Modelling the economic and environmental implications of reducing biosecurity risk by changing to a self-contained dairy grazing system in New Zealand

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Abstract

This study examines the economic and environmental implications of reducing the spread of contagious pathogens and diseases by implementing a self-contained dairy grazing system. Three typical New Zealand grazing-off systems were examined represented by a Waikato farm where all young stock are grazed off the milking platform, a Canterbury farm where both non-lactating cows and young stock are grazed off the milking platform and a Lower North Island farm where two thirds of the non-lactating cows and all young stock are grazed off the milking platform. For each grazing-off system (base), two options were modelled to reduce biosecurity risk: 1) reducing stocking rate to allow non-lactating cows and young stock to be grazed on the milking platform (self-contained); and 2) leasing support land to graze only owned non-lactating cows and young stock (lease). FARMAX and OVERSEER® models were used to predict the economic and environmental implications of each option. The results were tested at different milk prices representing low ($4.25/kg) milksolids (MS), medium ($6.25/kg MS) and high ($8.25/kg MS) prices. The results showed that a self-contained grazing system reduced profitability by at least 15% across all regions and milk prices when compared with the base farms. The self-contained options leached 3–7% more nitrogen and had 7–10% more greenhouse gas (GHG) emissions per hectare, compared with the base and lease options when grazing-off land was accounted for. However, at a catchment level, the land freed by moving to self-contained might be utilised by other farming enterprises that might have a different environmental footprint compared to dairy grazing.

Keywords: grazing-off, support land, milking platform

Introduction

To make more pasture available to lactating cows and manage seasonal pasture growth patterns, New Zealand dairy farmers often graze young stock, or both young stock and non-lactating cows, on owned or leased support land or with commercial graziers (grazing-off). The use of commercial graziers is a common practice for New Zealand dairy farmers and some commercial graziers graze several herds from different locations, which is a biosecurity risk particularly through transfer of contagious pathogens and diseases. Minimising stock movements and contact with other herds through a self-contained grazing system requires a farm-system change that might impact profitability. The objective of this study was to assess the economic and environmental implications of reducing the spread of contagious pathogens and diseases by implementing a self-contained dairy grazing system in New Zealand.

Methods

New Zealand dairy statistics (DairyNZ 2015a) and DairyNZ economic survey (DairyNZ 2015b) data for the 2014–15 dairy production season were used to model three typical New Zealand grazing-off systems (Table 1). The 2014–2015 year was a season when milk price was close to the long-term average and farm inputs and costs were not greatly altered from normal by adverse events. The three grazing-off systems were represented by a Waikato farm where all young stock are grazed off, a Canterbury farm where both non-lactating cows and young stock are grazed off, and a lower North Island farm where two thirds of the non-lactating cows and all young stock are grazed off. The Canterbury model is irrigated whilst Waikato and lower North Island are not irrigated.

For each grazing-off system, two options were modelled to reduce risk of pathogens transfer and spread of diseases: 1) reducing stocking rate to allow non-lactating cows and young stock to be grazed on the milking platform (self-contained); and 2) leasing support land to only graze owned non-lactating cows and young stock (lease). The stocking rate of the self-contained options was reduced to match feed supply to demand thus not importing extra feed or increasing nitrogen fertiliser use. This approach was taken to prevent an increase in the environmental footprint and farm working expenses of the self-contained options. All cows, including rising 2-year heifers, were artificially inseminated for the lease and self-contained options to minimise contact with imported service bulls. Excess replacements from artificial insemination were sold as bobby calves or to the sale yard as was being done in the base farm. The modelling also assumed no animals will be purchased into the herd and farm. However, farmers will have to ensure their farm boundary fence is strong

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Table 1 Typical New Zealand grazing-off models.

