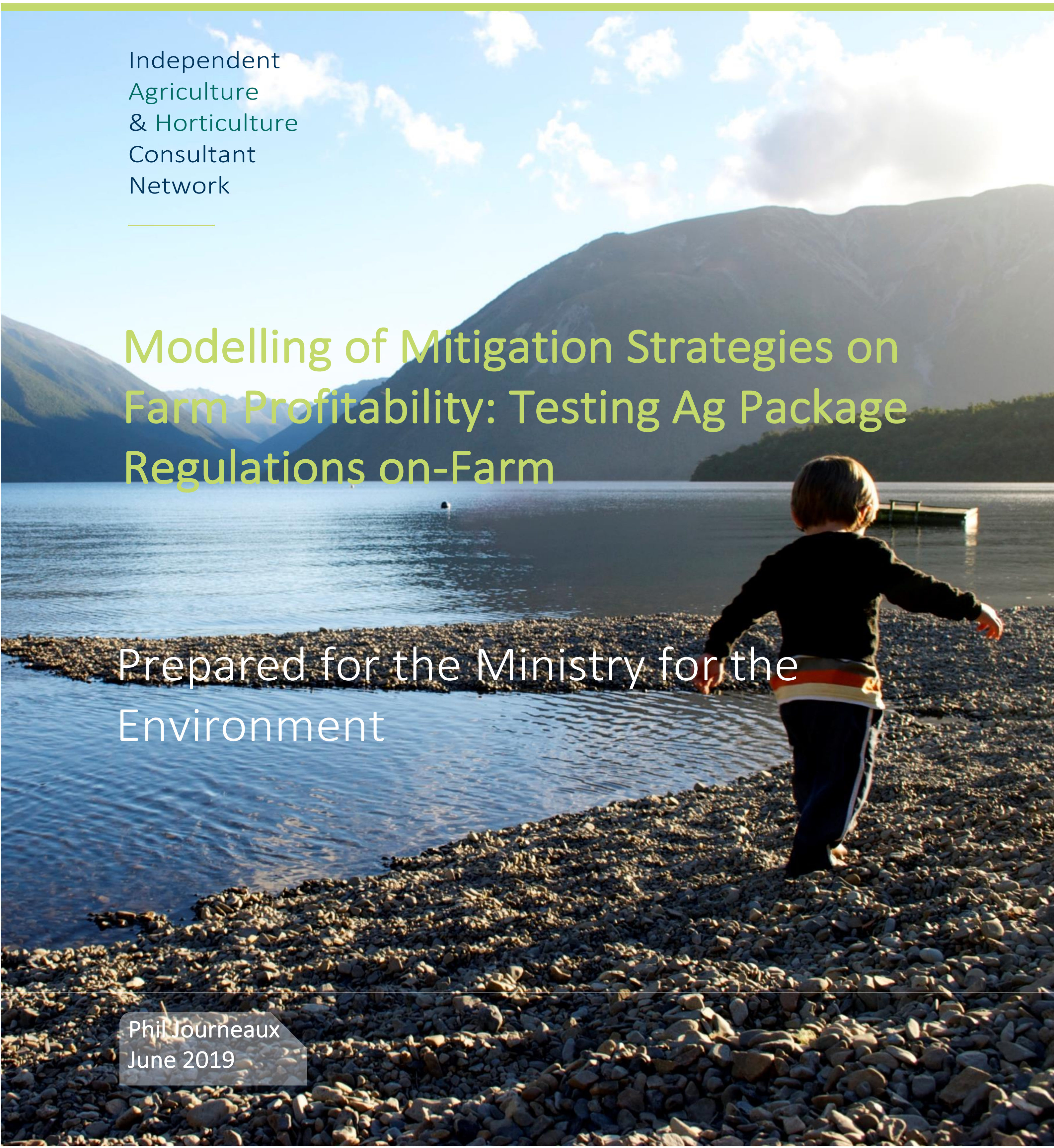

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Modelling of Mitigation Strategies on Farm Profitability: Testing Ag Package Regulations on-Farm

Prepared for the Ministry for the Environment

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Peer review by Lee Matheson, Managing Director, Perrin Ag, Rotorua.

1.0 EXECUTIVE SUMMARY

This report discusses the analysis of a number of modelling exercises assessing the impact of various mitigation strategies on farm profitability.

1.1 Stock Exclusion

This analysed the cost of fencing (and stock water reticulation on the sheep and beef farm), riparian planting, and opportunity cost of land lost to grazing, on a representative (Waikato/BoP) dairy, a (Central North Island) hill country sheep and beef farm, and a lowland/intensive sheep and beef farm, with setbacks of 1, 3, and 5 metres. The costs shown below are Present Values, discounted at 6%. The results are:

DAIRY FARM

	1 metre setback			3 metre setback			5 metre setback		
Time for installation	1 Year	5 Years	10 Years	1 Year	5 Years	10 Years	1 Year	5 Years	10 Years
Cost ($/ha)	$168	$154	$138	$703	$642	$575	$1,469	$1,353	$1,222
Cost as a % of EBITD[1]	5.7%	5.3%	4.7%	24.0%	21.9%	19.6%	50.2%	46.2%	41.7%

HILL COUNTRY SHEEP AND BEEF FARM

2-wire electric fence	1 metre setback			3 metre setback			5 metre setback		
Time for installation	1 Year	5 Years	10 Years	1 Year	5 Years	10 Years	1 Year	5 Years	10 Years
Cost ($/ha) 10% of farm	$19	$17	$8	$39	$35	$25	$59	$53	$41
Cost as a % of EBITD	5.2%	4.6%	2.3%	10.9%	9.7%	6.9%	16.2%	14.7%	11.3%
Cost ($/ha) 20% of farm	$42	$37	$20	$82	$74	$53	$121	$109	$85
Cost as a % of EBITD	11.5%	10.2%	5.6%	22.8%	20.4%	14.7%	33.6%	30.3%	23.5%

8-wire post & batten fence	1 metre setback			3 metre setback			5 metre setback		
Time for installation	1 Year	5 Years	10 Years	1 Year	5 Years	10 Years	1 Year	5 Years	10 Years
Cost ($/ha) 10% of farm	$41	$37	$18	$62	$55	$34	$81	$73	$50
Cost as a % of EBITD	11.5%	10.2%	4.9%	17.1%	15.3%	9.4%	22.5%	20.2%	13.8%
Cost ($/ha) 20% of farm	$87	$77	$38	$128	$114	$71	$167	$150	$103
Cost as a % of EBITD	24.1%	21.4%	10.6%	35.4%	31.6%	19.7%	46.1%	41.5%	28.5%

The cost as a proportion of EBITD shows (a) that a 1-year implementation is relatively expensive; and (b) proportionally the cost is higher on the hill country sheep and beef farm, recognising that 10-20% of the farm is being fenced, as compared with 100% of the dairy farm.

[1] EBITD = Earnings before Tax, Interest, Depreciation. This also excludes Owners drawings and Wages of Management

Lowland Sheep and Beef farm

2-wire electric	1 metre setback			3 metre setback			5 metre setback		
Time for installation	1 Year	5 Years	10 Years	1 Year	5 Years	10 Years	1 Year	5 Years	10 Years
Cost ($/ha)	$302	$267	$143	$608	$545	$389	$899	$812	$629
Cost as a % of EBITD	46.4%	41.1%	21.9%	93.5%	83.8%	59.8%	138.3%	124.9%	96.8%

8 wire post/batten	1 metre setback			3 metre setback			5 metre setback		
Time for installation	1 Year	5 Years	10 Years	1 Year	5 Years	10 Years	1 Year	5 Years	10 Years
Cost ($/ha)	$642	$569	$278	$948	$847	$525	$1,239	$1,114	$765
Cost as a % of EBITD	98.7%	87.6%	42.8%	145.8%	130.3%	80.7%	190.6%	171.4%	117.7%

This analysis again indicates that a 1-year implementation is relatively expensive, and proportionally more expensive relative to the dairy farm.

Assuming that a fence already exists at a 1 metre setback, which is the situation on many dairy farms, then the cost to strip and shift the fence to either a 3 or 5 metre setback based on a 2-wire electric fence, is:

Dairy

		1 Year	5 Years	10 Years
Shift to 3 metre setback	$/Ha	$640	$577	$515
	Cost as a % of EBITD	21.9%	19.7%	17.6%
Shift to 5 metre setback	$/Ha	$1,406	$1,288	$1,162
	Cost as a % of EBITD	48.0%	44.0%	39.7%

Hill country Sheep & Beef

		10% of farm			20% of farm		
		1 Year	5 Years	10 Years	1 Year	5 Years	10 Years
Shift to 3 metre setback	$/Ha	$29	$26	$23	$38	$33	$29
	Cost as a % of EBITD	8.1%	7.2%	6.3%	10.5%	9.2%	8.1%
Shift to 5 metre setback	$/Ha	$49	$44	$39	$57	$51	$45
	Cost as a % of EBITD	13.5%	12.1%	10.8%	15.9%	14.1%	12.5%

Lowland Sheep & Beef

		1 Year	5 Years	10 Years
Shift to 3 metre setback	$/Ha	$371	$332	$294
	Cost as a % of EBITD	57.0%	51.0%	45.2%
Shift to 5 metre setback	$/Ha	$662	$599	$534
	Cost as a % of EBITD	101.8%	92.1%	82.1%

While this analysis shows a lower fencing cost relative to the '100% new', it is important to note that the farmer has in fact paid twice; the original fence did incur a cost, albeit it is now a sunk cost, followed by a second cost in shifting it.

There are no greenhouse gas implications from the riparian plantings in this analysis, as they would not qualify under the ETS.

1.2 Nitrogen Leaching Cap

This involved modelling a real (Waikato) dairy farm currently leaching 76 kgN/ha/year, where scenarios of restricting N leaching to 60/50/40 kgN/ha/year were applied. The results are:

SUMMARY OF THE IMPACTS OF REDUCING THE NITROGEN LEACHED

	Base	60 kgN	50 kgN	40 kgN
Cows wintered	708	708	637	567
Total milksolids production (kg)	252,660	245,802	207,399	188,699
Milksolids/ha	915	891	751	699
Kg N fertiliser applied/ha	248	248	148	89
Total Supplement bought in (tDM)	309	432	309	250
Cash Operating Surplus (EBITD)($/ha)	$1,164	$1,328	$1,013	$860
Change in cash farm surplus relative to base		+14%	-13%	-26%
kg N leached/ha	76	60	50	40
Tonnes biological GHG emitted eff/ha	11.9	11.9	10.3	9.1

This shows an increase in farm profitability for the 60 kgN scenario, with decreases for the 50 and 40 kgN scenarios. The farm was carrying out an extensive two-year cropping programme, which was (a) expensive; and (b) resulted in a high nitrogen leach. Eliminating the second year of cropping gave a significant drop in nitrogen leaching, and the cost saving gave an increase in farm profitability, for the 60 kgN scenario.

Under an average level of debt servicing ($25/ha) and depreciation, the farm would be financially unviable, especially under the 50 and 40 kgN scenarios.

