Dairy Australia

ECONOMIC CASE STUDY TERANG (VICTORIA)

Quantifying the whole farm systems impact of nitrogen

BEST PRACTICE ON A RAINFED DAIRY FARM

About the research

The More Profit from Nitrogen Program (MPfN Program) is a cross-sector partnership between Australia's four intensive agricultural users of Nitrogen (N) fertilisers, formed to undertake research into improving nitrogen use efficiency (NUE). As part of the collaborative research, The University of Melbourne (UoM) and Tasmanian Institute of Agriculture (TIA), supported by Dairy Australia, used whole farm system analysis to validate current N best management practices (BMPs) at both the component and farm system level.

Biophysical modelling (DairyMod) was used to determine 90% of maximum pasture dry matter (DM) growth potential, over 18 years, comparing a seasonally adjusted N fertiliser application rate with a fixed monthly N rate.

The research highlighted inefficiencies in applying a fixed monthly rate of N, demonstrating that a fixed rate and timing would not deliver optimal NUE.

Analysis of farm level economic benefits

A farm level partial budget framework was developed to evaluate the economic implications of adopting a seasonally modified N fertiliser rate strategy modelled for a rain-fed dairy farm near Terang, south-west Victoria. The framework was based on the principle of profit maximisation, given the decreasing marginal returns from N application.

An example of a typical seasonal fixed N rate strategy for a dairy operation near Terang[1] was compared with the seasonally modified strategy identified in the research. Across 18 years of data (June 1999–May 2017), the change in cost of N was compared to the change in value of pasture DM produced, to determine if the strategy change was economically justified.

KEY MESSAGES

Economically beneficial to adopt a seasonally modified N application approach based on seasonal conditions and local growth potential.

In most years, marginally increasing the annual N application rate is economically sound, however varied from season to season depending on soil moisture conditions.

Increasing the N rate in spring provided the largest benefits.

Table 1 shows the change in N applied across the four seasons between the fixed and seasonally modified N rates, identified within the research. Table 2 shows the resultant impact on pasture DM production.

Combining the change in the cost of applied N and the change in the value of DM production generated a financial return of an additional $226/ha/year.

1 Typical fixed rate N application for Terang was based off 2017-18 South West Victoria Dairy Farm Monitor Project (Dairy Australia), and Project 3030 (Dairy Australia). These N rates were used to calculate corresponding DM production using the same approach as the seasonally modified N rate in the research. See also footnote 2, below, regarding autumn application.

Table 1 Comparison of fixed rate (FR) and seasonally modified (SM) N application for the Terang site over 18 years.

Season	FR N (kg/ha/month)[1]	SM rate N (kg/ha/month)[2]	Change in N (kg/ha/month)	$/t urea[3]	Change in cost of N ($/ha)
Summer	0	5	+5		+$7
Autumn	10	3	-7		-$10
Winter	23	19	-4	$596	-$6
Spring	23	40	+17		+$22
Annual total	**170**	**201**	**+31**		**+$40**

Table 2 Comparison of fixed rate (FR) and seasonally modified (SM) DM production for the Terang site over 18 years.

Season	FR DM (t/ha/month)	SM DM (t/ha/month)	Difference in DM (t/ha/month)	$/t hay[4]	Change in value DM ($/ha)
Summer	0.1	0.2	+0.1	$148	+$11
Autumn	0.5	0.4	-0.0	$147	-$4
Winter	1.2	1.2	+0.1	$174	+$9
Spring	1.7	2.1	+0.4	$188	+$72
Annual total	**10.4**	**11.9**	**+1.5**	**$183**	**+$265**

Combining the change in the cost of applied N (Table 1) and the change in the value of DM production (Table 2), analysis shows a net positive economic impact generated of an additional $226/ha/year (Table 3).

Table 3 Net economic impact of employing a seasonally modified rate of N for the Terang site (18-year averages).

Season	Average change in cost N ($/ha/month)[3]	Average change in value DM ($/ha/month)[4]	Net impact ($/ha/month) (benefit–cost)
Summer	$7	$11	$5
Autumn	-$10	-$4	$6
Winter	-$6	$9	$14
Spring	$22	$72	$50
Annual total	**$40**	**$265**	**$226**

Variability and sensitivity analysis

Across the 18 years simulated in the research, the annual impact of switching from a fixed rate to a seasonally modified rate of N application ranged between $104/ha/year and $388/ha/year. This variation is due to the influence of different climatic conditions on the pasture DM response.

