BRIEF COMMUNICATION: A case study of the effects of diet and winter management on dairy production, profit and nitrate leaching in Rotorua

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Abstract

Feed and winter management options were modelled for a dairy farm and its adjoining support land in the Lake Rotorua catchment. The dairy farm grew turnips, fodder beet and oats, with non-lactating cows grazing on the dry-stock unit on pasture, kale and fodder beet. Scenarios investigated were: removing crops from the dairy farm whilst either A) reducing stocking rates by 5%; B) feeding additional palm kernel expeller (PKE); C) replacing crops, PKE and pasture silage with purchased maize grain and maize silage; or D) grazing non-lactating cows on the dairy farm and reducing stocking rates by 17%. Using a milk price of $6.00/kg MS, D was the only scenario that increased profitability of the dairy farm (7%). Compared to the base scenario, nitrate leaching on the dairy farm increased for scenario D and decreased for scenarios A, B and C. When including the dry-stock unit, total N leaching was reduced by 5, 0, 13 and 15%, for A, B, C and D, respectively, compared to the base farm. These results reiterate the importance of investigating the impact of off-farm winter grazing in nitrogen-sensitive catchments.

Keywords: Farmax; nitrate leaching; Overseer; profit

Introduction

Many regions of New Zealand use forage crops to overcome autumn and winter feed shortages, however, this can increase nitrogen (N) leaching (Monaghan et al. 2013). Nitrogen is leached mainly from urine deposited in autumn and winter (Ledgard et al. 2000), particularly where land is left bare after grazing crops. Winter feed shortages are also commonly overcome by grazing cows off the dairy farm, transferring the leaching to another land unit, rather than reducing the total N load.

This study investigated potential options for a dairy farm in the Lake Rotorua catchment to profitably reduce N leaching both on the dairy farm and the supporting dry-stock unit. It assessed the impact of removing crops and using a range of purchased supplements, as well as lowering stocking rates and grazing non-lactating cows on or off the dairy farm.

Materials and methods

Base farm

The predominant soil was a Haparangi silt loam, with a 369-ha dairy farm and an adjoining 400-ha dry-stock unit. Nitrogen fertiliser was applied at 160 kg N/ha/year on the dairy farm. The dairy farm had Holstein-Friesian x Jersey crossbred cows, which were fed silage, a blend of palm kernel expeller (PKE) and dried distillers grain (DDG) during milking, turnips (grazed in February/March), fodder beet (grazed in April/May) and oats (grazed in September). The dry-stock unit had sheep and beef cattle, dairy replacements and grazed non-lactating dairy cows on fodder beet, kale and pasture. Crop areas and supplement amounts are reported in Table 1.

Modelling scenarios

Mitigation scenarios to reduce N leaching were developed (Table 1). All scenarios removed crops from the dairy farm, whilst either:

(a) Reducing the dairy farm stocking rate by 5%
(b) Feeding additional PKE and DDG
(c) Removing PKE and DDG and pasture silage and replacing it with low-N feeds (maize grain and maize silage)
(d) Reducing the dairy farm stocking rate by 17%, grazing non-lactating cows on the dairy farm, with no crops on the dry-stock unit.

Nitrogen fertiliser was reduced to 158 kg/ha on the dairy farm across all scenarios to account for the removal of crops. Supplement use in each scenario was set to achieve similar feed utilisation and milk production (kg MS/cow) as for the base farm. Sheep and beef cattle numbers on the dry-stock unit remained constant across all scenarios, whilst the number of dairy replacements changed in proportion to the number of milking cows. Crops grown on the dry-stock unit were the same across all scenarios except for D, where no cropping occurred, but additional pasture silage was made.

Models and assumptions

Dairy production and profitability was modelled using Farmax Dairy® (version 7.1.2.31) and nitrate leaching for the dairy farm and dry-stock unit in OVERSEER® (Overseer, version 6.3.0). Forage yields for the dairy farm were 11.3 t DM/ha for pasture, 3.5 t DM/ha for grazed oats, 10.6 t DM/ha for turnips and 17.2 t DM/ha for fodder beet, based on typical yields achieved on the farm. Model default nutritive characteristics were used.

Dairy-farm operating profit (both with and without the dry-stock unit crop establishment costs) was calculated as total revenue from milk and livestock sales less farm working expenses and depreciation. The milk price was set

Table 1 Farm inputs and predicted performance from Farmax Dairy and Overseer for a Rotorua dairy farm and its adjoining dry-stock unit under different feeding, wintering and stocking rate scenarios.