DairyNZ analysis has shown a wide variability in the cost of mitigating nitrogen leaching, as discussed in the report. This is important, as it is dangerous to extrapolate the results from just one farm.

As shown in the table above, the farm is emitting 11.9 tonnes CO_2e/ha of biological (CH_4 + N_2O) emissions. The cost of this to the farm, assuming a price of $25/t CO_2e and a 5% liability is:

	Base farm and 60 kgN scenario	50 kgN scenario	40 kgN scenario
Cost ($/ha)	$15	$13	$11

1.3 Land Intensification

This analysis considered the cost of converting land from:

(i) Forestry to dairying.
(ii) Forestry to sheep and beef.
(iii) Sheep and beef to dairying.

This showed that conversion from forestry to pastoral farming is generally uneconomic, particularly if the full cost of the carbon tax (at $25/NZU) under the ETS is payable. The cost of conversion from sheep and beef farming to dairying is dependent on a range of factors, but currently would be considered marginal at best.

CONVERSION COST SUMMARY

	Cost to achieve functioning farm ($/ha)	Full carbon tax cost ($/ha)	Total Cost ($/ha)	Resultant farm value ($/ha)
Forestry to dairying	$32,600	$18,875	$51,475	$30,000 - $35,000
Forestry to sheep and beef	$15,700	$18,875	$34,575	$15,000 - $20,000
Sheep and beef to dairying	$21,700		$21,700	Marginal increase = $15,000 - $20,000

1.4 Conversion of a Sheep & Beef Farm to Dairying

The objective for this analysis was to convert a sheep & beef farm to dairying, while staying within the nitrogen leaching level of the original sheep & beef farm, of 17 kgN/ha/year.

This was done by converting a 290-hectare sheep & beef farm in 3 scenarios:

	EBITD/ha	kgN/ha	GHG emissions (T CO_2e/ha
S&B Farm	$592	17	4.5
Base Dairy	$2,354	26	10.2
Scenario 1	$1,851	22	8.3
Scenario 2	$2,089	17	9.7

The investment analysis results showed:

	Base	Scenario 1	Scenario 2
NPV	$1,368,781	$623,165	$407,673
IRR	8.0%	7.0%	6.6%

While this showed a positive result inasmuch as the IRR is above the cost of capital, there are a range of factors which would deter conversions: the lack of capital gain on the conversion, the variability in dairy payouts, and access to capital.

1.5 Sensitivity Analysis around Dairy Milk Price relative to converting from Sheep & Beef to Dairying

The purpose of this analysis was to investigate the impact of increasing dairy payouts on the investment returns of converting from sheep & beef to dairying.

This was based on comparing an increasing level of milk price, from $6/kgMS through to $10/kgMS, against the initial sheep & beef profitability, which was held constant.

The results of this showed an obvious trend; as payout increases, the differential in profitability between dairying and sheep and beef increases, such that a conversion would be increasingly more profitable.

Milk Price ($/kgMS)	$6.00	$7.00	$8.00	$9.00	$10.00
NPV ($/ha)	$10,620	$19,657	$30,149	$40,641	$48,784
IRR	10.6%	14.2%	18.3%	22.2%	24.1%

2.0 OBJECTIVES

MfE have requested an analysis based on modelling, to assess the impact of various mitigation strategies on farm profitability. The assessments are:

1. **Stock Exclusion**
   This will involve modelling the cost of fencing, riparian planting, and opportunity cost of land lost to grazing, on a representative dairy and lowland/intensive, and hill country, sheep and beef farm.

   The modelling will include:

   (i) Setbacks of 1, 3, and 5 metres.

   (ii) Cost of with and without riparian planting.

   (iii) Discussion and analysis as to the impact any riparian planting has on carbon sequestration.

   (iv) The slope option will be <5 degrees; the assumption is that this will include all of the dairy farm, and the lowland sheep and beef farm, but inasmuch as it would include relatively little of the hill country sheep and beef farm, the modelling for the hill country sheep and beef farm will be 10%/20% of the effective area.

2. **Impact of a Nitrogen Cap**
   This will involve modelling a real dairy farm currently leaching 76 kgN/ha/year, where scenarios of restricting N leaching to 60/50/40 kgN/ha/year will be applied.

3. **Land Intensification**
   An analysis will be provided as to the cost, and implications thereof, of converting land from:

   (i) Forestry to dairying
   (ii) Forestry to sheep and beef
   (iii) Sheep and beef to dairying

4. **Greenhouse Gas Impact**
   The biological greenhouse gas emission (i.e. CH_4, N_2O) implications for the modelling scenarios in (1) and (2) will be included within the analysis and discussion, particularly as to a 5% liability (i.e. a 95% free allocation) and a carbon price of $25/tonne CO_2e.

5. **Conversion of a Sheep & Beef Farm to Dairying**
   The analysis is to investigate the conversion of a sheep & beef farm into a dairy farm, while remaining at the same nitrogen leaching level as the original sheep & beef farm.

6. **Sensitivity of Investment Return on Converting a Sheep & Beef Farm to Dairying, Based on Increasing the Dairy Milk Price**
   The analysis is to investigate the impact on the investment return of converting a sheep & beef farm to dairying, of increasing the dairy milk price, from $6/kgMS up to $10/kgMS.

3.0 LIVESTOCK EXCLUSION

This was modelled using the AgFirst Waikato/Bay of Plenty dairy model, which is a model representing the average farm for those regions, and the AgFirst Central North Island sheep and beef hill country model, again an average farm representing that area. Both these models have been developed as part of AgFirst's annual financial monitoring programme. The lowland/intensive sheep and beef farm is based on the Beef+Lamb NZ Economic Service Class 5 North Island Intensive Finishing Farm.

3.1 Length of streams on-farm

A key aspect of modelling the cost of stock exclusion is the average length of streams on farm that need to be fenced off.

For this analysis, stream length was based on farms in the Waikato (Waikato Regional Council 2015). This shows:

Table 1: Stream length on Waikato Farms

	No. of Farms[1]	Average stream length (km/farm)	Average metres/farm	Average farm size (eff ha)[2]	Average metres/ha
Dairy	3,972	2.69	2,692	126	21.4
Sheep and Beef	3,276	3.98	3,985	373	10.7

Note: [1] From Dairy Statistics and Statistics NZ. [2] Dairy Statistics and Beef + Lamb NZ Economic Service

The average metres per hectare was then used with the farm models.

Streams are classified as to their size, with the smallest streams with a year-round flow and no tributaries called first order (1) streams. When two first order streams flow into each other they form a second order stream (2). If two second order streams flow into each other they form a third order stream (3), and so on. The Waikato report (WRC 2015) described stream order based on the Strahler system of ranking stream channels, which ranks streams on a scale from 1 to 7 based on the number and size of tributaries contributing flow to a given stretch of waterway. The report also included stream order 0, which was classified as drains.

3.2 Cost of fencing and riparian planting

The cost of fencing was based on the MPI (2017) report, which shows a range of fencing costs depending on the type of fence and contour of the land.

For the purposes of this analysis, it was assumed that the fencing on the dairy farm would be a 2-wire electric fence, at a cost of $5/linear metre.

Inasmuch as the main requirement on sheep and beef farms is to fence out cattle, the assumption was again to use 2-wire electric fencing. In noting this, many farmers could well prefer a fully stock proof fence, and a further option using an 8-wire conventional post and batten fence, at a cost of $14/metre[2].

[2] This corresponds to the cost in the MPI report for flat/rolling country. On steeper country the cost would be $18+/metre

For the purposes of the analysis a key assumption was that the streams on the farms were currently unfenced, so the cost was 100%. In reality most dairy farms and a number of sheep and beef farms (particularly on the easier country) have already fenced the streams off. In this case the cost is sunk, which would give a zero cost in the analysis.

Riparian planting cost was also based on the MPI (2017) report, which used an average cost of $5.50 per planting, including labour, plants, and ground preparation, and an average of 4,500 plants/hectare. This gives an average cost of $2.48/m^2$.

The most effective riparian strip in mitigating sediment and microbial run-off for low-width strips is a grass strip (Ryder Consulting, 2013, Parkyn 2004), so on this basis the assumption was that if the fencing setback was 1 metre, then no planting would take place, whereas if the setback was either 3 or 5 metres, the riparian strip would be planted.

In addition to the capital cost, an allowance was made for repairs and maintenance, for both the fencing and riparian strip (i.e. weed control), starting in year two.

The modelling also assumed both sides of the streams were fenced and planted.

3.3 Opportunity cost of not grazing the riparian strip

By fencing off the set-back from the stream, the farm incurs an opportunity cost of not being able to graze that area. The opportunity cost was calculated based on the average EBITD/hectare for the farm[3].

For the analysis, the assumptions were:

Table 2: Opportunity cost of set-back

Setback	Opportunity cost
Up to 1 metre	Nil
From 1-3 metres	50%
Above 3 metres	100%

3.4 Time horizons

The analysis assumed three time periods to achieve the stock exclusion:

(i) 1 year; and
(ii) On the assumption that achieving the fencing and riparian planting within 1 year was unlikely, two other scenarios were modelled, namely 5 and 10 years.

For the longer time periods, the assumption was that the expenditure was evenly spread over the period (i.e. 20% per year for the 5-year period, 10% per year for the 10-year period). In the next year after the final year of capital expenditure (i.e. 6th and 11th year respectively), the present value of the repairs and maintenance costs for the next 20 years was included. The cashflow was then discounted back to a net present value using a 6% discount rate[4].

[3] The general calculation for this was: area of farm (ha) x metres of stream per hectare x 2 (both sides of the stream) x effective riparian width (e.g. a 3m wide would have an effective width of 2m, as the first metre has no opportunity cost) x the assumed proportion of opportunity cost x Ebitd/ha ÷10,000. This was then taken as the present value out over 20 years.

[4] Current government discount rate

4.0 DAIRY FARM ANALYSIS

The characteristic of the Waikato/Bay of Plenty dairy model are[5]:

Table 3: Waikato/BoP Dairy Model characteristics 2017/18

Effective area (ha)	125
Cows wintered	347
Kg Milksolids	126,900
EBITD ($/ha)	$2,927

The analysis was for land <5 degrees; for the purposes of this analysis, the assumption was that this covered 100% of the farm.

