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Mitigating Nitrogen Loss

The Financial Impact

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A study of the financial implications of proposed nitrogen mitigations in the Rangitata/Orton zone under the OTOP (Orari-Temuka-Opihi-Pareora) Draft Zone Implementation Program Addendum.

Executive Summary

Currently, the environment and water quality are at the forefront of New Zealanders minds. There is a general consensus that our environment is suffering from the strain modern society has put on it. As a consequence of this, the agriculture industry is coming under increased pressure and scrutiny to find solutions to address this problem. The subject has become a political football, with every one with a vested interest having their say, whether their opinions are informed or not.

The National Policy Statement for Freshwater Management places regulatory obligations on Regional Councils to improve or maintain water quality (MFE, 2016). Regional Councils around the country are in various stages of implementing policies to try to mitigate these problems. In Canterbury, Environment Canterbury is achieving this with the help and guidance of Zone Committees and catchment groups. The inclusion of local stakeholders and community engagement to help address local problems is a positive step. The outcomes locals decide will be far better received than policies imposed from outside influences.

To look deeper into the problem, I have studied the potential impacts of some of the proposed recommendations in the OTOP (Orari-Temuka-Opihi-Pareora) zone, one of the ten sub-regions in Canterbury. These Recommendations have been taken from the OTOP Draft ZIPA (Zone Implementation Program Addendum), which was released in December 2017 (OTOP Zone Committee, 2017). At the time of writing this document the above plan is in the submission period.

The specific part of the proposed plan I have looked at refers to the Rangitata-Orton area of the OTOP zone, which has been found to have high nitrates concentrations in ground water. The recommendations are that farms in the zone may have to reduce nitrogen leaching to ground water by up to 30-40% if water quality in the catchment does not improve in the next 5-10 years.

To test the implications of these proposed recommendations I have modelled a dairy farm, McClelland Dairies, which is situated in this zone. The purpose of the study is to determine what service industries will be significantly impacted from the implementation of such policies.

I believe this study is important because little information is circulated about who bears the brunt of cut backs to primary industries, whether these primary industries facing cutbacks are Agriculture, Mining, Forestry, or the likes.

To investigate the problem, I created Overseer nutrient budgets for McClelland Dairies, using current farm management factors (stocking rates, inputs and outputs), to calculate the total amount of nitrogen being lost (i.e. leached) below the root zone from the whole property. The current nitrogen losses to water per hectare from McClelland Dairies, at Good Management Practice (GMP), are 108kg/N/ha/yr. Therefore, to meet the 40% reduction in nitrogen leaching losses, nitrogen loss has to decrease to 65kg/N/ha/yr.

I applied nitrogen mitigations to McClelland Dairies by implementing soil moisture monitoring, reducing imported supplementary feed and the stocking rate, to achieve the desired 40% cut in nitrogen leaching. Following this, I created financial budgets of the two farming systems (base farm (status-quo) and 40% mitigation scenario) and compared their financial performance, in order to determine the financial implications of the 40% nitrogen leaching reduction. This data created a picture of where the impact will be felt.

When I started out on this project, I expected that the nitrogen mitigation would have a significant adverse impact on farm profitability. However, some of the results came as a surprise. The difference in profit between the base farm and 40% mitigation scenario was relatively small. The base farm had a profit of $684,647 compared to the farm with lower nitrogen leaching which had a profit of $664,642. The difference was $20,005 or 2.9%.

The greater financial impact was felt in the businesses that supplied the farm. The farm with the applied mitigations and lower nitrogen losses had farm working expenses of $95,339 less than the base farm. This money would have been spent locally and had a direct impact to the local economy. The most significantly impacted service industries were feed suppliers, fertiliser companies, transport firms and local jobs across the service industries. All of these have flow-on effects to the greater economy.

With the issues highlighted in this study I recommend that there should be greater emphasis on investigating all the implications of placing restrictions on primary industries.

Personally, the environment is also important to me. I live, work and play in the same environment that we farm. I believe there is a balance to be reached between the impact that we as a society have on the environment and the financial viability of this same society.

We are already here so with the help of new ideas, science and technology and time, I am positive a solution to the problems we face will be found.

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Introduction

McClelland Dairies is a 200 ha (hectare) seasonal dairy farm situated at Rangitata in South Canterbury, 35 kilometres south of Ashburton. The farm is fully irrigated with spray irrigation, sourcing its water from a newly formed irrigation scheme. The scheme has a consent to harvest and store flood water from the Rangitata river at a trigger flow of 110 cubic meters per second.

The farm has an average annual rainfall of 625mm. Before the introduction of irrigation the soil i was prone to severely drying out in the summer months, as the area can suffer from high evapotranspiration rates. This was not helped by the light, shingly and in turn low water holding capacity of the soil. The low water holding capacity of the soil has another negative impact when the soil gets too wet. In this instance nutrients are prone to leach through the soil profile in to ground water.

The farm is currently running 760 Friesian cows milked twice a day and operates as a milking platform with all the cows wintered off farm during June and July. Calving starts about the 25th July with the official start calving date of 1st August.

The farm is managed by a Contract Milker and has an average of 3.5 full time equivalent staff; four people from July to mid-December then dropping back to three full time staff for the remainder of the season.

At the time of writing this document, Environment Canterbury with the help of the OTOP (Orari-Temuka-Opihi-Pareora) Zone Committee and various catchment and community groups are in the process of public consultation and implementation of the "Healthy Catchments Project".