	Farm scenarios[1]				
	Base	A	B	C	D
Dairy cow numbers on 1 July	1,105	1,048	1,105	1,105	912
Stocking rate (cows/ha)	2.9	2.8	2.9	2.9	2.4
Graze non-lactating cows off dairy farm	yes	yes	yes	yes	no
PKE (67%) and DDG (33%) mix (t)	760	588	947	0	444
Pasture silage (t DM)	830	740	830	0	630
Maize grain (t)	0	0	0	595	0
Maize silage (t DM)	0	0	0	758	0
Fodder beet/oats on milking platform (ha)	7	0	0	0	0
Turnips on milking platform (ha)	16	0	0	0	0
Fodder beet on dry-stock unit (ha)	15	15	15	15	0
Kale on dry-stock unit (ha)	6	6	6	6	0
Milksolids production (kg/cow)	362	353	362	361	357
Milksolids production (kg/ha)	1,056	978	1,056	1,055	854
Dairy farm working expenses ($/ha)[2]	5,682	5,384	5,667	5,732	4,284
Dairy farm operating profit + crop ($/ha)[2]	1,040	823	1,037	971	1,113
Dairy farm operating profit – crop ($ha)[3]	1,200	983	1,197	1,131	1,113
Dairy farm N leaching (kg N/ha)	54	50	53	43	60
Whole farm N leaching (kg N/ha)	40	38	40	35	34

[1]Scenarios differed from the base farm by removal of crops from the dairy farm and: A, reduction of stocking rates by 5%; B, feeding of additional PKE and DDG (palm kernel expeller and dried distillers grain); C, replacing PKE and DDG and pasture silage with low N feeds (maize grain and maize silage); D, reduction of stocking rates by 17%, grazing non-lactating cows on the dairy farm and removing crops from the dry-stock unit.

[2]Includes costs of support block crops for non-lactating cows (not applicable for scenario D).

[3]Excludes costs of support block crops for non-lactating cows.

at $6.00/kg MS. Farm operating costs were those in Farmax Dairy for the Bay of Plenty region in 2015/16. This included supplement prices of $210/t DM for pasture silage, $330/t for PKE and DDG, $400/t for maize grain and $300/t DM for maize silage. Crop establishment costs were $1,500/ha for turnips and kale, $2,500/ha for fodder beet, $200/ha for oats, plus an additional $600/ha for returning crop paddocks to pasture.

Results and discussion

The effects of the scenarios on nitrate leaching are shown in Table 1. Removing dairy farm crops and increasing pasture silage and PKE and DDG use (scenario B) reduced N leaching slightly. The small impact of scenario B is likely due to the base scenarios use of a low-N autumn crop (fodder beet) resulting in low urinary N excretion from cows (Edwards et al. 2014), followed by the oats removing some of the excess N from the soil (Malcolm et al. 2016). A 5% reduction in stocking rate (scenario A) resulted in a 7% reduction in nitrate leaching. The largest reduction in leaching from the dairy farm (20%) was achieved by removing crops and replacing the pasture silage and PKE and DDG with maize grain and maize silage (scenario C). This concurs with previous findings of use of low N supplements reducing nitrate leaching, with the scale of reduction dependant on the base farm management, soils and climate (Howarth & Journeaux 2016).

When considering farm impacts at a catchment scale, this study has shown the importance of considering not just the dairy farm, but also leaching from the supporting dry-stock unit within the catchment (Table 1). Lowering the stocking rate on the dairy farm resulted in fewer replacements being reared, fewer cows and, hence, lower leaching across the total land area. Scenario D, in which non-lactating cows grazed on the dairy farm, had the highest dairy farm leaching, but as this system had a lower stocking rate (and, hence, fewer dairy replacements) and eliminated the need for winter crops on the dry-stock unit, it produced the greatest reduction (15%) in leaching across its total land area. There was potential, however, for higher sheep and beef cattle numbers and, hence, higher leaching on the dry-stock unit than that modelled in scenario D.

Using low-N supplements caused the greatest reduction in N leaching from the dairy farm, but their high cost meant this was less profitable than was using crops or other supplements (Table 1). It is recommended supplements cost <0.6% of the milk price on a cents per MJ ME basis to be profitable (Clark et al. 2007). Scenarios with reduced stocking rates (A and D) had the lowest farm working expenses, but also the lowest MS/ha, and hence, scenario A had the lowest operating profit (Table 1).

Grazing non-lactating cows off the dairy farm is generally considered a profitable management regime in New Zealand, but for this study it was dependant on how this was costed (Table 1). If winter crops were not required on the dry-stock unit (i.e., grazed on pasture instead), then grazing non-lactating cows on the dairy farm was less profitable than all scenarios except A. When the cost of establishing crops on the dry-stock unit was included in the dairy-farm working expenses, grazing non-lactating cows on the dairy farm on pasture became the most profitable option for the dairy farm.

Farm profitability and nitrate leaching depend on many variables, including feed costs, milk price, feed quality, crop yields, soil type and rainfall. Scenarios for evaluation should be co-developed with the farmer to align with their goals and the capacity of the farm to ensure maximum likelihood of adoption and impact.

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