4.1 Dairy results

Table 4: Stock exclusion costs assuming 1 metre setback

	1 Year	5 Years	10 Years
Fencing	$21,061	$19,229	$17,217
Riparian	$0	$0	$0
Opportunity Cost	$0	$0	$0
Total	**$21,061**	**$19,229**	**$17,217**
$/Ha	$168	$154	$138
Cost as a % of EBITD	5.7%	5.3%	4.7%

Table 5: Stock exclusion costs assuming 3 metre setback

	1 Year	5 Years	10 Years
Fencing	$21,061	$19,229	$17,217
Riparian	$48,808	$44,148	$39,126
Opportunity Cost	$17,952	$16,853	$15,539
Total	**$87,820**	**$80,231**	**$71,883**
$/Ha	$703	$642	$575
Cost as a % of EBITD	24.0%	21.9%	19.6%

Table 6: Stock exclusion costs assuming 5 metre setback

	1 Year	5 Years	10 Years
Fencing	$21,061	$19,229	$17,217
Riparian	$90,727	$82,426	$73,403
Opportunity Cost	$71,806	$67,414	$62,157
Total	**$183,594**	**$169,069**	**$152,776**
$/Ha	$1,469	$1,353	$1,222
Cost as a % of EBITD	50.2%	46.2%	41.7%

[5] https://www.agfirst.co.nz/project/waikato-bop-dairy-report-june-2018/

5.0 HILL COUNTRY SHEEP AND BEEF FARM ANALYSIS

The characteristics of the Central North Island Hill Country sheep and beef model are[6]:

Table 7: Central North Island Hill Country sheep and beef model characteristics 2017/18

Effective area (ha)	571
Sheep Stock units	3,088
Cattle Stock Units	1,894
Stocking Rate (SU/ha)	8.7
EBITD ($/ha)	$361

As noted in Section 2, the original objective was to constrain the setbacks to land <5 degrees. For the sheep and beef farm, this would mean a relatively minor area involved, as illustrated below:

Table 8: Slope differentiation for the Central North Island Hill Country sheep and beef model

Slope/Degrees	Area of Farm Involved
Flat (0-7)	2%
Rolling (8-15)	5%
Easy (16-25)	53%
Steep (>26)	40%

Source: Beef + Lamb NZ Economic Service

Consequently, the decision was made to model stock exclusion on 10% and 20% of the property, with the assumption that this would be mostly on the flat/rolling/easy country.

Also as noted in Section 3.2, the type of fencing was varied; while 2-wire electric may well suffice, many farms could well prefer a more traditional 8-wire fence which is stock-proof for all stock, and the electric fencing could interfere with working dogs. As a result, a mix of options was modelled as outlined below.

In addition, the fencing off of streams is very likely to require reticulated stock water in paddocks. While many farmers may well have reticulated water in their lower paddocks, the assumption for this analysis was that the model was starting from scratch. The costs involved for this are based on Journeaux and van Reenen (2016)[7].

[6] https://www.agfirst.co.nz/project/central-north-island-hill-country-sheep-and-beef-report-june-2018/

[7] This study showed some significant benefits to water reticulation, but this was (largely) in a situation where the farm was going from either no/limited stock water to good water in each paddock, accompanied by increased subdivision. In this analysis, the assumption was that the farm was in effect swapping one source of water for another; pre-exclusion, stock had access to water from the streams, post-exclusion they had water in troughs, plus no additional subdivision was carried out. In this sense the assumption is of swapping water for water, and as such there was a cost with no direct benefit.

5.1 Hill Country sheep and beef results, assuming 10% of farm with stock exclusion

Table 9: Stock exclusion costs assuming 1 metre setback (10% of farm)

	100% 2-wire electric fencing			50% 2-wire electric 50% 8-wire fencing			100% 8-wire fencing		
	1 Year	5 Years	10 Years	1 Year	5 Years	10 Years	1 Year	5 Years	10 Years
Fencing + Water	$10,737	$9,504	$4,830	$17,210	$15,252	$7,415	$23,683	$20,999	$9,999
Riparian	$0	$0	$0	$0	$0	$0	$0	$0	$0
Opportunity cost	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total	$10,737	$9,504	$4,830	$17,210	$15,252	$7,415	$23,683	$20,999	$9,999
$/Ha	$19	$17	$8	$30	$27	$13	$41	$37	$18
Cost as a % of EBITD	5.2%	4.6%	2.3%	8.3%	7.4%	3.6%	11.5%	10.2%	4.9%

Table 10: Stock exclusion costs assuming 3 metre setback (10% of farm)

	100% 2-wire electric fencing			50% 2-wire electric 50% 8-wire fencing			100% 8-wire fencing		
	1 Year	5 Years	10 Years	1 Year	5 Years	10 Years	1 Year	5 Years	10 Years
Fencing + Water	$10,737	$9,504	$4,830	$17,210	$15,252	$7,415	$23,683	$20,999	$9,999
Riparian	$11,148	$10,083	$8,936	$11,148	$10,083	$8,936	$11,148	$10,083	$8,936
Opportunity cost	$506	$475	$438	$506	$475	$438	$506	$475	$438
Total	$22,390	$20,062	$14,204	$28,863	$25,810	$16,789	$35,336	$31,558	$19,374
$/Ha	$39	$35	$25	$51	$45	$29	$62	$55	$34
Cost as a % of EBITD	10.9%	9.7%	6.9%	14.0%	12.5%	8.1%	17.1%	15.3%	9.4%

Table 11: Stock exclusion costs assuming 5 metre setback (10% of farm)

	100% 2-wire electric fencing			50% 2-wire electric 50% 8-wire fencing			100% 8-wire fencing		
	1 Year	5 Years	10 Years	1 Year	5 Years	10 Years	1 Year	5 Years	10 Years
Fencing + Water	$10,737	$9,504	$4,830	$17,210	$15,252	$7,415	$23,683	$20,999	$9,999
Riparian	$20,722	$18,826	$16,765	$20,722	$18,826	$16,765	$20,722	$18,826	$16,765
Opportunity cost	$2,023	$1,899	$1,751	$2,023	$1,899	$1,751	$2,023	$1,899	$1,751
Total	$33,481	$30,229	$23,346	$39,954	$35,977	$25,931	$46,427	$41,724	$28,516
$/Ha	$59	$53	$41	$70	$63	$45	$81	$73	$50
Cost as a % of EBITD	16.2%	14.7%	11.3%	19.4%	17.5%	12.6%	22.5%	20.2%	13.8%

5.2 Hill Country sheep & beef results, assuming 20% of farm with stock exclusion

Table 12: Stock exclusion costs assuming 1 metre setback (20% of farm)

	100% 2-wire electric fencing			50% 2-wire electric 50% 8-wire fencing			100% 8-wire fencing		
	1 Year	5 Years	10 Years	1 Year	5 Years	10 Years	1 Year	5 Years	10 Years
Fencing + Water	$23,705	$21,030	$11,454	$36,651	$32,525	$16,624	$49,597	$44,021	$21,794
Riparian	$0	$0	$0	$0	$0	$0	$0	$0	$0
Opportunity cost	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total	$23,705	$21,030	$11,454	$36,651	$32,525	$16,624	$49,597	$44,021	$21,794
$/Ha	$42	$37	$20	$64	$57	$29	$87	$77	$38
Cost as a % of EBITD	11.5%	10.2%	5.6%	17.8%	15.8%	8.1%	24.1%	21.4%	10.6%

Table 13: Stock exclusion costs assuming 3 metre setback (20% of farm)

	100% 2-wire electric fencing			50% 2-wire electric 50% 8-wire fencing			100% 8-wire fencing		
	1 Year	5 Years	10 Years	1 Year	5 Years	10 Years	1 Year	5 Years	10 Years
Fencing + Water	$23,705	$21,030	$11,454	$36,651	$32,525	$16,624	$49,597	$44,021	$21,794
Riparian	$22,295	$20,167	$17,873	$22,295	$20,167	$17,873	$22,295	$20,167	$17,873
Opportunity cost	$1,011	$950	$875	$1,011	$950	$875	$1,011	$950	$875
Total	$47,012	$42,146	$30,203	$59,958	$53,642	$35,373	$72,904	$65,137	$40,542
$/Ha	$82	$74	$53	$105	$94	$62	$128	$114	$71
Cost as a % of EBITD	22.8%	20.4%	14.7%	29.1%	26.0%	17.2%	35.4%	31.6%	19.7%

Table 14: Stock exclusion costs assuming 5 metre setback (20% of farm)

	100% 2-wire electric fencing			50% 2-wire electric 50% 8-wire fencing			100% 8-wire fencing		
	1 Year	5 Years	10 Years	1 Year	5 Years	10 Years	1 Year	5 Years	10 Years
Fencing + Water	$23,705	$21,030	$11,454	$36,651	$32,525	$16,624	$49,597	$44,021	$21,794
Riparian	$41,444	$37,652	$33,530	$41,444	$37,652	$33,530	$41,444	$37,652	$33,530
Opportunity cost	$4,046	$3,798	$3,502	$4,046	$3,798	$3,502	$4,046	$3,798	$3,502
Total	$69,195	$62,480	$48,487	$82,141	$73,975	$53,656	$95,087	$85,471	$58,826
$/Ha	$121	$109	$85	$144	$130	$94	$167	$150	$103
Cost as a % of EBITD	33.6%	30.3%	23.5%	39.8%	35.9%	26.0%	46.1%	41.5%	28.5%

It is important to note that proportionally the cost is higher on the sheep and beef farm, recognising that 10-20% of the farm is being fenced, as compared with 100% of the dairy farm.

6.0 LOWLAND SHEEP AND BEEF FARM ANALYSIS

This farm is based on the Beef + Lamb NZ Economic Service Class 5 North Island Intensive Finishing farm. Characteristics of the farm are:

Table 15: Intensive Finishing Farm Characteristics 2017/18

Effective area (ha)	281
Sheep stock units	1,184
Cattle stock units	1,517
Stocking Rate (SU/ha)	9.6
EBITD ($/ha)	$650

Source: B+L NZ Economic Service

As outlined earlier, the analysis is for land <5 degrees; while properties of this nature could have a variety of slope classes, for the purposes of this analysis the assumption was that this covered 100% of the farm.

The stream length per farm discussed in Section 3.1 indicated stream lengths for dairy and sheep & beef farms in the Waikato region. A key assumption for the hill country modelling involved using the sheep & beef stream length figure directly. Inasmuch as an intensive finishing farm would be, on average, more rolling that a dairy farm, but less steep than a hill country farm, a key assumption for this analysis is to use an average of the two figures shown in Table 1. This is illustrated as:

Table 16: Stream length metres per hectare for the intensive finishing farm

Dairy	21.4
S&B	10.7
Average	16.05

The hill country farm analysis included a cost of installing reticulated stock water as a result of the stock exclusion fencing. For intensive finishing farms, the majority are very likely to have an existing reticulated water system, given the nature of the farming system. This would vary between farms; for the purposes of this analysis it is assumed that 25% of the farm will require installation of reticulated water, and similar to the hill country analysis, the further assumption was that the farm was swapping natural water for reticulated water, and hence the gains from reticulating water would be minimal.

Many of these farms would be using electric fencing as part of, if not all of, their subdivisional fencing. It is very probable therefore that a 2-wire electric fence would suffice for their stock exclusion fencing[8]. In noting this, assuming that the riparian margins were planted up, farmers would also want to exclude sheep, in order to protect these plantings. It is probable therefore, that there would be a mix of electric fencing and 5-8 wire fencing. Given this, the analysis has included the same fencing mix as per the hill country example.

[8] This is primarily aimed at cattle exclusion. Sheep exclusion would require a minimum of a 5-wire fence, although most Regional Councils are not requiring sheep exclusion as they do not habitually enter streams.