In mid-December 2017, the OTOP Water Zone Committee released the Draft Zone Implementation Programme Addendum (ZIPA) (OTOP Zone Committee, 2017). This document contains the draft plans for the sub zones or Fresh Water Management Units (FMUs) as they are referred to in the document. The Draft ZIPA Plan contains recommended Water Quality Outcomes for ground water and surface water for the Zone (See Appendix 1).

McClelland Dairies is situated in the Rangitata Orton area of the Orari FMU Zone. The Zone Committee highlighted water quality in the Rangitata Orton area as a concern in the draft ZIPA, which states "*The Zone Committee note the challenges in the Orari FMU, in particular the nitrate hot spots in the Rangitata Orton area, and the general poor health of the lowland spring-fed streams."* To their credit the also stated*;" While the Committee understand the need for a pathway to improving surface and groundwater quality, it is also recognised that these improvements will take time. While aiming to improve water quality across the entire zone, the committee targeted mitigations that address nitrate hot spots and stream health in the area."* (OTOP Zone Committee, 2017, p.50).

The Zone Committee's recommendations for the Rangitata Orton area are as follows;

"If the zone-wide water quality outcomes are not met within 10 years of the OTOP sub-region plan change becoming operative, diffuse discharges of nutrients from farming activities will be required to reduce nitrogen losses beyond Baseline GMP (Good Management Practice) Loss Rates. Based on its current state, this could be in the order of 30-40%." (OTOP Zone Committee, 2017, p.50).

The purpose of this study is to investigate the potential implications of these specific recommendations, by applying a 40% reduction in nitrogen leaching losses to a case study dairy farm, McClelland Dairies.

Aims

- Investigate the financial implications of a potential 40% reduction in nitrogen leaching losses at a farm level.
- Investigate the flow-on effects of the potential nitrogen leaching reduction to the farm's suppliers and agriculture support industries.

Objectives

- Provide context on the potential future implications that nitrogen leaching reductions will have on the wider community.
- Highlight the economic and social contribution an individual farm has to the greater community.

Methodology

McClelland Dairies was selected for this study as a case study farm, as its size (ha) and production, is reasonably representative of an average Canterbury irrigated dairy farm, according to the New Zealand Dairy Statistics of herd analysis by region for 2015-16 (refer to Appendix 3). This is important, as the information and findings in this study may be applied and used as a comparison for other Canterbury dairy farms.

Overseer is a computer modelling programme designed to create a nutrient budget for a farm (Overseer, 2016). It does this by modelling the impact of nutrient use and the flow of nutrients within a farming system below the root zone according to the biophysical aspects of the farm (for example soil type, climate and topography) and farm management factors (for example fertiliser application, stocking rates and imported supplements). Because of its unique ability to quantify nutrient losses at the farm level, Overseer is increasingly being adopted by Regional Councils in New Zealand as a means of calculating nutrient losses to water from individual farms, and in turn set limits on their nutrient losses. There is debate around New Zealand as to whether Overseer should be used by as a regulatory tool (Shepherd et al., 2013). I will not go into this in this paper.

Being a computer programme, Overseer is updated from time to time, as research advances. For this study, I have used the Version 6.2.3 (the current Version in March 2018).

With the use of Overseer, I created a base nutrient budget for McClelland Dairies as a status-quo farm, using actual current farm management, input and production data. This was an important step to establish a base in order to compare the farm input data for the base and mitigated farms. I then created another nutrient budget model by applying nitrogen mitigations to the base farm to achieve nitrogen losses that were 40% below GMP. The mitigation strategies were chosen based on their cost-effectiveness (i.e. I reduced inputs which would have the least financial impact) and being recognised in Overseer Version 6.2.3.

Using the farm management input data entered into Overseer to create the two nutrient budgets, financial budgets were created for two scenarios. The financial budgets were used to show comparisons and the effect that the potential nitrogen leaching reduction will have on the farm's financial viability. Following this, I illustrated the potential implications of nitrogen cut backs on the farms suppliers, customers, and staff. In order to work out the latter, the farm's income and expenses will be broken down into individual sectors.

To provide reality and comparable results in the financial modelling, I have used debt levels of $22 per milksolid. This figure was derived from the Reserve Bank Statistics for December 2017, Dairy Farm Agriculture loans total $40.872 billion, divided by the 2016-17 New Zealand total milk production of 1.8 billion kilograms of milksolids (New Zealand Dairy Statistics, 2017[i]).

To form a standard milk price in the financial modelling I have used $6.37/kgMS. This is Fonterra's ten-year average milk price (including dividend) for the seasons 2007/08- 2016/17. (refer to Appendix 2)

Other costs and prices used for the paper were;

- Fertiliser Prices – Ravensdown April 2018 price list
- Stock prices – Market Research April 2018
- Palm Kernel Expeller price – Market Research April 2018
- Wheat price- Market Research April 2018

Results/Analysis.

Overseer budget.

The current nitrogen losses to water per hectare from McClelland Dairies, at Good Management Practice (GMP[ii]), are 108kg/N/ha/yr. Therefore, to meet the 40% reduction in nitrogen leaching losses, nitrogen loss has to decrease to 65kg/N/ha/yr.

When applying the nitrogen mitigations to the Overseer file of the base farm, the adjustment that had the biggest impact on reducing nitrogen leaching was the implementation of soil moisture probes to schedule irrigation. Soil moisture monitoring minimises the chance of over irrigating and exceeding soil moisture field capacity, which results in excessive drainage and elevated nitrogen losses. The impact the soil moisture monitoring had on the Overseer modelling was profound. The use of the probes had the effect of reducing the farms nitrogen leaching to 76kg/N/ha/yr (or a reduction of 30%). If the use of soil moisture monitors and strict policies on their use for irrigation management have as much of a mitigating effect on nitrogen leaching as was modelled, I believe they should be a requirement of any irrigation consent.

