IDENTIFYING OPPORTUNITIES TO REDUCE N LEACHED WHILE MAINTAINING FARM PROFITABILITY AND MILKSOLIDS PRODUCTION – A CASE STUDY ANALYSIS

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Abstract
Current environmental objectives in some catchments in New Zealand require a reduction in nitrogen (N) leached per hectare. Ideally, this would be achieved with minimal impact on profitability or milksolids production so that farm businesses and regional communities can be sustained. A recent Nimmo-Bell report (2013), undertaken for the Horizons catchment, suggested that an 18% reduction in N leached/ha, through optimising the use of existing resources (within-system focus), would best align environmental, farm and community objectives.

The analyses reported here were undertaken to identify opportunities to reduce N leached/ha while maintaining current levels of milksolids production and farm profitability. Three case study farms in the Lower North Island were simulated using Overseer® and Farmax models. Mitigation options assessed included reducing the amount of imported feed and/or N fertiliser use, increasing effluent application areas, removing winter forage crops, grazing cow's off-farm in winter, and standing cows off paddocks in the autumn. Current management practices along with the farm production system, infrastructure, stocking rate and farmer goals had a large impact on the most suitable approach to achieving a reduction in N leached for individual farms.

Predicted reductions in N leached/ha derived from Overseer were 16%, 25% and 21% for farms A, B and C, respectively, without negative impacts on existing levels of farm profitability or milksolids production. Options varied between farms and were selected to meet farmer and environmental objectives. The option selected for farm A was to reduce N fertiliser and supplement use, and reduce cow numbers slightly to offset the change in feed supply. For farm B, a reduction in cow numbers with an increase in milksolids/cow was considered the best approach. For farm C the exclusion of a winter oats crop, increase in the number of cows wintered off and a slight increase in cow numbers was considered the best option to meet the combined objectives.

If the use of existing resources on farms is optimised moderate reductions in N leached are possible without large negative impacts on current levels of milksolids production and financial performance. Larger system changes such as large reductions in stocking rate, eliminating N fertiliser use and substantial infrastructural changes have a detrimental impact on the financial indicators of farm businesses and introduce additional risk. The environmental and financial impact of different mitigation options varied between farms highlighting the requirement for individual farm analysis. It also emphasised the benefit of a detailed discussion on mitigation options with farmers to identify wider management considerations of implementing changes.

Keywords Dairy, N leaching, profitability

Introduction

Environmental objectives in some catchments in New Zealand require a reduction in nitrogen (N) leached per hectare. Ideally, this would be achieved with minimal impact on profitability or milksolids production so that farm businesses and regional communities can be sustained. A recent Nimmo-Bell report (2013) undertaken for the Horizons catchment suggested that an 18% reduction in N leaching/ha through optimising the use of existing resources (within-system focus) would best align environmental, farm and community objectives. The aims of this study were to determine a useful template for assessing opportunities to improve the utilisation of existing resources on farms and subsequently to use this on a number of case study farms. This analysis will also deliver improved understanding of the relationship between N mitigation options and farm profitability.

Materials and Method

Three spring calving case study farms were selected and the physical data captured directly from the farmers and also from an existing database (DairyBase). This was subsequently entered into the OVERSEER® v6 nutrient budget model (Wheeler et al., 2003; www.overseer.org.nz) and a base file created. Using the Overseer model, multiple scenarios were tested to derive possible options to reduce N leaching on the milking platform and ultimately within the catchment. These scenarios were then assessed using the Farmax model (Bryant et al., 2010) to determine the biological and financial outcomes and to ensure feasibility. Scenarios were then discussed with the farmers to determine any weaknesses in assumptions made and determine which scenarios aligned with their goals and principles.