The results of the analysis are:

Table 17: Stock exclusion costs assuming 1 metre setback

	100% 2-wire electric fencing			50% 2-wire electric 50% 8-wire fencing			100% 8-wire fencing		
	1 Year	5 Years	10 Years	1 Year	5 Years	10 Years	1 Year	5 Years	10 Years
Fencing + Water	$84,747	$75,131	$40,069	$132,530	$117,560	$59,150	$180,312	$159,988	$78,231
Riparian	$0	$0	$0	$0	$0	$0	$0	$0	$0
Opportunity cost	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total	$84,747	$75,131	$40,069	$132,530	$117,560	$59,150	$180,312	$159,988	$78,231
$/Ha	$302	$267	$143	$472	$418	$210	$642	$569	$278
Cost as a % of EBITD	46.4%	41.1%	21.9%	72.6%	64.4%	32.4%	98.7%	87.6%	42.8%

Table 18: Stock exclusion costs assuming 3 metre setback

	100% 2-wire electric fencing			50% 2-wire electric 50% 8-wire fencing			100% 8-wire fencing		
	1 Year	5 Years	10 Years	1 Year	5 Years	10 Years	1 Year	5 Years	10 Years
Fencing + Water	$84,747	$75,131	$40,069	$132,530	$117,560	$59,150	$180,312	$159,988	$78,231
Riparian	$82,290	$74,434	$65,967	$82,290	$74,434	$65,967	$82,290	$74,434	$65,967
Opportunity cost	$3,733	$3,505	$3,231	$3,733	$3,505	$3,231	$3,733	$3,505	$3,231
Total	$170,770	$153,070	$109,267	$218,553	$195,498	$128,348	$266,335	$237,927	$147,429
$/Ha	$608	$545	$389	$778	$696	$457	$948	$847	$525
Cost as a % of EBITD	93.5%	83.8%	59.8%	119.7%	107.0%	70.3%	145.8%	130.3%	80.7%

Table 19: Stock exclusion costs assuming 5 metre setback

	100% 2-wire electric fencing			50% 2-wire electric 50% 8-wire fencing			100% 8-wire fencing		
	1 Year	5 Years	10 Years	1 Year	5 Years	10 Years	1 Year	5 Years	10 Years
Fencing + Water	$84,747	$75,131	$40,069	$132,530	$117,560	$59,150	$180,312	$159,988	$78,231
Riparian	$152,966	$138,970	$123,757	$152,966	$138,970	$123,757	$152,966	$138,970	$123,757
Opportunity cost	$14,932	$14,018	$12,925	$14,932	$14,018	$12,925	$14,932	$14,018	$12,925
Total	$252,645	$228,119	$176,751	$300,427	$270,548	$195,832	$348,209	$312,976	$214,912
$/Ha	$899	$812	$629	$1,069	$963	$697	$1,239	$1,114	$765
Cost as a % of EBITD	138.3%	124.9%	96.8%	164.5%	148.1%	107.2%	190.6%	171.4%	117.7%

This shows the cost as a percentage of EBITD being much higher than the hill country model, mainly due to the stock exclusion covering all of the farm, a higher stream length per hectare, and a higher opportunity cost due to a higher EBITD. It also reinforces the impracticality of achieving stock exclusion within one year.

7.0 SHIFTING FENCES

In this scenario, the stream is already fenced, at a 1 metre setback, but needs to be shifted back to either a 3 or 5 metre setback.

The cost to do this would vary significantly, depending on a number of factors, especially contour of the land, and the condition of the existing fence. Contour is particularly important, in that the use of machinery (i.e. tractor) in pulling posts out makes the job significantly easier. In many instances, if it was not possible to pull post via a machine, the labour costs would be significant, and in all probability the posts would not be shifted; essentially the wire would be stripped and then re-used on new posts.

Accepting this variability, the following assumptions, for stripping and shifting a 2-wire electric fence, were made:

Table 20: Assumptions for "shifting Fences" scenario

Fence in good condition	reuse 90-95% of posts and wire	
Fence in poor condition	reuse 50% of posts and wire	
Labour cost	2 people at $50/hr each (contract rate)	
Tractor cost	$120/hour	
Striping time	200m/hour on flat/rolling country	
	120m/hour on easy country	
	Flat/rolling	Easy
Rebuild fence*: Labour cost ($/m)	$2.90	$3.00
(new) material cost ($/m)	$2.10	$2.50

*From MPI, 2016

For the dairy farm therefore, the costs for shifting a fence in reasonable condition would be:

Table 21: Dairy farm costs to shift fences

Ha	125
Stream m/ha	21.4
Total length (m)	2,675
Stripping cost	$2,943
Rebuild	
Labour	$7,758
Material	$843
	$8,600
Total	$11,543

For a fence in poor condition, the cost increases to $14,141 due to higher material costs; particularly replacement posts and wire.

For the sheep and beef farm, the costs would be higher due to a greater proportion of land in the easier (i.e. steeper contour) category.

Table 22: Sheep & beef farm costs to shift fences

	Flat/Rolling		Easy
Ha	571		571
Stream m/ha	10.7		10.7
Total length (m)	6,110		6,110
Stripping cost	$6,721		$11,201
Rebuild			
Labour	$17,718		$18,329
Material	$5,774		$3,055
	$23,492		$21,384
total - 10% of farm	$3,021		$3,259
- 20% of farm	$6,042		$6,517
Weighted average*	10% of farm	$3,230	
	20% of farm	$6,460	

*Based on slope areas as shown in Table 8

For the sheep and beef farms, stripping and shifting an 8-wire post and batten fence becomes even more problematic, as this is very laborious to do, and in most situations would only be done if the fence was in very good condition. In most other instances the posts would be salvaged (if possible) and the rest left. Given the wide variabilities, the costing around all this has not been attempted within this analysis.

Comparison with the '100% new fence' costings in Section 4.1 and 5.1 are as follows.

7.1 Dairy

Table 23: Shift to 3 metre setback

	1 Year	5 Years	10 Years
Fencing	$13,228	$11,144	$9,736
Riparian	$48,808	$44,148	$39,126
Opportunity Cost	$17,952	$16,853	$15,539
Total	**$79,988**	**$72,145**	**$64,401**
$/Ha	$640	$577	$515
Cost as a % of EBITD	21.9%	19.7%	17.6%

Table 24: Shift to 5 metre setback

	1 Year	5 Years	10 Years
Fencing	$13,228	$11,144	$9,736
Riparian	$90,727	$82,426	$73,403
Opportunity Cost	$71,806	$67,414	$62,157
Total	**$175,761**	**$160,984**	**$145,296**
$/Ha	$1,406	$1,288	$1,162
Cost as a % of EBITD	48.0%	44.0%	39.7%

What this shows is a saving in the fencing cost, although this is relatively minor compared with to the opportunity and riparian costs.

7.2 Hill Country Sheep and Beef

The following figures only relate to the 2-wire electric costings.

Table 25: Hill country sheep and beef: Shift to 3 metre setback

	10% of farm			20% of farm		
	1 Year	5 Years	10 Years	1 Year	5 Years	10 Years
Fencing + Water	$4,988	$4,202	$3,671	$9,977	$8,405	$7,343
Riparian	$11,148	$10,083	$8,936	$11,148	$10,083	$8,936
Opportunity cost	$506	$475	$438	$506	$475	$438
Total	**$16,642**	**$14,760**	**$13,045**	**$21,631**	**$18,963**	**$16,717**
$/Ha	$29	$26	$23	$38	$33	$29
Cost as a % of EBITD	8.1%	7.2%	6.3%	10.5%	9.2%	8.1%

Table 26: Hill country sheep and beef: Shift to 5 metre setback

	10% of farm			20% of farm		
	1 Year	5 Years	10 Years	1 Year	5 Years	10 Years
Fencing + Water	$4,988	$4,202	$3,671	$9,977	$8,405	$7,343
Riparian	$20,722	$18,826	$16,765	$20,722	$18,826	$16,765
Opportunity cost	$2,023	$1,899	$1,751	$2,023	$1,899	$1,751
Total	**$27,733**	**$24,927**	**$22,187**	**$32,722**	**$29,130**	**$25,859**
$/Ha	$49	$44	$39	$57	$51	$45
Cost as a % of EBITD	13.5%	12.1%	10.8%	15.9%	14.1%	12.5%

This again shows a saving in fencing cost relative to the "100% new".

7.3 Lowland Sheep and Beef

Assuming the same slope distribution as for the easier component of the hill country farm, gives an average cost of $15,962 to strip and shift the existing 2-wire electric fence. The overall costs of shifting the fence line are:

Table 27: Cost of shifting the fence line for the lowland intensive sheep & beef farm

	3 m setback			5 m setback		
	1 Year	5 Years	10 Years	1 Year	5 Years	10 Years
Fencing + Water	$18,125	$15,270	$13,340	$18,125	$15,270	$13,340
Riparian	$82,290	$74,434	$65,967	$152,966	$138,970	$123,757
Opportunity cost	$3,733	$3,505	$3,231	$14,932	$14,018	$12,925
Total	**$104,148**	**$93,208**	**$82,539**	**$186,022**	**$168,258**	**$150,022**
$/Ha	$371	$332	$294	$662	$599	$534
Cost as a % of EBITD	57.0%	51.0%	45.2%	101.8%	92.1%	82.1%

It is important to note that while 'shifting the fence' is a cheaper option that building a new one, the farmer has in fact paid twice; the original fence did incur a cost, albeit it is now a sunk cost, followed by a second cost in shifting it.

7.4 Greenhouse Gas Implications

To be eligible for the New Zealand Emissions Trading Scheme (ETS), the minimum definition of a forest is 1 hectare of trees capable of growing greater than 5 metres, with 30% or greater crown coverage.

For riparian margins to qualify, they need to be 30 metres wide (i.e. 15 metres on either side of the stream) and planted in trees capable of growing greater than 5 metres.

For the riparian buffer strips modelled in this analysis, none would qualify for the ETS. As mentioned in Section 3.2, the most effective vegetative cover for short riparian strips is grass; it is very probable that farmers would leave a 1 metre strip in pasture, but may plant up a 3 or 5 metre strip with shrubs, sedges, and rushes – none of which would qualify as carbon sinks.

As an increasing area of effective grazing land is used as the riparian margin, it is possible that the farmer may reduce stocking rates slightly to compensate for the loss of land, which would reduce GHG emissions. Inasmuch as the amount of land taken by the riparian strip is relatively small, it is very probable that the same number of stock would be grazed on the (slightly) smaller area, in which case overall GHG emissions would be much the same. Given the marginality of the changes, this impact was not modelled.

8.0 IMPACT OF A NITROGEN CAP

This analysis utilised a real dairy farm, leaching 76 kg nitrogen per hectare per year, with the analysis then imposing a cap on nitrogen leaching of 60, 50, and 40 kgN/ha/year across the farm.

The analysis was carried out via modelling the farm system on Farmax, and then the environmental impact via Overseer - this latter impact assessing nitrogen leaching as well as biological greenhouse gas emissions. At the time of the initial analysis, the farm profitability was below the industry average.