Input	Waikato	Canterbury	Lower North Island
Milking platform area(ha)	85	233	146
Stocking rate(cows/ha)	2.9	3.5	2.7
Average cow live-weights(kg) as of December	460	470	460
Planned start of calving	18 Jul	1 Aug	23 Jul
Days in milk	255	257	255
Milksolids production/ha(kgMS/ha)	1068	1474	1052
Pasture grown including nitrogen(tDM/ha)	14.5	16	12
Nitrogen fertilizer use(kgN/ha)	124	202	112
% bought supplements /feed offered	5.4	5.6	9.4
% non-lactating cows grazed-off farm	0	100	66
Average days non-lactating cows grazed-off farm	0	70	60
% young stock grazed-off farm (weaning to first calving)	100	100	100
Farm operating expenses $/kgMS	4.5	4.61	4.68
Operating profit $/ha @ $6.25/kgMS	2203	2887	2097

enough to minimise the risk of stray animals. The lease option had labour adjustments to reflect time spent on the lease block. For the Canterbury and lower North Island farms, an additional labour unit was assumed in order to manage the lease block and, for Waikato, a quarter of a labour unit was assumed. The Waikato lease option had a lower labour requirement as it is only grazing-off young stock. FARMAX (Bryant et al. 2010) and OVERSEER® (Watkins & Selbie 2015) models were used to evaluate the economic and environmental implications of each option. The results were tested at different milk prices representing low ($4.25/kg MS), medium ($6.25/kg MS) and high ($8.25/kg MS) prices. Grazing fees were assumed to be sensitive to milk price and were adjusted based on historical data, as shown in Tables 2 and 3. The grazing and lease fees were based on average prices obtained from the Lincoln University financial budget manual (Askin & Askin 2016). The lease fees were assumed to be $800/ha for the Waikato and lower North Island farm and $1000/ha/year for Canterbury due to availability of irrigation systems and water there.

In modelling base farms and lease options, nitrogen (N) leaching and GHG from land used for grazing-off were accounted for. In the Canterbury base and lease option, it was assumed that non-lactating cows grazed fodder beet crop and young stock grazed kale crop in winter and pasture in the rest of the year. In the lower North Island base and lease option, it was assumed that non-lactating cows grazed a kale crop and young stock grazed pasture year-round. In the Waikato base and lease option, it was assumed that young stock grazed pasture year-round. Grazing-off land was assumed to grow 10% less pasture in Canterbury, 15% less in the lower North Island, and 30% less in Waikato compared with the milking platform. Canterbury grazing-off land is likely to yield more pasture than other regions because of irrigation, while the Lower North Island and Waikato grazing-off land were progressively on marginal and less productive land. The land areas required for grazing-off were calculated based on animal demand and pasture supply.

Results and Discussion

The results showed that a self-contained grazing system reduced profitability by at least 15% across all regions and milk prices when compared with the base farms (Table 4). This situation occurred because revenue is foregone by reducing the size of the lactating herd to

Table 2 Assumed grazing rates adjusted for milk price and age (months) for the Waikato and Lower North Island farms.

	$ per head per week		
Milk price	**0–9 months**	**10–21 months**	**≥22 months**
$4.25	6.50	9.50	22
$6.25	7.50	10.50	25
$8.25	9.50	12.50	28

Table 3 Assumed grazing rates adjusted for milk price and age (months) for the Canterbury farm.

	$ per head per week		
Milk price	**0–9 months**	**10–21 months**	**≥22 months**
$4.25	6.50	9.50	22
$6.25	7.50	12	25
$8.25	9.50	15	30

Table 4 Operating profit (OP) for different grazing-off systems at different milk prices across three regions.

Region	Milk price $/kg MS	Base OP $/ha	Lease OP $/ha	Self-contained OP $/ha
Waikato	4.25	128	-76	-29
	6.25	2203	2058	1769
	8.25	4226	4192	3566
Canterbury	4.25	164	-163	-102
	6.25	2887	2786	2317
	8.25	5498	5735	4736
Lower North Island	4.25	95	-35	-212
	6.25	2097	2070	1514
	8.25	4049	4174	3239

feed the non-lactating herd and young stock now on the milking platform. This is the traditional reason dairy farmers choose to maximise the number of lactating cows by grazing non-lactating and young stock off the milking platform. The lease options had a comparable operating profit to the base farms at medium and high milk prices (Table 4). However, profitability of the lease options was reduced at low milk price because lease fees remain constant irrespective of the milk price. Lease agreements are renegotiated only when the lease expires, so fees are not sensitive to changes in milk price. Whilst the lease option allows the farmer to minimise biosecurity risk by only grazing owned non-lactating cows and young stock, a challenge could be finding readily available lease land that suits grazing demands. If the available land is larger than the required grazing area this will increase the lease expense, so farmers might have to find other profitable uses for the surplus land to offset the cost.