Farm A consists of 218 ha effective milking area with an additional 12 ha non-effective area. The dominant soils on the milking platform are Rangitikei silt loam and Parewanui silt loam. 110 ha of the farm is irrigated with a combination of pivot and pods. Ninety eight percent of the milking platform is classified as land use capability (LUC) II, 1% LUC I and 1% LUC VI with 50% classified as free draining. Farm B is located in the Tararua with 1300-1500 mm rainfall per annum. This farm consists of 195 ha effective milking area with an additional 5 ha non-effective area. The dominant soils on the milking platform are Kairanga silt loam and Manawatu silt loam. Seventy three percent of the milking platform is classified as LUC III with 40% classified as free draining. This farm has a feed-pad. Farm C is located in the Tararua with less than 1300 mm rainfall per annum. This farm consists of 78 ha effective milking area with an additional 14 ha non-effective area. The dominant soils on the milking platform are Dannevirke silt loam, Manawatu silt loam and Kairanga silt loam. Fifty six percent of the milking platform is classified as LUC II and 26% LUC III with 58% classified as free draining. Four hectares of winter oats are currently grown to graze dry cows on the milking area.

Results

The physical information for the current farm system (Current) and one proposed scenario which delivers the objective of reduced N leached while maintaining profitability for each case study farm (Proposed) is outlined in Table 1. For Farms A and B a reduction in stocking rate was suggested, while for Farm C stocking rate increased from 2.6 to 2.9 cows/ha. Farm B was considered to be over stocked and hence a reduction in stocking rate was aligned with an increase in milksolids from 379 to 437 kg/cow. Milksolids per cow was not altered significantly for Farm C as this is a lower input farm with Jersey cows. For this farm, grazing of a winter oats crop on the milking area was discontinued and 10% more cows wintered outside the catchment to balance the feed supply.

Table 1: Physical information for current and proposed scenarios

FARM	A		B		C	
	Current	Proposed	Current	Proposed	Current	Proposed
Effective area (ha)	218	218	195	195	78	78
Effluent application area (ha)	36	36	66	66	41	41
Total milksolids (kg)	278,902	274,854	250,077	248,806	75,352	80,637
Milksolids/ha (kg)	1,279	1,261	1,282	1,276	9,66	1,034
Milksolids/cow (kg)	451	459	379	437	369	358
Peak cows milked	619	599	660	569	204	225
Breed	FR	FR	JX	JX	J	J
Stocking rate (cows/ha)	2.8	2.7	3.4	2.9	2.6	2.9
Days in Milk	292	292	282	282	263	263
Pasture eaten (t DM/ha)	11.9	11.7	12. 6	12.0	9.1	9.5
Bought-in feeds (t DM/ha)	1.1	1.1	1.5	0.4	0.4	0.8
Total feed eaten (t DM/ha)	14.0	13.7	14.0	12.7	10.7	11.3
Imported supplement						
Palm kernel (t DM)	-	-	53	29	-	6
Maize silage (t DM)	213	175	113	-	-	-
Pasture silage (t DM)	134	164	167	60	43	76
Hay (t DM)	23	23	38	-	10	7
Winter grazing (% / weeks)	52/6	50/6	70/6	100/6	50/8	60/8
N fertiliser (kg/ha)	200	160	198	150	76	86

The key environmental parameters derived from Overseer are outlined in Table 2. For Farm A, N conversion efficiency (NCE: N output in products ÷ sum of N inputs) was increased from 27 to 29% while N surplus and N leached were reduced. Overseer predicted a reduction in N leached of 16%, from 31 to 26 kgN/ha/yr. For Farm B, NCE was increased from 31 to 37%, N surplus reduced and N leached was reduced from 35 to 26kgN/ha/yr. The proposed scenario for Farm C also predicted an increase in NCE, a reduction in N surplus and a 21% reduction in N leach/ha.

Table 2: Key environmental parameters

FARM	A		B		C	
	Current	Proposed	Current	Proposed	Current	Proposed
Nitrogen conversion efficiency (%)	27	29	31	37	30	41
N surplus (kg/ha)	246	224	215	167	142	130
N leached (kg/ha)	31	26	35	26	33	26

The modelled financial implications of the proposed options are outlined in Table 3. The analyses were completed using a total milk price of $6/kg milksolids. Farm A and B saw a slight reduction in revenue which was offset by a reduction in total expenses.