The characteristics of the farm are:

Table 28: Characteristics of farm used to model nitrogen leaching

Effective Area	276
Cows wintered	708
Kg Milksolids	252,660
Soil type	Volcanic ash/pumice
Rainfall	1273 mm/year
Kg nitrogen fertiliser applied (kg/ha)	248
Current nitrogen leaching	76 kgN/ha/year
Assumed milksolids payout ($/kgMS)	$6.20

For the purposes of the modelling, it was assumed that all replacement young stock are run on the property. While it is common for young stock to be grazed off the farm, this in effect transfers the nitrogen leaching and greenhouse gases to somewhere else, so the decision was to include them so as to give a total farm picture.

The farm also had a relatively complex 2-year cropping system, growing fodder crops for the farm, which materially added to the nitrogen leached.

8.1 Scenario 1: Nitrogen leach capped at 60 kgN/ha

In this scenario, the following adjustments were made, relative to the base farm:

- Inasmuch as the second-year cropping was leaching 282 kgN/ha from the (18.6 ha) block, this second year of cropping was eliminated[9].
- Supplementary feed bought in was increased by 82 tonne (of palm kernel).
- Cow numbers were held, while per cow production was reduced by 3%, which reduced total milksolids production by 3%.

The result of this was to reduce the nitrogen leached to 60 kg/ha.

The overall effect on farm profitability was to **increase** it, by $164/ha. While gross revenue declined as a result of lower milksolids production, the reduction in the cost of the cropping was significant (-$263/ha), which was not offset by the increased cost of buying in supplements.

[9] The cropping regime involved 4 crops over the 2 years, with attendant nitrogen fertiliser applications.

8.2 Scenario 2: Nitrogen leach capped at 50 kgN/ha

In this scenario, the following adjustments were made, relative to the base farm:

- Second year of cropping eliminated.
- Nitrogen fertiliser application was reduced down to 148 kgN/ha/year, particularly any applications over the period May - August.
- Supplementary feed (palm kernel) bought in was reduced by 82 tonne.
- Stock numbers were reduced by 10%.
- Milksolids production was reduced by 10%.

The result of this was to reduce the nitrogen leached to 50 kg/ha.

The impact on farm profitability was to reduce it (relative to the base) by $151/ha, or 13%.

8.3 Scenario 2: Nitrogen leach capped at 40 kgN/ha

In this scenario, the following adjustments were made, relative to the base farm:

- Second year of cropping eliminated.
- Nitrogen fertiliser applied was reduced to 89 kgN/ha.
- All palm kernel bought in was eliminated (leaving 250 tonnes of maize silage as the only bought-in supplement).
- Stock numbers were reduced by 20%.
- Milksolids production was reduced by 25%.

The result of this was to reduce the nitrogen leached to 40 kg/ha.

The impact on farm profitability was to reduce it (relative to the base) by $304/ha, or 26%.

8.4 Summary of nitrogen cap modelling

A summary of the impacts of the nitrogen cap is illustrated below:

Table 29: Summary of the impacts of reducing the nitrogen leached

	Base	60 kgN	50 kgN	40 kgN
Cows wintered	708	708	637	567
Total milksolids production (kg)	252,660	245,802	207,399	188,699
Milksolids/ha	915	891	751	699
kg N fertiliser applied/ha	248	248	148	89
Total Supplement bought in (T DM)	309	432	309	250
Operating Cash Surplus (EBITD) ($/ha)	$1,164	$1,328	$1,013	$860
kg N leached/ha	76	60	50	40
Tonnes biological GHG emitted eff/ha	11.9	11.9	10.3	9.1

8.5 Commentary

1. The 'Operating Cash Surplus' shown in Table 29 is Gross Farm Revenue less Farm Working Expenses[10], with the surplus money available then needing to cover:

   - Debt servicing (interest) and debt repayment
   - Depreciation
   - Tax
   - Any further farm development

   These costs vary depending on the individual farms' circumstances, especially their level of debt servicing.

   For the average farm, the 'base' surplus shown would be barely breaking even: assuming an average level of debt of $25/kg milksolids (DairyNZ, 2017) for the case study farm, debt servicing alone would equate to $1,143 per hectare. Average depreciation would add another $450/ha.

   While the profitability of the case study farm improves under the 60 kgN/ha scenario (discussed below), this is relatively marginal, and the Operating Cash Surplus shown in Table 29 for the 50 and 40 kgN scenarios would mean that, assuming a reasonable level of debt on the farm[11], it would be financially unviable under these scenarios (in the sense that the resultant EBITD would not be sufficient to cover the costs identified above).

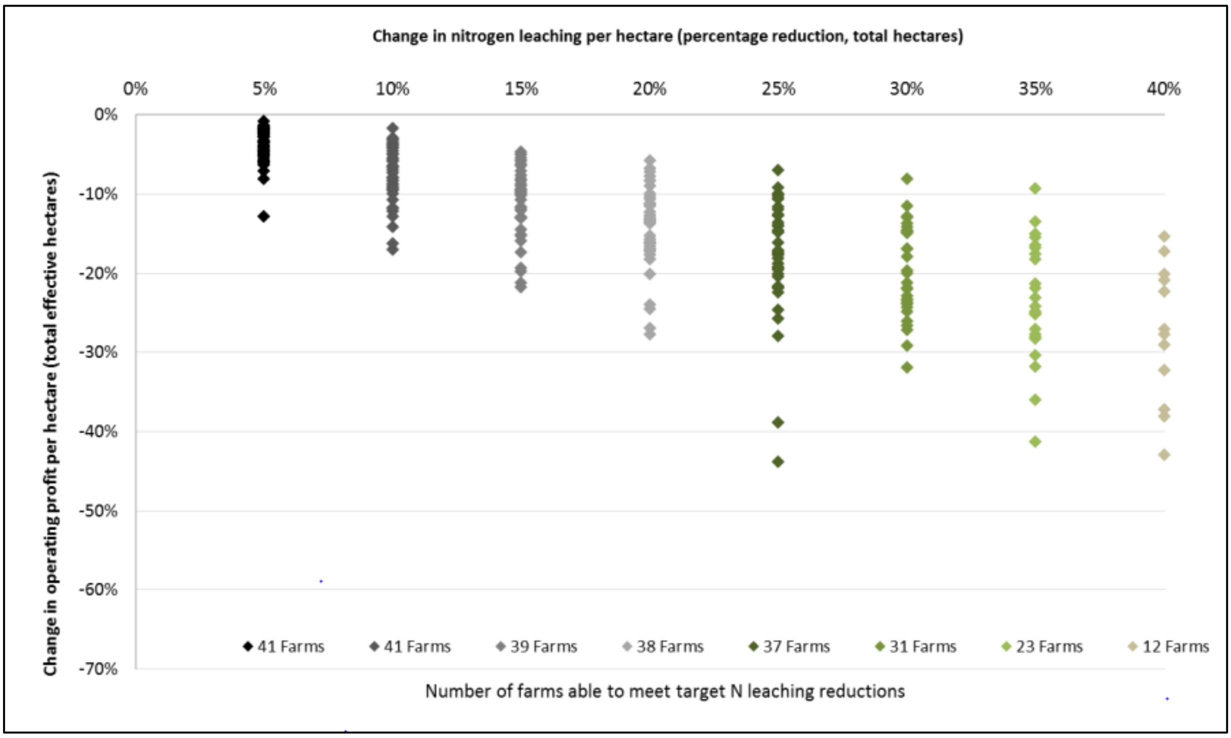
2. While an improvement in profitability as well as a decline in nitrogen leaching as a result of an initial farm management improvement is not uncommon, it does reflect the variability inherent in farming. For the case study farm, the cropping regime used was essentially a farm development programme to upgrade pastures. The side effect was a relatively high cost, and a high level of nitrogen leaching.

   In many respects therefore, this practice was a 'low-hanging fruit' that was easy enough to mitigate and which gave a win-win solution. Further alterations to the farm system resulted in a net decrease in farm profitability.

   Analysis by DairyNZ in Southland (in Moran *et al* 2017) shows the variation in the cost to case study farms in mitigating nitrogen leaching, with a general increase in cost as the percentage reduction increases. This reinforces the need to consider abatement costs across a range of farms, as opposed to just one farm.

[10] Within this context therefore, Cash Operating Surplus is taken as the same as EBITD
[11] Actual debt level is unknown. Actual depreciation is $365/ha

Figure 1: Nitrogen leaching abatement curve



Source: Figure C69, Moran *et al* 2017

8.6 Greenhouse Gas Emissions

Table 29 shows the biological (i.e. $CH_4 + N_2O$) emissions from the case study farm, per effective hectare. This shows no change for the 60 kgN scenario but reducing for the 50 and 40 kgN scenarios.

Methane emissions are directly related to the level of dry matter intake by the livestock, whereas nitrous oxide emissions are related to the amount of nitrogen deposited on the ground via urine and fertiliser.

For the 60 kgN scenario, livestock numbers and nitrogen fertiliser were unchanged relative to the base, and while production was down slightly, the GHG figures calculated were the same. For the 50 and 40 kgN scenarios, both livestock numbers and nitrogen fertiliser applications were both well down on the base situation, resulting in the lower GHG emissions.

The 11.9 tonne CO_2e/ha emission for the base farm is high relative to average: DairyNZ and other modelling work indicates that the average dairy farm emits 9.6 tonnes CO_2e/ha, with a range of 3.1 - 18.8 tonnes CO_2e/ha (AgFirst 2019). The cause of this higher than average GHG emission is a higher level of supplementary feeding, plus high nitrogen fertiliser usage.

Assuming that agriculture comes into the Emissions Trading Scheme, the cost of the emissions relative to varying carbon prices and level of liability is shown below. Note that the government has indicated that initially, the level of liability (i.e. the proportion of emissions which would attract a charge) will be set at 5%. Current carbon price is $25/tonne CO_2e.

Table 30: Cost per hectare for the case study farm, for the base and 60 kgN scenario

	Carbon Price ($/tonne CO_2e)			
Percent Liability	$25	$35	$50	$100
5%	$15	$21	$30	$60
10%	$30	$42	$60	$119
50%	$149	$208	$298	$596
100%	$298	$417	$596	$1,191

Table 31: Cost per hectare for the case study farm, for 50 kgN scenario

	Carbon Price ($/tonne CO_2e)			
Percent Liability	$25	$35	$50	$100
5%	$13	$18	$26	$51
10%	$26	$36	$51	$103
50%	$129	$180	$257	$515
100%	$257	$360	$515	$1,029

Table 32: Cost per hectare for the case study farm, for 40 kgN scenario

	Carbon Price ($/tonne CO_2e)			
Percent Liability	$25	$35	$50	$100
5%	$11	$16	$23	$46
10%	$23	$32	$46	$91
50%	$114	$160	$228	$456
100%	$228	$319	$456	$912

The 5-year average Cash Operating Surplus for dairy farms (Dairy NZ, 2018) through to 2016/17, is $2,584/ha. As noted earlier, this is still required to cover:

- Debt servicing (interest) and debt repayment
- Depreciation
- Tax
- Further farm development
- Farmer living costs

A summary of this, through to 2016/17 is:

Table 33: 5-year average dairy costs ($/ha)

	2012/13	2013/14	2014/15	2015/16	2016/17	Average
EBITD	$2,661	$4,007	$2,483	$957	$2,811	$2,584
Interest	$1,239	$1,198	$1,345	$1,331	$1,334	$1,289
Depreciation	$399	$402	$455	$425	$449	$426
Tax	$251	$407	$234	$54	$113	$212
Drawings	$659	$813	$759	$528	$555	$663
Net	$113	$1,187	-$310	-$1,380	$359	-$6

Source: Dairy NZ, 2018

The net figure shown in Table 33 would then be required to meet any debt (principal) repayments and further farm development costs, which means payment of a carbon charge on top of this becomes problematic.