A further 10% reduction was required to achieve the 40% nitrogen reduction. Firstly, nitrogen fertiliser use was examined, which formed the basis for the mitigations. Nitrogen applications that were less effective due to lower pasture response rates were reduced, particularly those applied in the autumn and winter. Given there were no winter nitrogen applications (according to the current farm practices and GMP[iii]), autumn fertiliser applications were targeted first due to their nitrogen loss risk. Following this, imported supplements were also reduced, to reduce additional imported nitrogen into the system. These mitigations reduced feed supply which was compensated for by reducing cow numbers and milk production, which indirectly reduced nitrogen leaching from cow urine. These further mitigations reduced the farms nitrogen losses to 65kg/N/ha/yr. This achieved the desired 40% reduction.

Table 1 compares the key changes to the farm system inputs, production and outputs between the base farm model and 40% reduction scenario.

Table 1: Comparison in key changes to the farm inputs in the nutrient budgets

	Base Farm	**40% N reduction mitigation scenario**	**% reduction from base farm**
Soil moisture monitoring	No	Yes	
Urea fertiliser (total tonnes)	102.9	73.5	29%
Urea fertiliser (kg/ha)	510	364	29%
Imported PKE	200	120	40%
Imported wheat grain	200	120	40%
Imported baleage	50	30	40%
Baleage produced and fed on farm (T)	170	0	100%
Peak cows milked	760	733	4%
Stocking rate	3.8	3.6	5%
Total MS production	374400	355416	5%
MS per effective hectare	1855	1761	5%
MS per cow	493	485	2%
Nitrogen lost to water (kgN/year)	22669	13604	40%
Nitrogen lost to water (kgN/ha/year	**108**	**65**	**40%**

Financial Modelling.

The nitrogen mitigations used to achieve the 40% reduction in nitrogen leaching loss had a slight financial impact on the farm.

The base farm had a cash operating surplus of $684,647, compared to the 40% nitrogen reduction scenario farms of $664,642, a reduction in surplus of $20,005 (or 2.9%). This result came as a bit of a surprise, as the nitrogen mitigations implemented did not have as much of an adverse effect on the farms profitability as I was expecting. The reason for this relatively small change in income is the difference in revenue between the two farms was $123,836 (5% reduction) and the difference in expenses was $95,339 (7% reduction). These two figures on the most part off set each other.

Table 2 and 3 show the cash budgets for the base farm and 40% nitrogen reduction scenario.

Table 2: Base Farm Cash Budget

McClelland Dairy Base Farm

CAPITAL STOCK		Stock No.			
Cows		580			
Heifers		170			
	Peak Milk	750			
PRODUCTION PARAMETERS					
Calving			70%		
Death rates			4%		
Cows culled			18%		
MS/Cow			493		
Cows/ha			3.8		
MS/ha			1849		
Milk price Fonterra 10yr Avg including Dividend			$ 6.37		
Area Total Ha			200		
Total MS production			374400		
INCOME					
Milk income (solids)		374400	$ 6.37	$ 2,384,928.00	
Cull Cows		105	$ 600.00	$ 63,000.00	
Calves (Bobby)		228	$ 30.00	$ 6,825.00	
Calves (Bull)		110	$ 120.00	$ 13,200.00	
Surplus Heifers (empty)		20	$ 800.00	$ 16,000.00	
TOTAL INCOME					**$ 2,483,953.00**
Farm Working EXPENDITURE					
	c/kg	kgs			
Wheat	$ 0.38	200	$ 76.00	$ 57,000.00	
PKE	$ 0.24	200	$ 48.00	$ 36,000.00	
Balage	$ 0.35	50	$ 17.50	$ 13,125.00	
Contract Milkers Cut			$ 1.00	$ 374,400.00	
Animal Health (/cow)			$ 50.00	$ 37,500.00	
Cow wintering		780	$ 199.98	$ 155,984.40	
Heifer Grazing		188	$ 764.00	$ 143,250.00	
Breeding & Testing (/cow)			$ 42.00	$ 31,500.00	
Dairy shed expenses (/cow)			$ 5.00	$ 3,750.00	
Contracting Balage/ bales	170	@	$ 40.00	$ 6,800.00	
Cartage General				$ 20,000.00	
Cartage & Spreading Fertiliser	per tonne	$ 76.30		$ 28,688.80	
Fertiliser & lime (/ha)			$ 491.42	$ 98,283.54	
Regrassing 10%	Ha	20	$ 400.00	$ 8,000.00	
Weeds & Pests (/ha)			$ 80.00	$ 16,000.00	
Repairs & Maintenance				$ 30,000.00	
Vehicle Expenses				$ 8,000.00	
Calf Feed		10Tonne		$ 6,000.00	
Irrigation Charges Ha			$ 800.00	$ 160,000.00	
Irrigation Electricity/Charges Ha			$ 300.00	$ 60,000.00	
Consultants				$ 12,000.00	
Administration				$ 10,000.00	
Standing charges (Rates)				$ 7,000.00	
Insurance				$ 13,000.00	
Depreciation				$ 10,000.00	
FARM WORKING EXPENDITURE					
FWEx/kgMS		$ 3.60			**$ 1,346,281.74**
Dept Servicing					
Mortgage & Current Account @		5.50%	$ 8,236,800.00	$ 453,024.00	
DptSvc/kgMS		$ 1.21			
Operating Expenditure					**$ 1,799,305.74**
OPERATING SURPLUS					**$ 684,647.26**
Financial Indices					
EBIT (Earnings Before Interest & Tax)				$ 1,137,671.26	
EBIT /Ha				$ 5,688.36	
Gross/ha				$ 12,419.77	
Surplus/Ha				$ 3,423.24	
Costs/MS				$ 4.81	