Table 3: Financial Analysis

FARM	A		B		C	
	Current ($)	Proposed ($)	Current ($)	Proposed ($)	Current ($)	Proposed ($)
Net milk sales	1,663,927	1,639,779	1,491,962	1,484,376	449,547	481,082
Net livestock sales	59,136	59,994	67,489	59,128	16,058	22,086
Total revenue	1,723,062	1,699,774	1,559,451	1,543,504	465,605	503,168
Wages	198,816	192,276	215,820	185736	66,678	71,109
Stock expenses	105,056	102,106	119,670	102,601	31,618	35,523
Supplementary feed	180,752	176,728	93,742	33,622	31,708	32,560
Grazing & Run-off	24,043	24,043	111,841	123,118	42,481	56,802
Other working expenses	287,108	272,334	284,456	275,788	100,466	101,128
Overheads	73,030	73,030	65,325	65,325	26,130	26,130
Depreciation	58,860	58,860	52,650	52,650	21,012	23,175
Total operating expenses	927,665	899,377	943,504	838,840	320,094	346,427
Total operating profit	795,397	800,397	615,947	704,664	145,511	156,741
Operating profit / ha	3,649	3,672	3,159	3,614	1,866	2,010

Importantly, this study also improved our understanding of the association between N leached and farm profitability, Figure 1. S seeking to reduce N leached identifiedopportunities to improve the use of all existing resources and, hence, improve efficiency on farm. Therefore, this may identify opportunities which have little impact on performance and profitability, while offering some reductions in N leaching. To achieve further reductions in N leached more expensive mitigation options are necessary. These include large investments in infrastructure and excessive reductions in stocking rate and use of inputs such as N fertiliser.

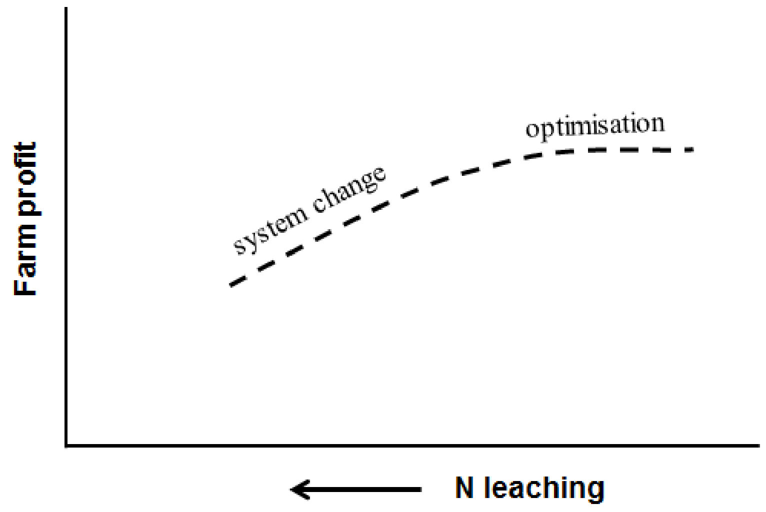

Figure 1: Schematic representation of the relationship between N leaching and farm profitability.

Conclusion

These analyses determine a useful approach to modelling options to reduce N leached on New Zealand dairy farms and also improve understanding of the impact of reducing N leached on farm profitability. When modelling scenarios it is important to understand the implications of the underlying assumptions, the management considerations of any proposed changes and any risk implications. The results presented for the case studies relate largely to optimising the use of existing resources. The implementation of larger farm system changes requires more detailed investment analyses alongside a clear understanding of philosophies and goals of those involved. The analyses indicate that there is some opportunity to reduce N leached while ensuring that the farms remain financially viable, however mitigation options get increasingly expensive and therefore thorough farm specific analysis needs to be undertaken.

References

Bryant, J.R., Ogle, G., Marshall, P.R., Glassey, C.B., Lancaster, J.A.S., Garcia, S.C., and Holmes, C.W. (2010) 'Description and evaluation of the Farmax Dairy Pro decision support model' *New Zealand Journal of Agricultural Research* 53, 13–28.

Nimmo-Bell, (2013) Cost Benefit and Economic Impact Analysis of the Horizons One Plan

Wheeler, D.M., Ledgard, S.F., de Klein, C.A.M., Monaghan, R.M., Carey, P.L., McDowell, R.W., and Johns, K.L. (2003), 'OVERSEER® Nutrient Budgets - moving towards on-farm resource accounting', *Proceedings of the New Zealand Grassland Association* 65, 191–194.