As can be seen from Table 33 relative to the costs in Tables 30-32, the situation is relatively complex; in some years the farm could sustain the cost, in others, not. As a generalisation, a low (i.e. $25/tonne) carbon cost at a low liability (i.e. 5-10%) could be bearable. At a higher cost (i.e. $50-$100/tonne) and a higher liability (i.e. 50-100%) the farm is likely to be financially unviable.

9.0 LAND INTENSIFICATION

This section discusses land use change into a more intensive farming system.

9.1 Forestry to Dairying

For this analysis, the main assumption is the conversion of a mature *Pinus Radiata* forestry block into a dairy farm. The cost to do this varies depending on the circumstances and land involved. A broad indication of the costs to create a 150 hectare dairy farm in the Waikato are:

Table 34: Indicative Land Conversion Costs – Forestry to Dairying ($/ha)

Land clearance, fertiliser/lime, sowing into pasture	$7,000
Tracks/races, fencing, water	$3,400
Electricity, Milking shed, effluent system, houses	$15,000
Vehicles, plant and equipment	$1,200
Livestock	$6,000
Total	**$32,600**

Source: AgFirst

Land converted from forestry also takes between 8-10 years before it is fully functioning as a 'status quo' farm. Over this period significant additional costs are also necessary, particularly extra fertiliser, and one or two resowings of pasture.

In addition to these costs is the potential to also pay for the cost of carbon released as a result of the harvesting of trees and subsequent pasture development. Under the current ETS, when a forest is harvested the carbon is deemed to be released. In a normal forestry operation, the stumps and roots etc. remain, so the carbon within this is not deemed to be released. While these eventually rot down, the carbon is replaced in the replanted replacement forest.

In a forestry conversion situation, 100% of the trees are removed, so the carbon liability in this situation is the full amount. For Pinus Radiata forests, the total carbon sequestered per hectare for a mature forest in the Waikato Region is circa 755 tonnes per hectare[12]. At the current carbon price of $25/tonne, this represents a liability of $18,875/ha.

Whether this liability is due depends on several factors:

- If the forest was first planted prior to 31 December 1989, the full liability is payable.
- If the forest was planted post 1 January 1990, and registered with the ETS, then any carbon credits claimed must be repaid.
- If the forest was planted post 1 January 1990, and not registered with the ETS, then no carbon liability is payable.

Overall therefore, the current cost of converting forestry to dairying is too expensive in most situations, especially if the full carbon liability would be incurred. This is based on the combined conversion cost (excluding vehicles and livestock) plus the carbon liability, which equals $44,275/ha, which is then compared with the resultant farm value of circa $30,000 - 35,000/hectare, which represents the value of future cashflows.

[12] MPI 2017 ETS Lookup Tables Guide. Note that carbon stocks per hectare vary regionally.

At an environmental level, obviously there would be an increase in nitrogen leached and GHGs emitted:

(i) Nitrogen leaching under pine trees is circa 2.5 kgN/ha/year, whereas under dairying, this would vary widely depending on several factors, especially soil type and rainfall, but say 30 - 60+ kgN//ha/year.

(ii) Greenhouse gas emissions would go from a net sequestration through to an average 9.6 tonne CO_2e/ha/year (refer Section 7.6).

9.2 Forestry to Sheep and Beef

Essentially the same factors pertaining to the forestry to dairying conversion as discussed in the previous section also relate to a forestry to sheep and beef conversion.

An estimate of the conversion costs for a 400 hectare sheep and beef farm are:

Table 35: Indicative Land Conversion Costs – Forestry to Sheep & Beef ($/ha)

Land clearance, fertiliser/lime, sowing into pasture	$7,000
Tracks/races, fencing, water	$2,000
Woolshed, stock yards, houses	$4,500
Vehicles, plant and equipment	$500
Livestock	$1,700
Total	**$15,700**

Source: AgFirst

Again it would take some years before the farm was fully functioning as a 'status quo' farm, and additional expenditure on fertiliser and pasture sowing would be required.

The carbon cost would be the same as well; $18,875/ha assuming a forest in the Waikato.

Again, therefore, the conversion is too expensive to make it a worthwhile investment; the combined conversion cost (excluding vehicles and livestock) plus the carbon liability, equals $32,375/ha, as against the resultant farm value of circa $15,000 - $20,000/ha.

The environmental impact would be:

(i) Nitrogen leaching would increase from 2.5 kgN/ha/year to around 10 - 30 kgN/ha/year.

(ii) GHG emissions would increase from a net sequestration to circa 3.1 tonne CO_2e/ha (S&B average; range 0.9 - 5.1 tonnes).

9.3 Sheep and Beef to Dairying.

A conversion from a sheep and beef farm to dairying is somewhat more straightforward, inasmuch as the land is already in pasture. The main conversion issues therefore are:

- Capital fertiliser and pasture resowing.
- Reconfiguration of fencing and races/tracks.
- Upgrade of the water reticulation system.
- Construction of a dairy shed and effluent system.

These again would vary depending on the land involved, but an indicative cost for a 150 hectare property would be:

Table 36: Indicative Land Conversion Costs –Sheep & Beef to Dairy ($/ha)

Fertiliser/lime, regrassing	$1,000
Tracks/races, fencing, water	$3,000
Electricity, Milking shed, effluent system, dairy company shares, houses*	$12,500
Vehicles, plant and equipment	$1,200
Livestock	$4,000
Total	**$21,700**

Note: The above costing assumes someone purchasing the farm and converting it. If the current owner converted it there would be salvage costs from the existing operation, in the form of livestock sold and plant and equipment not required to be purchased, of circa $2,000/ha.

*Note there would be an existing house already on the farm.

Again the economics of this are currently marginal, depending on the original value of the sheep and beef farm. Assuming this is $15,000/ha, added to the cost of conversion (excluding vehicles and livestock), gives a total cost of $31,500/ha, as against the value of the new dairy farm at circa $30,000 - $35,000.

Or, looking at it slightly differently; assuming the current value of the farm is $15,000/ha, plus the cost of conversion (excluding vehicles and livestock) is $16,500, thereby adding a marginal increase in value to the land of $15,000 - $20,000/ha.

The environmental impact would be:

(i) Nitrogen leaching would increase from circa 10 - 30 kgN/ha/year to circa 30 - 60+ kgN/ha/year, depending on a range of factors, particularly soil types and rainfall.

(ii) GHG emissions would increase, based on average, from 3.1 tonne CO_2e/ha to 9.6 tonne CO_2e/ha. This could again vary significantly depending on a range of factors.

10.0 CONVERSION OF A SHEEP AND BEEF FARM TO DAIRYING

10.1 Objective

The objective of this analysis is to model the conversion of a sheep & beef farm to dairying, while endeavouring to stay within the nitrogen leaching level of the sheep & beef farm.

The analysis would involve:

(i) The capital cost of the conversion.

(ii) Any further capital required, e.g. for a feed pad or wintering barn.

(iii) Profitability comparison between the dairy conversion scenarios and the base sheep & beef farm.

(iv) An investment analysis on the conversions.

10.2 Methodology

The methodology involved:

(i) Setting the dairy farm conversion up in Farmax and Overseer.

(ii) Modelling the various dairy scenarios in both models in order to ensure the farming system was feasible, determine the physical farming system level of profitability, and the nitrogen leaching level.

(iii) Determining the capital requirements, and then incorporating this into the investment analysis.

10.3 Results

10.3.1 Base sheep & beef farm.

The base sheep & beef farm is an intensive finishing property, largely based on the Beef + Lamb NZ Class 5 North Island Intensive Finishing model. The characteristics of the farm are:

Table 37: Sheep & Beef farm characteristics

Effective Area (ha)	290
Breeding Ewes	1,264
Finishing Cattle	221
Dairy Grazers	50
EBITD ($/ha)	592
Nitrogen leaching (kgN/ha/yr)	17
Biological GHG emissions (TCO_2e/ha)	4.47

Essentially the farm runs a breeding ewe flock buying in replacements and finishing all lambs. In addition, it finishes a mix of bulls and steers through to 300 kg carcase weight, plus runs some dairy heifer grazers. It is based on a sedimentary soil type, with 1200 mm of rainfall.

The scenario is based on the existing sheep & beef farmer converting the farm, so there are no up-front capital purchase costs for land.

10.3.2 Base Dairy Farm

The base farm conversion assumed 680 cows wintered, plus 150 replacement heifers run[13]. The farm was setup as a basic System 3 farm (i.e. some supplementary feed bought in to feed the dry and milking cows). Milk price used is $6.00/kgMS (10-year average milk price to 2017/18 = $5.99/kgMS, 5-year average milk price to 2017/18 = $5.91/kgMS), plus a 25c dividend on the (Fonterra) company share (7-year average).

The characteristics of the farm therefore are:

Table 38: Base dairy farm characteristics

Effective Area (ha)	290
Milking cows wintered	680
Replacement heifers	150
Supplementary feed bought in:	
Maize silage (tonnes)	300
Palm Kernel (tonnes)	292
Crop (summer turnips) (ha)	30
Nitrogen fertiliser applied (kgN/ha)	130
Milksolids produced (kg)	249,318

The result was:

- EBITD of $2,311/ha
- Nitrogen leaching = 26 kgN/ha/year
- Biological GHG emissions = 10.2 tonnes CO_2e/ha

10.3.3 Dairy Scenario 1

In this scenario, the farm system was altered as follows:

Table 39: Scenario 1 dairy farm characteristics

Effective Area (ha)	290
Milking cows wintered	580
Replacement heifers	127
Supplementary feed bought in:	
Maize silage (tonnes)	300
Palm Kernel (tonnes)	0
Crop (summer turnips) (ha)	0
Nitrogen fertiliser applied (kgN/ha)	66
Milksolids produced (kg)	182,527

Essentially stock numbers were reduced by 15%, cropping was eliminated, no palm kernel was purchased in, and nitrogen fertiliser usage was halved.

[13] In many instances the replacement heifers would be grazed off-farm, coming back to the milking platform 1-2 months prior to their first calving. In this analysis it was assumed that they were run on the milking platform in order to assess the total nitrogen leaching from the farming operation.