Cow wintering	weeks			
$ 22.22	9		$ 199.98	
Heifer Grazing				
$ 764.00				
Fert/ha/Year	Tonne/ha	Tonne/total	price	
Urea	0.510	102.000	$ 526.00	$ 268.26
Superphosphate	0.500	100.000	$ 309.00	$ 154.50
Lime (Geraldine)	0.750	150.000	$ 13.75	$ 10.31
Ammo	0.120	24.000	$ 486.21	$ 58.35
Total per ha	1.880		Tonne	$ 491.42
Total Farm 200ha		376	Tonne	$ 98,283.54

(Fertiliser prices taken from Ravensdown Direct Debit price list 13/02/2018)

Note

McClelland Dairies debt has been worked out using $22 per kg MS. This figure was derived from the Reserve Bank of New Zealand Bank Stats for December 2017 Dairy Farming Agricultural loans total $40,872b, divided by NZ milk production of 1.8b kgs MS from Dairy NZ Quick Stats

Table 3: 40% Nitrogen Mitigation Scenario Farm Cash Budget

McClelland Dairy 40% N discharge reduced

CAPITAL STOCK		Stock No.
Cows		569
Heifers		164
	Peak Milk	733

PRODUCTION PARAMETERS		
Calving		70%
Death rates		4%
Cows culled		18%
MS/Cow		485
Cows/ha		3.67
MS/ha		1761
Milk price Fonterra 10yr Avg including Dividend	$	6.37
Area Total Ha		200
Total MS production		355416

Cow wintering	weeks		
$ 22.22	9		$ 199.98
Heifer Grazing			
$ 764.00			

Fert/ha/Year	Tonne/ha	Tonne/total	price	
Urea	0.368	73.500	$ 526.00	$ 193.31
Superphosphate	0.500	100.000	$ 309.00	$ 154.50
Lime (Geraldine)	0.750	150.000	$ 13.75	$ 10.31
Ammo	0.120	24.000	$ 486.21	$ 58.35
Total per ha	1.738		Tonne	$ 416.46
Total Farm 200ha		347.5	Tonne	$ 83,292.54

(Fertiliser prices taken from Ravensdown Direct Debit price list 13/02/2018)

INCOME					
Milk income (solids)		355416	$ 6.37	$ 2,263,999.92	
Cull Cows		103	$ 600.00	$ 61,572.00	
Calves (Bobby)		225	$ 30.00	$ 6,745.50	
Calves (Bull)		105	$ 120.00	$ 12,600.00	
Surplus Heifers (empty)		19	$ 800.00	$ 15,200.00	
TOTAL INCOME					**$ 2,360,117.42**
Farm Working EXPENDITURE					
	c/kg	kgs			
Wheat	$ 0.38	120	$ 45.60	$ 33,424.80	
PKE	$ 0.24	120	$ 28.80	$ 21,110.40	
Balage	$ 0.35	30	$ 10.50	$ 7,696.50	
Contract Milkers Cut			$ 1.00	$ 355,416.00	
Animal Health (/cow)			$ 50.00	$ 36,650.00	
Cow wintering		763	$ 199.98	$ 152,584.74	
Heifer Grazing		183	$ 764.00	$ 140,003.00	
Breeding & Testing (/cow)			$ 42.00	$ 30,786.00	
Dairy shed expenses (/cow)			$ 5.00	$ 3,665.00	
Contracting Balage				$ -	
Cartage General				$ 19,000.00	
Cartage & Spreading Fertiliser	per tonne	$ 76.30		$ 26,514.25	
Fertiliser & lime (/ha)			$ 416.46	$ 83,292.54	
Regrassing 10%	Ha	20	$ 400.00	$ 8,000.00	
Weeds & Pests (/ha)			$ 80.00	$ 16,000.00	
Repairs & Maintenance				$ 30,000.00	
Vehicle Expenses				$ 7,000.00	
Calf Feed		9 Tonne		$ 5,400.00	
Irrigation Charges Ha			$ 800.00	$ 160,000.00	
Irrigation Electricity/Charges Ha			$ 300.00	$ 60,000.00	
Consultants				$ 12,000.00	
Administration				$ 10,000.00	
Standing charges (Rates)				$ 7,000.00	
Insurance				$ 13,000.00	
Depreciation				$ 10,000.00	
Capital Cost Supply and Installation of Soil Moisture Monitoring Probes				$ 2,400.00	
FARM WORKING EXPENDITURE					
FWEx/kgMS		$ 3.52			**$ 1,250,943.23**
Dept Servicing					
Mortgage & Current Account @		5.50%	$ 8,082,396.00	$ 444,531.78	
DptSvc/kgMS		$ 1.25			
Operating Expenditure					**$ 1,695,475.01**
OPERATING SURPLUS					**$ 664,642.41**
Financial Indices					
EBIT (Earnings Before Interest & Tax)				$ 1,109,174.19	
EBIT /Ha				$ 5,545.87	
Gross/ha				$ 11,800.59	
Surplus/Ha				$ 3,323.21	
Costs/MS				$ 4.77	

Note

Debt levels from the status quo budget, minus the sale of 27 cows at $1500/head ($40,500) due to the reduced stocking rate, and the sale of 18,984 fonterra shares at $6.00 ($113,904) due two a lower milk production, have been used for this budget.