The base farms and lease options had a similar environmental footprint across the regions because the total feed eaten by all stock classes remained the same (Table 5). The self-contained options leached 3–7% more N and had 7–10% more greenhouse gas (GHG) emissions per hectare, compared with the base and lease options (Table 5).

Nutrient losses from the base and lease options are diluted across the milking platform and the grazing-

Table 5 Environmental metrics from the OVERSEER® model for the three grazing options across the regions. GHG – greenhouse gases, N – nitrogen.

Region	Environmental metric	Base/ Lease	Base milking platform only	Self-contained
Waikato	Total land area including grazing-off (ha)	108	85	85
	N Leaching (kg N/ha)	28	30	30
	Total N leaching (kg N)	3033	2544	2532
	Kg N Leached/1000 kg MS	35.5	29.8	35.2
	GHG emission (t CO_2 eq/ha)	10.1	10.9	10.9
	Total GHG emissions (t CO_2 eq)	1091	927	927
	Kg CO_2 eq /kgMS	12.8	10.7	12.9
Canterbury	Total land area including grazing-off (ha)	308	233	233
	N Leaching (kg N/ha)	53	49	56
	Total N leaching (kg N)	16882	11631	13440
	Kg N Leached/1000 kg MS	52.0	35.9	50.5
	GHG emission (t CO_2 eq/ha)	13.6	14.5	14.5
	Total GHG emissions (t CO_2 eq)	4189	3379	3379
	Kg CO_2 eq /kgMS	12.9	10.4	12.7
Lower North Island	Total land area including grazing-off (ha)	194	146	146
	N Leaching (kg N/ha)	32	31	33
	Total N leaching (kg N)	6193	4338	4845
	Kg N Leached/1000 kg MS	40.4	28.3	38.6
	GHG emission (t CO_2 eq/ha)	9.5	10.6	10.5
	Total GHG emissions (t CO_2 eq)	1843	1544	1533
	Kg CO_2 eq /kgMS	12	10.1	12

off land. Grazing-off land typically grows less pasture than milking platforms and so has a lower carrying capacity compared with milking platforms. As a result, stock on grazing-off land require more land compared with the milking platform to meet their grazing demands. In an analysis of the milking platforms only of the three systems, the environmental footprint was similar because the amount of feed eaten was similar. Methane (GHG) emissions are related to feed eaten; as feed eaten increases so does methane emission from ruminant animals (Van der Weerden et al. 2018). Also, an increase in feed eaten increases total N intake, which increases urinary N, increasing the risk of N leaching and nitrous oxide (GHG) emission (Selbie et al. 2015). The difference in leaching between the Canterbury self-contained option and milk platform only analysis was larger compared to other regions mainly because of the absence of a winter crop block for the milk platform only analysis. The emission intensities analysis on N leached per milksolids produced and GHG emission per milksolids produced were similar for all options. All options maintained similar emission intensities as stocking rate for the self-contained options was reduced to match feed supply to demand thus not importing extra feed or increasing nitrogen fertiliser. This was done to prevent an increase in the environmental footprint and farm working expenses. However, at a catchment level, the land freed by moving to self-contained might be utilised by other farming enterprises that might have a different environmental footprint compared to dairy grazing. Emission intensities for milking platform only analysis was less than base/lease and self-contained because emissions from off-farm grazing are not included, highlighting the need to do a full system analysis (Table 5).

Conclusions

Reducing stocking rate to operate a self-contained dairy grazing system may reduce the risk of pathogen transfer and spread of diseases but is unlikely to be more profitable than systems where young stock or non-lactating cows are grazed off. Leasing support land may also reduce the risk of pathogen transfer and spread of diseases whilst maintaining a similar operating profit to the base farm but the challenge could be finding readily available lease land that suits grazing demands. When accounting for grazing-off land, the self-contained options leached slightly more nitrogen and greenhouse gas (GHG) emissions per hectare, compared with the base and lease options. However, at a catchment level, the land freed by moving to self-contained systems might be utilised by other farming enterprises that might have a different environmental footprint compared to dairy grazing.

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