There was a large variation in the application of N across the 18 years of data. The results highlighted the opportunity for increased N application and DM production in spring and the potential to apply N opportunistically under certain summer and autumn conditions when soil moisture is optimal to generate a sufficient pasture response. In the 18 years there were only two summers (11%) with sufficient rainfall and soil moisture content to justify the application of any N fertiliser. There were only nine autumns (50%) where N application was economically justified but primarily this was at a reduced rate of N compared to the typical fixed rate.

The analysis highlighted the opportunity to increase N application in spring, while using N more opportunistically in summer and autumn when soil moisture content is high.

To test the sensitivity of the results to individual changes in market prices, a range of potential urea[3] and pasture hay[4] values were derived from historical datasets. Table 4 shows how the potential impact ($/ha/year) of applying the seasonally modified N approach varies with different combinations of urea and pasture hay values. For example, when urea and hay prices were $596/t and $183/t respectively, a seasonally modified approach could generate $226/ha/year above the typical fixed rate approach. As the seasonally modified approach modelled in this case study shows an average annual increase in N application to generate additional DM, the economic viability is supported by high prices of DM, low prices of N, or a combination of both. Table 4 shows that the potential economic impact was positive for all combinations of urea and pasture hay prices identified.

2 For the Terang region there are typically only pasture growing conditions for half of autumn. N application would reflect these conditions, so for the month and a half of active pasture growth the "monthly" N application rate would be double that identified in table 1.
3 N was valued using farmgate urea prices (N content of 46%). Average, high and low urea prices were derived from 5 years of TradeMap imported urea data and Ag Econ data. A spreading cost of $40/t was applied based on Dairy Australia Fert$mart Nitrogen Guidelines. All figures adjusted to 2020 prices.
4 The modelling assumed that increased pasture DM production was converted to pasture hay (with a DM content of 85%) and either used to offset existing supplementary feed, or sold at the prevailing market price. Conversely, DM was purchased at the prevailing market price to offset any decreases in production. Market values for DM were derived from five years of Dairy Australia Hay and Grain Report data, using pasture hay prices for South West Victoria, and adjusted for cartage, or the cost of cutting, raking, bailing and field losses as appropriate. All figures adjusted to 2020 prices.

Table 4 Sensitivity of the economic impact ($/ha/year) to changes in urea and DM (pasture hay) values.

		Urea price ($/t)[3]				
		$493	$544	$596	$641	$686
Average hay price ($/t)[4]	$75	$77	$75	$74	$73	$73
	$129	$154	$151	$148	$145	$142
	$183	$236	$230	**$226**	$223	$220
	$253	$350	$344	$337	$332	$326
	$323	$464	$458	$451	$446	$440

Conclusion

By combining economic analysis with the biophysical modelling research undertaken in the MPfN Program , this case study quantified the lost opportunity of following a fixed recipe for N application. By applying a seasonally modified strategy to N application, the annual benefit of increased DM production exceeded the increased cost of fertiliser, generating an average economic benefit of $226/ha/year. Sensitivity analysis showed the economic impact remained positive for a wide range of urea and DM market prices.

At the Terang site, it was economically beneficial to increase the average annual rate of N, although there were large variations across the 18 years of data. This opportunity, however, varied from season to season and year to year, with the greatest potential demonstrated in spring and options under certain conditions in summer and autumn, when soil moisture is optimal to generate a sufficient pasture response.

Overall, this case study highlights the benefit of moving from a fixed rate of N application to a rate adjusted each time to local growth potential.

ENVIRONMENTAL OUTCOMES

By more accurately matching nutrient supply with plant growth, the seasonally modified N application strategy in this case study also leads to:

- Higher and more consistent DM production and therefore increased ground cover through the year.
- Higher root growth leading to higher soil organic matter.
- Improved nitrogen use efficiency in terms of DM production per unit of N applied.

FOR FURTHER INFORMATION

On the MPfN Program visit **crdc.com.au/more-profit-nitrogen**

For more information on this case study, please contact Cath Lescun, Lead - Soils and Irrigation, Dairy Australia, **Cath.Lesun@dairyaustralia.com.au**

This case study was prepared by the dairy research projects of the More Profit from Nitrogen Program, with the assistance of AgEcon, through the MPfN: final evaluation and economic case studies project. The More Profit from Nitrogen Program: enhancing the nutrient use efficiency of intensive cropping and pasture systems is supported by funding from the Australian Government Department of Agriculture, Water and the Environment as part of its Rural R&D for Profit program.

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This project is supported by funding from the Australian Government Department of Agriculture, Water and the Environment as part of its Rural R&D for Profit program, The University of Melbourne, Tasmanian Institute of Agriculture, Queensland University of Technology and Dairy Australia.

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2584.1 | Sep 2020