Further flow-on Financial Implications.

As stated above, the nitrogen mitigations used to model the desired nutrient cut backs did not have a significant impact on the farm's profitability, only 2.9%. However, the flow-on effects of the cuts made to farm income and farm working expenses will have larger implications, as they will be felt in the local community and greater economy.

Table 4 shows a spreadsheet which compares the financial results of the base farm and the 40% nitrogen reduction scenario, the difference in cash operating income and expenses ; this difference shown as a percentage.

In the spreadsheet I have assessed the farms change in income and expenses on a per hectare basis. This was done to make a comparable connection when multiplying out the farms financial results by the total hectares of dairy farms in Canterbury. I have done this using the 2015-16 New Zealand Dairy NZ Statistics (Total 270,079 hectares making up 1170 dairy farms or 15.4% of the national herd, South and North Canterbury combined) (Appendix 3)[iv]. Although the rules looked at in this study are specific the OTOP zone, I felt obligated to highlight the impact these nitrogen mitigations would have if all the sub-regions had to achieve similar nitrogen loss reductions. This will help show the potential effect that the greater Canterbury region could encounter. It also highlights the financial contribution the dairy industry makes to the greater economy.

Table 4: Comparison of Base Farm and 40% Nitrogen Mitigation Scenario Farm

Income and Expenses						
	Status quo	40% reduction	$ Difference	% Change	Per Hectare Difference	Total Region (1179 Farms)
Income						Total 270,079 Hectares
Milk income	$ 2,384,928	$ 2,264,000	$ (120,928)	-5.1%	$ (604.64)	$ (163,300,675)
Cull Cows	$ 63,000	$ 61,572	$ (1,428)	-2.3%	$ (7.14)	$ (1,928,364)
Calves (Bobby)	$ 6,825	$ 6,746	$ (79)	-1.2%	$ (0.40)	$ (107,356)
Calves (Bull)	$ 13,200	$ 12,600	$ (600)	-4.5%	$ (3.00)	$ (810,237)
Surplus Heifers (empty)	$ 16,000	$ 15,200	$ (800)	-5.0%	$ (4.00)	$ (1,080,316)
Totals	$ 2,483,953	$ 2,360,117	$ (123,836)	-5.0%	$ (619.18)	$ (167,226,948)
Expenses						
Wheat	$ 57,000	$ 33,425	$ (23,575)	-41.4%	$ (117.88)	$ (31,835,832)
PKE	$ 36,000	$ 21,110	$ (14,890)	-41.4%	$ (74.45)	$ (20,106,841)
Balage	$ 13,125	$ 7,697	$ (5,429)	-41.4%	$ (27.14)	$ (7,330,619)
Contract Milkers Cut	$ 374,400	$ 355,416	$ (18,984)	-5.1%	$ (94.92)	$ (25,635,899)
Animal Health (/cow)	$ 37,500	$ 36,650	$ (850)	-2.3%	$ (4.25)	$ (1,147,836)
Cow wintering	$ 155,984	$ 152,585	$ (3,400)	-2.2%	$ (17.00)	$ (4,590,884)
Heifer Grazing	$ 143,250	$ 140,003	$ (3,247)	-2.3%	$ (16.24)	$ (4,384,733)
Breeding & Testing (/cow)	$ 31,500	$ 30,786	$ (714)	-2.3%	$ (3.57)	$ (964,182)
Dairy shed expenses (/cow)	$ 3,750	$ 3,665	$ (85)	-2.3%	$ (0.43)	$ (114,784)
Contracting balage	$ 6,800	$ -	$ (6,800)	-100.0%	$ (34.00)	$ (9,182,686)
Cartage General	$ 20,000	$ 19,000	$ (1,000)	-5.0%	$ (5.00)	$ (1,350,395)
Cartage & Spreading Fertiliser	$ 28,689	$ 26,514	$ (2,175)	-7.6%	$ (10.87)	$ (2,936,501)
Fertiliser & lime (/ha)	$ 98,284	$ 83,293	$ (14,991)	-15.3%	$ (74.96)	$ (20,243,771)
Regrassing 10%	$ 8,000	$ 8,000	$ -	0.0%	$ -	$ -
Weeds & Pests (/ha)	$ 16,000	$ 16,000	$ -	0.0%	$ -	$ -
Repairs & Maintenance	$ 30,000	$ 30,000	$ -	0.0%	$ -	$ -
Vehicle Expenses	$ 8,000	$ 7,000	$ (1,000)	-12.5%	$ (5.00)	$ (1,350,395)
Calf Feed	$ 6,000	$ 5,400	$ (600)	-10.0%	$ (3.00)	$ (810,237)
Irrigation Charges	$ 160,000	$ 160,000	$ -	0.0%	$ -	$ -
Irrigation Electricity/Charges	$ 60,000	$ 60,000	$ -	0.0%	$ -	$ -
Consultants	$ 12,000	$ 12,000	$ -	0.0%	$ -	$ -
Administration	$ 10,000	$ 10,000	$ -	0.0%	$ -	$ -
Standing charges	$ 7,000	$ 7,000	$ -	0.0%	$ -	$ -
Insurance	$ 13,000	$ 13,000	$ -	0.0%	$ -	$ -
Depreciation	$ 10,000	$ 10,000	$ -	0.0%	$ -	$ -
Soil Moisture Probe	$ -	$ 2,400	$ 2,400	0.0%	$ 12.00	$ 3,240,948
Totals	$ 1,346,282	$ 1,250,943	$ (95,339)	-7%	$ (476.69)	$ (128,744,647)
EBIT Surplus	$ 1,137,671	$ 1,109,174	$ (28,497)	-2.5%	$ (142.49)	$ (38,482,301)
Dept servicing	$ 453,024	$ 444,532	$ (8,492)	-1.9%	$ (42.46)	$ (11,467,851)
Surplus (deficit)	$ 684,647	$ 664,642	$ (20,005)	-2.9%	$ (100.02)	$ (27,014,449)

