is an option for reducing methane emissions, as grain increases soluble carbohydrate and proportionately reduces fibre intake and therefore the proportion of energy converted to methane. Grain feeding can also reduce nitrous oxide emissions (see section on next page on energy-to-protein ratio) however this strategy may increase off-farm transport emissions.

Higher digestibility increases both voluntary intake and the rate of passage through the digestive system, so that digestion is more energetically efficient and less energy is diverted to methane production.

Overall improvements in diet quality will lead to more milk per unit of feed and lower emissions per unit of milk solids

High-fat feeds will reduce methane and potentially provide ERF income

Another key dietary strategy for reducing methane emissions is through feeding high-fat supplements. Research has shown that for every 1% extra oil added to the diet of livestock in summer and autumn when pasture quality is low, enteric methane can be reduced by 3.5% (Moate et al., 2011).

Increased dietary fat suppresses the activity of the methane-producing microbes in the rumen. High fat supplements suitable for dairy cows include canola meal, cold-pressed canola meal, brewers grain, hominy meal and dried distillers grain. As they are by-products of other agricultural industries, little or no added emissions are produced through their use as supplementary feed in dairy systems.

In addition to reducing methane, high-fat supplements will also increase milk production if they are adding new energy to the diet. However as feed intake and milk production are both suppressed when dietary fat exceeds 6-7%, high-fat supplements should only be used when pasture quality (and therefore natural grass oils) are low. In southern dairy systems, the response to dietary oil supplementation will be highest in summer, when oil levels in grass are about 1%.The ERF provides a financial incentive for dairy farmers to reduce methane emissions through feeding of specific high-fat supplements. The comparative contributions of increased production and ERF income to profitability are highlighted in the modelled calculations below. In this example, when a high oil supplement was used at a $5 / tonne carbon price, 98% of the profit increase came from extra milk production and 2% from the ERF payment. At a $20 / tonne carbon price the ERF contribution to profit rose to 9%.

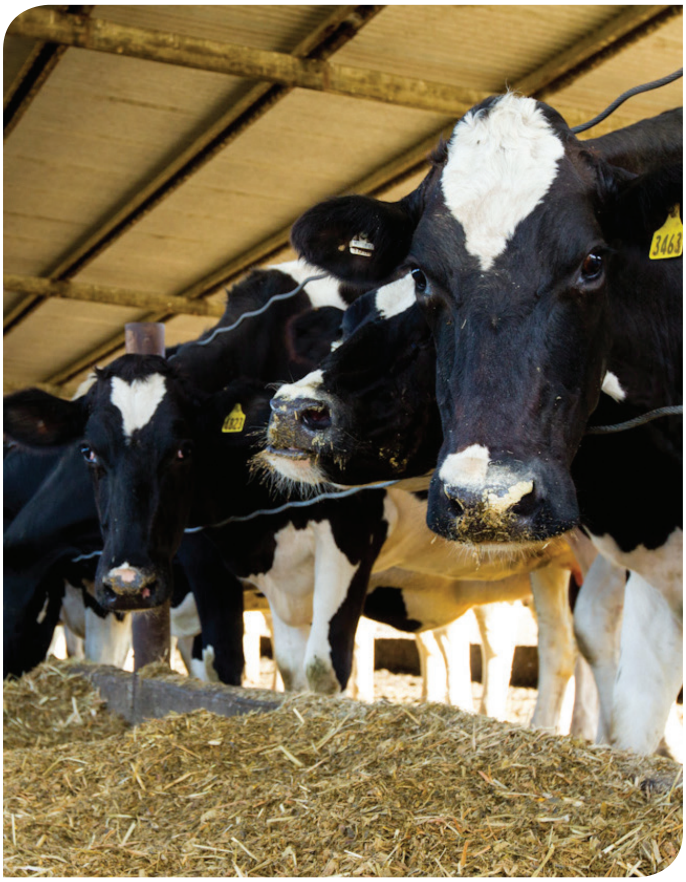
Optimal energy-to-protein ratio will minimise nitrogen loss

Balancing dairy cow nutrition in terms of protein and energy also offers an opportunity to reduce emissions – in this case, the nitrous oxide emissions that result from excess dietary nitrogen.

Dairy cows are poor converters of dietary nitrogen to milk, with most excess nitrogen excreted in urine as urea, and then lost to the environment as nitrous oxide, ammonia gas or through leaching. At various times of the year pasture protein is in surplus while energy is limited, leading to excess nitrogen intake. High protein feeds, on which cows will ingest high levels of nitrogen, include lush spring and autumn pastures, and silage made from these.