The result was:

- EBITD of $1,851/ha
- Nitrogen leaching = 22 kgN/ha/year
- GHG emissions = 8.33 tonnes CO_2e/ha

10.3.4 Dairy Scenario 2

Under this scenario, stock number were reduced by 23.5% relative to the base scenario, all nitrogen fertiliser and bought in supplement was eliminated, and a wintering barn was constructed, which allowed for the cows to be on/off grazed over the winter; 8 hours on pasture, rest of the time in the barn.

Table 40: Scenario 2 dairy farm characteristics

Effective Area (ha)	290
Milking cows wintered	504
Replacement heifers	107
Supplementary feed bought in:	
Maize silage (tonnes)	0
Palm Kernel (tonnes)	0
Crop (summer turnips) (ha)	0
Nitrogen fertiliser applied (kgN/ha)	0
Milksolids produced (kg)	184,793

The result was:

- EBITD of $2,089/ha
- Nitrogen leaching = 17 kgN/ha/year
- GHG emissions = 9.7 tonnes CO_2e/ha

10.3.5 Capital requirements

The following assumptions were made relative to the costs of conversion. Livestock values are based on the 2017/18 IRD Herd Scheme values, and the Fonterra share value on the 7-year average value of $5.54/share[14].

Table 41: Conversion cost assumptions

	Base	Scenario 1	Scenario 2
Effective hectares	290	290	290
Cows	680	580	504
Heifers	150	127	107
Shares	241,475	182,527	184,793
Houses	3	3	2
Full time labour units	4	4	3

[14] Based on data readily available. It could be argued that the share investment is a separate exercise, with the cost covered by the dividend. It is included in the analysis in that (a) the share purchase is compulsory (b) it represents a significant up-front cost, and (c) the average dividend return is less than the cost of borrowing for most farmers.

Table 42: Conversion cost assumptions continued

Cows value ($/cow)	$1,529
Heifers value ($/heifer)	$691
Shares (each)	$5.54
Houses (each)	$300,000
Dairy shed + effluent ($/cow)	$2,200
Fencing, water, races, electricity ($/ha)	$2,000
Fertiliser, regrassing ($/ha)	$1,000
Vehicles, plant and equipment ($/ha)	$1,725
Wintering Barn $/cow	$3,000

Table 43: Total Conversion costs

	Base	Scenario 1	Scenario 2
Cows	$1,039,720	$886,820	$770,616
Heifers	$103,650	$87,757	$73,937
Shares	$1,381,222	$1,011,200	$1,023,753
Dairy Shed + effluent	$1,496,000	$1,276,000	$1,108,800
Houses	$900,000	$900,000	$600,000
Vehicles, plant and equipment	$500,250	$500,250	$500,250
Fencing, water, races, electricity	$580,000	$580,000	$580,000
Fertiliser, regrassing	$290,000	$290,000	$290,000
Wintering Barn			$1,512,000
Less salvage costs from S&B farm	-$581,160	-$581,160	-$581,160
(livestock, plant and vehicles)			
Total	**$5,709,682**	**$4,950,867**	**$5,878,196**

Inasmuch as it takes a number of years for the newly converted dairy farm to fully perform, the value of the differential between the dairy and sheep & beef EBITD has been reduced as indicated:

Table 44: Percent of full EBITD relative to year of conversion

Year	% of full EBITD differential
1	50%
2	60%
3	75%
4	85%
5+	100%

10.4 Investment Analysis

In this analysis a cashflow over 20 years was developed, with the capital cost as calculated occurring in Year 0, and the differential between the dairy and sheep & beef EBITD then cash flowed over the 20-year period. In the 20th year, a salvage value of the difference in value of the dairy farm ($35,000/ha) relative to the original value of the sheep & beef farm ($15,000/ha) was included, as an estimate of the present value of future cashflows past the 20 years.

The discount rate used was 6%, the current government discount rate.

The results of this analysis showed:

Table 45: Investment analysis results

	Base	Scenario 1	Scenario 2
NPV	$1,368,781	$623,165	$407,673
IRR	8.0%	7.0%	6.6%

10.4.1 Discussion

The analysis shows a steady decrease in the return (NPV) as the farm is constrained down to the 'allowable' nitrogen discharge limit. The difference in EBITD between the Unconstrained farm (Base) and the N constrained farm (Scenario 2) is $265/ha, or around $77,000 at a whole farm level.

In essence, the constrained farm Gross Revenue is down $403,200 per year compared with the unconstrained farm, which is then offset to some degree by reduced Farm Working Expenses of $232,000 (i.e. due to no supplement or nitrogen fertiliser being bought in). Nevertheless, the difference adds up to just under $1 million difference at a Net Present Value level.

On the face of it, the analysis does indicate that the conversion to a 'constrained' farm is still profitable, in the sense that the NPV is positive, and the IRR is above the cost of capital (i.e. the discount rate). This ignores the risk component inherent within such a conversion, and the owners need to be paid for their labour and management, which is excluded in the EBITD figure. A major assumption within the investment analysis is that the differential between the dairy and sheep & beef EBITD will be maintained over the life of the investment. In reality, this will vary considerably, as is discussed in Section 11.4.2 in the sensitivity analysis.

Another aspect to consider is debt, as it is very probable that much of the conversion would be debt funded. At the total net cost of the conversion as outlined in Table 43, relative to production levels gives the following.

Table 46: Debt level per kilogramme of milksolids

% debt	Base	Scenario 1	Scenario 2
50%	$10.81	$12.92	$15.26
75%	$16.21	$19.38	$22.89
100%	$21.61	$25.83	$30.52

Current (2016/17) dairy debt is $25/kg milksolids (Dairy NZ 2018). The following is speculative as lending decisions vary between the banks and are based on individual circumstances. But the probability is, given the current conservatism in dairy lending by the banks and a renewed expectation that debt can be amortised over a reasonable period, say 20 years, the 50% debt level is probable, the 75% debt level could be considered but is unlikely, whereas the 100% debt lending is very unlikely. This then adds a further layer of risk to the conversion proposition, as to the level of capital that the farmer could inject relative to any debt.

10.5 Greenhous Gas Emissions

Not surprisingly, biological greenhouse gas emissions rise when the farm is converted to dairying. A summary of the emissions are:

Table 47: Total biological GHG emissions (tonnes CO_2e/ha/year)

Sheep & Beef Farm	Base Dairy Farm	Dairy Scenario 1	Dairy Scenario 2
4.5	10.2	8.3	9.7
% change relative to dairy base		-19%	-5%

The main driver of methane emissions is dry matter intake; these have risen appreciably in the base dairy scenario given a much higher stocking rate, and feeding level compared with the sheep & beef farm. Nitrous oxide emissions also rise due to a combination of higher urine deposition onto the pastures, and higher nitrogen fertiliser usage.

GHG emissions then drop in dairy Scenario 1 compared with the base dairy scenario, due to a lesser number of livestock, coupled with a lower level of feed input (i.e. less supplements being fed).

The GHG emissions rise in the dairy Scenario 2 compared with dairy Scenario 1 (but less than the base dairy scenario) due to two reasons:

(i) While livestock numbers are less, this is offset by an increase in per cow production; while GHG emissions will drop due to the lower stocking rate, this is partially offset in that the individual cows are being better fed (i.e. higher DM intake), leading to a higher per cow production of milksolids.

(ii) The wintering barn used had a bark/woodchips floor (being both cheaper and easier for cows to lie on) but does result in a higher level of nitrous oxide emissions as the urine-soaked material breaks down.

The percentage change in GHG emissions for Scenario 2 is only 5% less than the base; (of which approximately 80% is methane). This is below the intended 10% reduction in methane emissions by 2030 target, and hence further strategies would be required to reduce GHG emissions, particularly methane, further, which in turn are very likely to reduce profitability further.

11.0 SENSITIVITY OF DAIRYING PAYOUT AFFECTING CONVERSION OF A SHEEP AND BEEF FARM TO DAIRYING

11.1 Objective

The objective of this analysis is to analyse the sensitivity of the investment returns from a conversion of a sheep and beef farm into a dairy farm, based on increases in the dairy payout.

The analysis involves:

(i) Calculation of the differential between the original sheep and beef farm EBITD (which would remain constant) and the dairy farm EBITD in line with an increasing milksolids payout.

(ii) An investment analysis based on the differing cashflows over a 20-year period.

The capital cost of the conversion is assumed the same as for the analysis investigating the conversion of a sheep and beef farm into a dairy farm (Section 9.3)

11.2 Methodology

The analysis is based on:

(i) The average EBITD for a dairy farm, based on the Dairy NZ Economic Survey

(ii) The average EBITD for the Class 5 North Island Intensive Sheep and Beef farm as per the Beef + Lamb NZ Economic Service survey. This class of farm was chosen as it is the most likely to be converted to dairying.

(iii) Calculation of the proportion of expenditure on farm working expenses relative to the increasing milksolids payout.

(iv) These are then combined into a 20-year cashflow, from which the NPV and IRR are calculated.

11.3 Results

11.3.1 Average Farm EBITDs

These were calculated as 10-year averages as shown:

Table 48: Average dairy and sheep & beef EBITD ($/ha)

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Average	Std Deviation	% Std Deviation
Dairy	$1,638	$2,854	$3,596	$3,302	$2,661	$4,007	$2,483	$957	$2,811	$3,161	$2,747	$931	34%
Class 5 S&B	$397	$352	$495	$567	$432	$552	$677	$555	$527	$650	$520	$118	23%
Difference	$1,241	$2,502	$3,101	$2,736	$2,229	$3,455	$1,806	$403	$2,284	$2,511	$2,227	$952	43%

Dairy information from Dairy NZ Economic Survey, Sheep & beef information from Beef + Lamb NZ Economic Service

The average differential between the dairy and sheep and beef EBITDs is $2,227/ha. The average dairy milk price over this period was $5.99/kg milksolids, which will be taken as the '$6/kgMS' base for the analysis.

11.3.1.1 Farm Working Expenses as a proportion of the dairy payout.

A key aspect of the sensitivity analysis is in determining the proportion of an increasing payout which would be expended on farm working expenses; all things being equal, as the payout increased, a smaller proportion would be spent on farm working expenses, and correspondingly a larger proportion would flow through to the EBITD.

The issue is that this relationship is not linear or even curvilinear; as the payout increases, it is very likely that an increasing proportion would be spent on farm working expenses, up to a point. Once the farm was operating at full maintenance expenditure, any increase in payout is likely to flow directly to EBITD.

Analysis of the relationship between farm working expenses and the dairy payout shows:

Table 49: Dairy Payout versus average Farm Working Expenses ($/kgMS)

	Milk price	FWE	FWE as a % of Milk price
2008/09	$4.75	$3.86	81%
2009/10	$6.10	$3.56	58%
2010/11	$7.60	$4.06	53%
2011/12	$6.08	$3.95	65%
2012/13	$5.84	$4.13	71%
2013/14	$8.40	$4.33	52%
2014/15	$4.40	$4.07	93%
2015/16	$3.90	$3.64	93%
2016/17	$6.12	$3.73	61%
2017/18	$6.69	$4.20	63%

Milk price data from Interest.Co, Farm Working Expenses data from DairyNZ

Regression analysis gave a correlation between the two of 0.55, and a R^2 value of 0.30. These are low-moderate values and are not good enough to develop a reliable regression formula.