Income/Revenue

Overall, the farms income/revenue was reduced by $123,836. This reduction was made up of the combination of less milk sold due to lower milk production, and less stock sold due to a reduced stocking rate.

On a region wide scale this reduction in income could potentially equate to $167,226,984.

Milksolid pay out

Milk production reduced by 18,984 milksolids (95MS/ha) or 5%. This was due to a reduced stocking rate and less inputs used on farm.

Regionally 25,635,898 milksolids could be lost. With the regions total milk production being 385,393,573 milksolids, this would be a reduction of 6.65%. (Appendix 4)

Stock sales

Stock sales reduced by a total of $2,907 ($14.53/ha), due to less stock.

Regionally revenue from stock sales would reduce by $3,925,598.

The impact of the reduction in Farm Working Expenses

The reduction in expenditure from the base farm to the mitigation scenario farm is $95,339 ($476.69/ha). Multiplied out to cover the entire region this reduction in expenditure would equate to $128,744,647. Below is a breakdown of these expenses and some commentary on each.

Wheat

The mitigation scenario resulted in a $23,575 ($117.88/ha) decrease in expenditure on wheat, making it the largest cut to expenses (roughly quarter of the total reduction in expenses). At the current market value of $380/t delivered, this equates in a 64 tonnes reduction of grain purchased on the farm.

For Canterbury, $31,835,832 equates to a reduction of 83,778 tonnes wheat purchased and imported on to dairy platforms. According to Statistics NZ, Canterbury's total wheat production for year ending 2016, was 372,114 tonnes. Therefore, 83,778 tonnes is 22.5% of the regions wheat production.

Palm Kernel Extract (PKE)

The mitigation scenario resulted in a $14,890 ($74.45/ha) reduction in expenditure on PKE, at a value of $240 per tonne delivered. This equates to a 64 tonnes reduction in PKE imported to the farm system.

For the Canterbury region, this would equate a $20,106,841 reduction in expenditure on PKE from dairy farms; 83,778 tonnes less PKE used.

Baleage

$5,429 ($27.14/ha) less spent on purchasing baleage following the nitrogen mitigation; at $105 per bale (300kgDM per bale) this is a reduction in 53 bales imported to the farm.

The total reduction in baleage purchased by Canterbury dairy farmers would equate to $7,330,61; or 69,815 less bales of balage traded.

Contract Milkers income

The $18,984 ($94.92/ha) cut from the Contract Milkers gross income would in part be off-set in a reduction in their costs. Some of the cost reductions would be from lower shed power costs due to less cows being milked, therefore the milking duration would be reduced, resulting in less milk to cool and refrigerate. However, these cost reductions would be small. To use a common budgeting figure of $35 per cow for shed power, a reduction of 27 cows (as a result of the nitrogen mitigations) will cut costs by only $945. The main cost reduction will be in labour expenses. At a cost of $48,000 for a Dairy assistant, the remaining $18,039 ($90.19/ha) of cost cut in Contract Milkers gross income is 0.37 (0.00185/ha) of a labour unit.

Multiplied out over 1179 Canterbury farms total hectares (270,079 ha) it would mean 500 less jobs for the region. The total income of $24,359,775 from the 500 less direct on-farm jobs would also disappear from the region's economy.

Animal health

The nitrogen reduction scenario resulted in a $850 ($4.25/ha) reduction in animal health expenses due to less stock, which would mostly come at the expense of local vets. In the greater region, the figure of $1,147,836 would have an significant impact.

Cow wintering and heifer grazing

Due to lower stocking rates, expenditure on cow wintering and heifer grazing was reduced by $6,647 ($33.24/ha),

On a region scale $8,975,617 less will be spent on grazing. The integration of dairy support land into other farming operations (particularly arable) has been significant in the wider Canterbury region, therefore this is likely to impact third party graziers.

Breeding and herd testing

There was a $714 ($3.57/ha) reduction in breeding and herd testing expenditure due to the reduction in cow numbers, which will affect the vets and artificial breeding companies, for example LIC.

Contracting baleage

The $6,800 ($34/ha) cut from McClelland's Dairies expenditure will impact on rural contractors. On a region wide basis $9,182,686 won't be spent. This will mean less seasonal jobs will be available.

Cartage general and Cartage and Spreading Fertiliser

Reduced spending to these will affect the local trucking firms. $3,175 ($15.87/ha), $4,286,153 regionally.

Fertiliser and Lime

$14,991 ($74.96/ha) less spent on farm and $20,243,771 less spent regionally will affect the fertiliser companies.

The above figures are the direct financial effects of proposed nitrogen mitigations. The dollars lost to the system are permanently lost. In situations like this every extra dollar earned will have gone on to create greater wealth every time it passes down the economy. The subsequent levels of flow-on effects and how and where the wealth created would go and beyond the scope of this study.