Feed management options for matching nitrogen intake with dietary requirements include replacing pasture silage with maize or cereal silage, supplementing with grain (wheat, barley and maize have high metabolisable energy and low nitrogen contents); or selecting a pasture species with higher energy-to-protein ratio so that the additional energy can be converted into additional milk. Timing of grazing is also important – grazing pastures at three-leaf emergence stage, when energy-to-protein ratio is highest, will reduce nitrogen loss in urine and therefore nitrous oxide emissions.

However there can be large cost differences and equipment needs for different silages and supplementary feeds, so cost and management implications need to be taken in account when replacing one with another. Also, as discussed above, any changes that reduce overall diet quality can lead to reduced milk production and increased methane emissions per unit of milk solids.



What will it mean for emissions and profit?

The following figures model the impacts of increasing the level of dietary fat via supplements in a typical dairy farm system, explaining the likely effects on emissions and profit.

Farm:	400-cow milking herd
Baseline diet:	2.6% dietary fat with grain supplementation
New feed strategy:	grain replaced with hominy meal at a rate of 5.0 kg dry matter/ cow / day for 90 days during the three summer months; 6.4% dietary fat concentration
Emissions reduction:	enteric methane reduced by 40 tonnes of carbon dioxide equivalents (t CO2e) per annum; waste methane reduced by 0.5 t CO2e / annum; nitrous oxide reduced by 1.6 t CO2e / annum*
Cost of replacing grain with hominy meal:	$18,000 / farm
Gains in milk production due to hominy meal:	70,200 litres extra during summer
Extra income due to higher production:	$26,676 extra based on a summer milk price of $0.38 / litre
ERF income:	At a carbon price of $20 / t CO2e, the reduction in enteric methane emissions was valued at $800/farm. At $5 / t CO2e, the value was $200 / farm.
Net increase in farm profit:	$8,676 with no ERF payment, $9,476 at $20 / CO2e; $8876 at $5 / t CO2e

**Reductions in waste methane and nitrous oxide are not yet covered by a ERF methodology so therefore do not provide offset income.*

Australian research:

Looking to novel supplements, forages and pre-treatments to mitigate methane

Background

Researchers from the Department of Environment and Primary Industries Victoria and the University of Melbourne are studying cereal pre-treatment techniques, and a range of novel feed supplements and forages that reportedly mitigate enteric methane production.

The supplements under investigation include grape marc, a vineyard by-product containing both oil and tannin. Tannins have been shown to reduce methane emissions by inhibiting methane-producing microbes; however more research is required on their potentially negative production effects. This project is working collaboratively with the Australian Wine Research Institute to better understand the tannin concentration and composition of various grape marc products, so that products with less adverse impacts on animal performance can be identified.

The research team are measuring the impact on both animal emissions and production, with the aim of developing recommendations for feed-based mitigation options in the dairy, beef and sheep sectors.

Findings

- Supplementing dairy cows with wheat at higher rates than standard practice (up to 9 kg / cow / day) reduced methane emissions by as much as 50%. Milk fat concentration was reduced, but the increase in milk output observed meant total fat production was not affected. Protein concentration and yield increased at the higher wheat rates, resulting in an increase in milk solids (fat + protein) yield.
- Supplementing dairy cows with grape marc reduced methane by up to 20%, with minimal effects on milk production and composition.

What next?

Further research is now required to investigate the complementary effects of combinations of oils, starch and tannins, as well as the effects of various forage versus supplement options, on emissions (methane and nitrous oxide) and productivity.

More information on this research

Project leaders: Dr Joe Jacobs, Department of Environment and Primary Industries Victoria, and Associate Professor Brian Leury, University of Melbourne

Project website:
www.piccc.org.au/research/project/265

Further information

Dairy Climate Toolkit:
http://www.dairyaustralia.com.au/Environment-and-resources/Climate/MicroSite1/Home.aspx

ERF methodology for feeding dietary fats and oils:
http://bit.ly/1gdgwCd

Moate P, Williams S, Grainger C, Hannah M, Ponnampalam E, Eckard R (2011). Influence of cold-pressed canola, brewers grains and hominy meal as dietary supplements suitable for reducing enteric methane emissions from lactating dairy cows.
Animal Feed Science and Technology 166-167, 254-264.
http://dx.doi.org/10.1016/j.anifeedsci.2011.04.069

The Australian dairy industry has committed to reducing greenhouse gas emissions intensity by 30% by 2020.
This project is supported by funding from Dairy Australia and the Australian Government.

Published by Dairy Australia Limited.

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