Discussion

The part of this study that came as a surprise to me was the impact the inclusion of soil moisture monitoring had on the outcome of the Overseer model. Whether the actual use of this monitoring would have the effect the modelling shows is another question. That being said, my personal experience in using soil moisture probes to help make the decision whether to start and stop irrigators, I would be inclined to agree that there are some major gains to be made with their use.

Besides the above debate, the inclusion of soil moisture monitoring in the Overseer model and the subsequent effect that this component has on reducing the modelled nitrogen leaching on the farm, we are lucky it's there. The work was not done to model the effects of a 40% reduction in nitrogen leaching beyond GMP with the absence of the soil moisture monitoring. It is assumed that achieving the above reduction without soil moisture monitoring, would be far greater than the $123,836 reduction in revenue and $95,339 reduction in expenses. The subsequent flow-on effects to the regional economy would be significant.

Another thing highlighted by this exercise is that gross income from the primary industries is directly linked to the prosperity of the greater economy. "The trickledown effect" is real. Cutting off an income stream at a primary industry level will be lost. It will not miraculously start flowing again further down the economy.

Adding value to products produced in the primary industries has been touted as a solution to replace the economic losses that will occur from cutbacks to production. While this is well intended, I believe it is flawed. Our primary sector export companies are currently placing as much of our primary produce as possible into value add products. The move from trading commodity products to marketing value add products will grow over time but this transition can be slow and expensive.

The outcome of this study has highlighted the impact that the decisions made by Regional Councils could have on provincial communities. It begs the question, is the community aware of these potential financial impacts and is the community aware that their aspirations for water quality are going to come at a cost.

Given the outcomes of this project, I believe a more in-depth study should be done to investigate the wider implications of the proposed regulations. This will be important so everyone can be better informed of what sacrifices they may need to make to realise a dream. With this information the public may have a different attitude towards where the solution may lie.

Farmers also have a big part to play in the future state of the environment. Gone are the days of the 'she'll be right' attitude, ignoring the rules or just doing bare minimum. Rules are general and because of this they sometimes don't fit certain situations, sometimes they may go too far and sometimes they don't go far enough. Because of this, we as a group and as individuals need to take responsibility and think of the implications of everything we do on farm. We need to evaluate whether these actions are going to impact the environment beyond the farm gate. Conversely to this we need time to implement environmentally sustainable farm practices. We also need help and education around what changes on farm are going to have the most impact when it comes to improving the environment and in turn water quality. Science too has a large part to play in helping to find solutions to some of these problems. Already studies are under way on things that could help reduce nitrogen leaching in pastoral systems. For example, extensive trial work is being done on the use of the forage plantain and its ability to help reduce nitrogen leaching in pastoral systems.

Conclusions/Recommendations

- The study of the proposed 40% nitrogen reduction and the effects it will have on a farm, have shown McClelland Dairies or a similar irrigated farm with light soils, could carry on with little adverse effects to its financial viability if it effectively implemented soil moisture monitoring.
- However, it is worth noting there is no 'one size fits all 'approach to mitigating nitrogen leaching, as these factors need to be considered on a farm-specific and farm system basis.
- The impact that the inclusion of soil moisture monitoring had on the modelled nitrogen losses of the mitigated farm were significant. This prompts me to question why the inclusion of these monitors is not compulsory in all irrigation consents.
- The financial impact of the proposed regulations, go beyond the farm gate. The study has shown that cuts to the primary industry can have greater and sometimes unintended consequences. In this instance, businesses who supply the farming community will bear most of the brunt of the environmental mitigations.

Appendices.

Appendix 1: OTOP Draft ZIPA.

4.8.1 Recommendation: Water Quality Outcomes
I. No Deterioration of Water Quality:
a. The recommendations below are the freshwater outcomes that apply across the zone for freshwater resources. Where existing freshwater quality is already better than the outcome, there shall be no deterioration of that water quality.
II. Groundwater:
a. Within five years of the OTOP sub-region plan change becoming operative nitrate nitrogen in groundwater shall meet ½ Maximum Allowable Value (MAV) of 5.65 mg/l as an annual median.
b. Within five years of the OTOP sub-region plan change becoming operative E. coli in groundwater shall meet the limit in the Land and Water Regional Plan14.
III. Surface Water:
a. Freshwater bodies in the zone that do not meet the national bottom line for nitrate toxicity of 6.9 mgN/l are required to meet this within five years of the OTOP subregion plan change becoming operative.
b. Within 10 years of the OTOP sub-region plan change becoming operative, water quality is to meet the Land and Water Regional Plan limit for nitrate toxicity of 3.8
14 In 95% of samples, E. coli must meet a limit of <1 organism per 100 millilitres.
mgN/l, where the national bottom line is currently being met, or are maintained at current levels where concentrations are less than 3.8 mgN/l.
c. Periphyton outcomes are set at levels appropriate and consistent with NPS-FM 2017.
d. Instream nutrient concentration levels (for managing periphyton and macrophytes) do not deteriorate from current and if the periphyton and macrophyte outcomes are not being met, concentrations are reduced over time until the outcomes are met.

Appendix 2: Fonterra Milk Price (including dividend) from 2007/08 – 2016/17

Fonterra Milk Price Average (10 year)			
Year	Milk	Dividend	Total
2007/08	$7.59	$0.07	$7.66
2008/09	$4.75	$0.45	$5.20
2009/10	$6.10	$0.27	$6.37
2010/11	$7.60	$0.30	$7.90
2011/12	$6.08	$0.32	$6.40
2012/13	$5.84	$0.32	$6.16
2013/14	$8.40	$0.10	$8.50
2014/15	$4.40	$0.25	$4.65
2015/16	$3.90	$0.40	$4.30
2016/17	$6.12	$0.40	$6.52
Average	$6.08	$0.29	$6.37

Appendix 3: New Zealand Herd Data

Table 3.1: Herd analysis by region in 2015/16

Farming region	Total herds	Percentage of herds	Total cows	Percentage of cows	Total effective hectares	Percentage of effective hectares	Average herd size	Average effective hectares	Average cows per hectare
Northland	907	7.6	280,435	5.6	123,167	7.0	309	136	2.28
Auckland	410	3.4	111,192	2.2	48,041	2.7	271	117	2.31
Waikato	3,436	28.8	1,152,340	23.1	390,364	22.3	335	114	2.95
Bay of Plenty	592	5.0	198,706	4.0	70,317	4.0	336	119	2.83
Central Plateau	490	4.1	267,690	5.4	99,094	5.7	546	202	2.70
Western Uplands	90	0.8	46,706	0.9	18,178	1.0	519	202	2.57
East Coast	10	0.1	5,884	0.1	2,286	0.1	588	229	2.57
Hawkes Bay	76	0.6	48,770	1.0	17,231	1.0	642	227	2.83
Taranaki	1,675	14.1	486,953	9.7	172,168	9.8	291	103	2.83
Manawatu	552	4.6	221,124	4.4	80,066	4.6	401	145	2.76
Wairarapa	458	3.8	166,192	3.3	60,908	3.5	363	133	2.73
North Island	**8,696**	**73.0**	**2,985,992**	**59.7**	**1,081,820**	**61.8**	**343**	**124**	**2.76**
Nelson/Marlborough	237	2.0	85,986	1.7	30,052	1.7	363	127	2.86
West Coast	378	3.2	158,070	3.2	70,814	4.0	418	187	2.23
North Canterbury	867	7.3	690,010	13.8	198,578	11.3	796	229	3.47
South Canterbury	312	2.6	240,076	4.8	71,501	4.1	769	229	3.36
Otago	438	3.7	262,293	5.2	88,024	5.0	599	201	2.98
Southland	990	8.3	575,384	11.5	210,915	12.0	581	213	2.73
South Island	**3,222**	**27.0**	**2,011,819**	**40.3**	**669,884**	**38.2**	**624**	**208**	**3.00**
New Zealand	**11,918**		**4,997,811**		**1,751,704**		**419**	**147**	**2.85**

Appendix 4: Herd Analysis by Region

Table 3.2: Herd production analysis by region in 2015/16

Farming region	Total kg milksolids	Percent milk-solids	Average litres per herd	Average kg milkfat per herd	Average kg protein per herd	Average kg milksolids per herd	Average kg milkfat per effective hectare	Average kg protein per effective hectare	Average kg milksolids per effective hectare	Average kg milkfat per cow	Average kg protein per cow	Average kg milksolids per cow
Northland	90,416,108	4.9	1,140,423	56,358	43,329	99,687	415	319	734	182	140	322
Auckland	38,597,810	2.1	1,082,531	53,143	40,998	94,141	454	350	803	196	151	347
Waikato	418,013,083	22.5	1,373,793	68,952	52,704	121,657	607	464	1,071	206	157	363
Bay of Plenty	69,674,594	3.7	1,350,876	66,454	51,239	117,694	559	431	991	198	153	351
Central Plateau	98,546,969	5.3	2,282,193	114,192	86,924	201,116	565	430	994	209	159	368
Western Uplands	14,323,716	0.8	1,775,420	90,035	69,118	159,152	446	342	788	173	133	307
East Coast	1,695,227	0.1	1,939,627	95,616	73,907	169,523	418	323	742	163	126	288
Hawkes Bay	16,435,783	0.9	2,491,882	121,026	95,234	216,260	534	420	954	189	148	337
Taranaki	179,819,017	9.7	1,174,982	61,046	46,308	107,355	594	451	1,044	210	159	369
Manawatu	80,780,059	4.3	1,680,811	82,349	63,991	146,341	568	441	1,009	206	160	365
Wairarapa	59,100,692	3.2	1,439,366	73,145	55,896	129,041	550	420	970	202	154	356
North Island	**1,067,403,059**	**57.3**	**1,384,573**	**69,525**	**53,222**	**122,746**	**559**	**428**	**987**	**202**	**155**	**357**
Nelson/Marlborough	32,268,422	1.7	1,500,485	77,416	58,737	136,154	611	463	1,074	213	162	375
West Coast	53,168,981	2.9	1,517,111	80,674	59,984	140,659	431	320	751	193	143	336
North Canterbury	287,311,596	15.4	3,735,651	185,656	145,730	331,386	811	636	1,447	233	183	416
South Canterbury	98,081,977	5.3	3,521,125	176,668	137,697	314,365	771	601	1,372	230	179	409
Otago	101,001,425	5.4	2,590,798	129,175	101,422	230,597	643	505	1,147	216	169	385
Southland	222,635,351	12.0	2,497,617	125,524	99,360	224,884	589	466	1,056	216	171	387
South Island	**794,467,752**	**42.7**	**2,754,157**	**138,353**	**108,223**	**246,576**	**665**	**521**	**1,186**	**222**	**173**	**395**
New Zealand	**1,861,870,811**	**100.0**	**1,754,836**	**88,132**	**68,091**	**156,223**	**600**	**463**	**1,063**	**210**	**162**	**373**

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