Another approach was to consider the average farm working expenses from Table 2 ($3.95/kgMS), assume this is a full maintenance expenditure, and calculate this as a proportion of any increased milk price. The results are:

Table 50: Farm Working Expenses as a proportion of an increased dairy milk price

Milk price ($/kg)	FWE as a proportion	Resultant EBITD ($/ha)
$6.00	66%	$2,227
$7.00	56%	$3,103
$8.00	49%	$4,120
$9.00	44%	$5,137
$10.00	40%	$6,155

This gives a curvilinear relationship, which while not exact, does relate the principle of a decreasing proportion of expenditure on farm working expenses as milk price increases.

> **Note**: At the higher milk prices, it is very probable that farmers would look to increase production by buying in further supplementary feed. Provided the marginal cost of the extra supplementary feed is less than the marginal revenue, this would be a profitable exercise – and would have the effect of increasing average farm working expenses.
>
> For the purposes of this analysis, this aspect was ignored, as the impact depends on the individual farm circumstances.

11.3.2 Investment Analysis

As discussed in the section on converting a sheep and beef farm to dairying (Section 10.3.5), it takes a number of years for the newly converted dairy farm to fully perform, and the value of the differential between the dairy and sheep & beef EBITD in the initial years has been reduced as indicated:

Table 51: Percent of full EBITD relative to year of conversion

Year	% of full EBITD differential
1	50%
2	60%
3	75%
4	85%
5+	100%

A 20-year cashflow was constructed, similar to that discussed in Section 10.4 and discounted at 6%. The results of this are:

Table 52: NPV and IRR relative to dairy milk price

Milk price ($/kgMS)	$6.00	$7.00	$8.00	$9.00	$10.00
NPV ($/ha)	$10,620	$19,657	$30,149	$40,641	$48,784
IRR	10.6%	14.2%	18.3%	22.2%	24.1%

This shows an obvious trend; as milk price increases, the differential in profitability between dairying and sheep and beef increases, such that a conversion would be increasingly more profitable.

11.4 Discussion

From Table 52, the sheep and beef conversion to dairying appears profitable at a $6/kgMS milk price and increasing so as milk price improves.

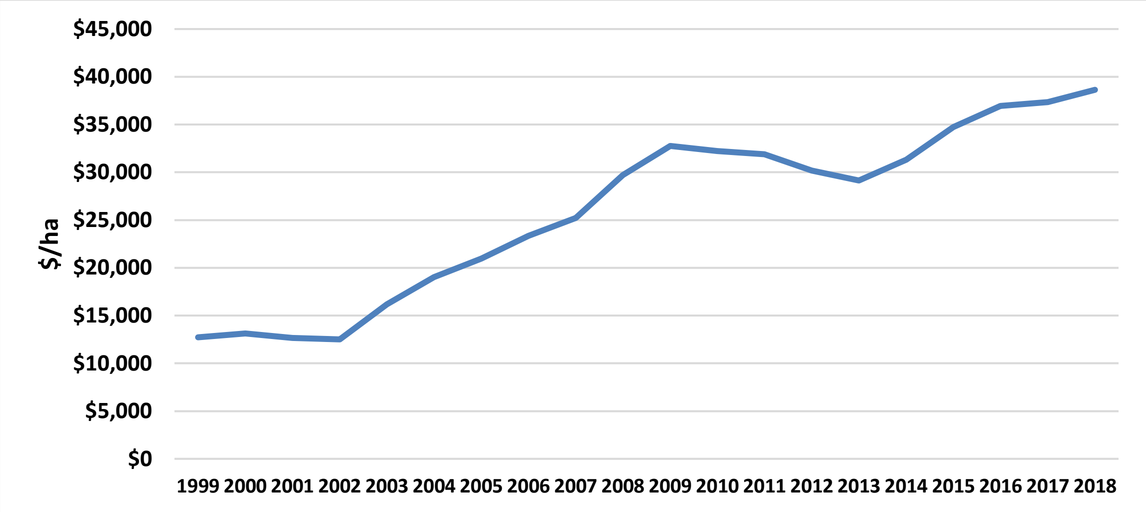
The question then is why farmers wouldn't convert, even at a $6.00 milk price. A key issue here is one of risk. There are several aspects to this:

11.4.1 *Land Values*

A key driver of dairy conversions was the capital appreciation in land values; over the 1990's and early 2000's, farmland value appreciated quite rapidly, which materially added to the return from a dairy farm conversion. In 2008 the global financial crisis slowed this appreciation markedly, and while land values have appreciated since, it has not been at the same rate as prior to 2008. In addition, dairy land values have softened appreciable over the last 2-3 years, driven in part by the variability in milk price and reduced profitability, and in part by increasing environmental constraints – or at least the perception of this, as few councils have fully implemented their water quality plans.

This is illustrated below.

Figure 2: Dairy land values ($/ha) 1999-2018



Source: Dairy NZ Economic Survey

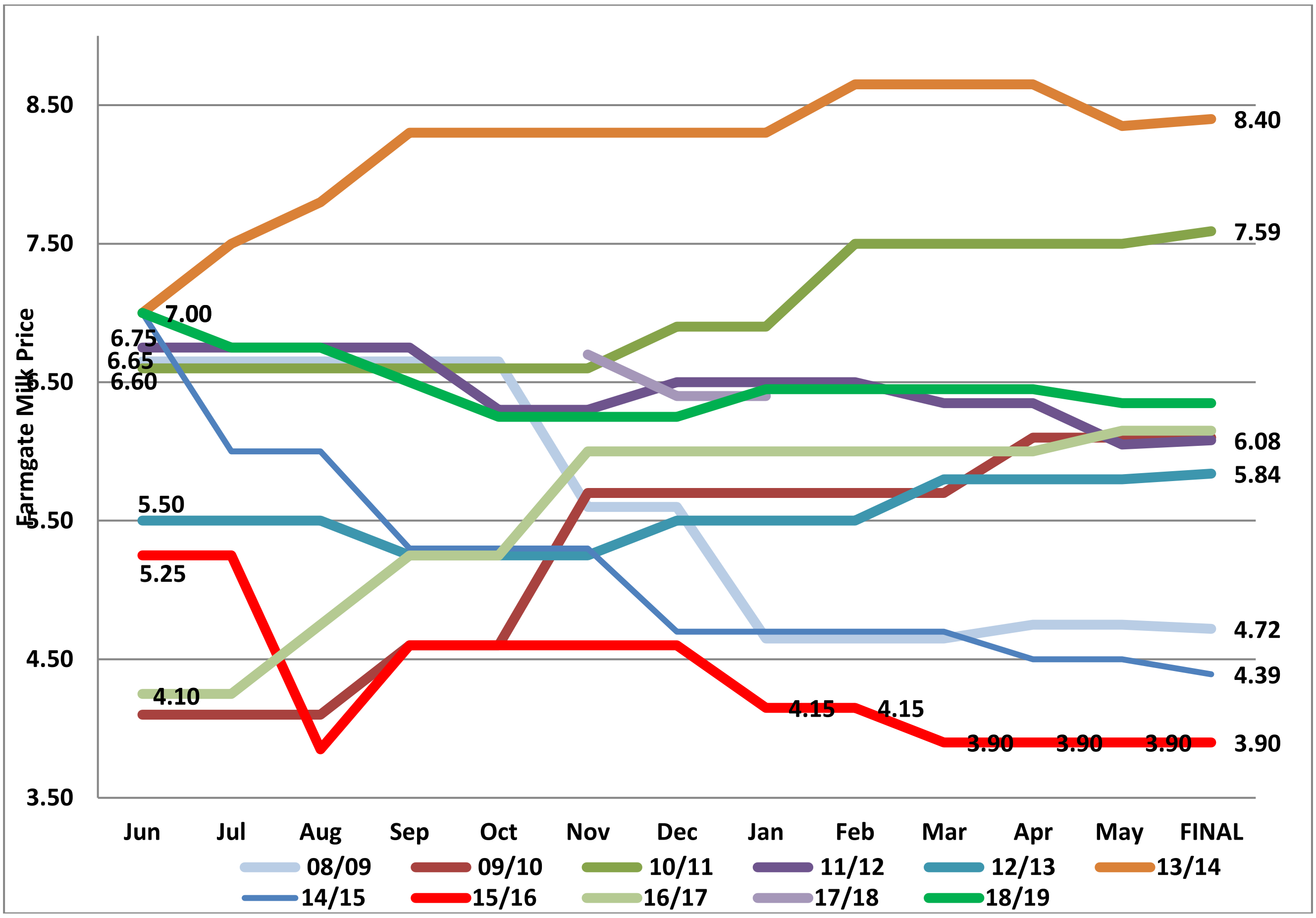
What this figure shows is that the compound rate of growth in land values from 1999-2008 was 8.8% per annum, whereas the compound growth from 2009 – 2018 is 1.7%.

11.4.2 *Profitability Differential*

The investment returns calculated primarily depend on the EBITD differential between sheep and beef farming and dairying being maintained over the life of the (20 year) cashflow.

In reality, this is very unlikely to occur. As shown in Table 48, the percentage standard deviation for the EBITD differential, over the 10-year period indicated, is 43%. In other words, there is significant variation within the differential. A large part of this is the variation in dairy milk price that has been increasing over the last decade. This can be illustrated:

Figure 3: Variation in the milk price 2008/09 – 2018/19 ($/kgMS)



Source: AgFirst

What this figure shows is that there is a significant variation in milk price within a year; over the period in question, there is, on average, a $1.55/kgMS variation (standard deviation) within a year between the opening and final milk price, plus a significant variation between years. This infers a significant degree of risk; farmers looking to convert to dairying would be looking for a reasonable degree of certainty around the dairy milk price before committing to a conversion.

Part of this is around the perception of dairying; a lot of the conversions in the 1990's/2000's was based around a perception that dairying was financially more secure than sheep and beef farming. This perception has diminished, in part due to the environmental issues facing the dairy industry, but also because the financial situation has changed; increased variation in milk price coupled with recent drops in the dairy milk price, combined with improvements in meat returns has markedly increased the risk of conversions.

11.4.3 Other Factors

Other factors which would impact on the riskiness of conversion would be:

(i) Access to capital. This was discussed in Section 10.4.1, where the tightening of bank lending to dairying means that any conversion would require a reasonable degree of equity.

(ii) Limited labour availability, especially for experienced people.

(iii) Alternative land uses that could compete with dairying, including the recent greater appreciation of sheep and beef land prices, which has squeezed some of the speculative conversions.

(iv) Much of the more 'easily convertible' land has already been converted, pushing some conversions onto more marginal land.

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13.0 APPENDIX ONE: TYPICAL FARM BUDGETS

The following budgets are from the AgFirst annual financial survey of farming, based on an average Waikato/Bay of Plenty dairy farm, and an average Central North Island Sheep & Beef Hill Country farm. The reports are published annually, and can be found at:

https://www.agfirst.co.nz/wp-content/uploads/2018/07/WaikatoBoP-Dairy-Report-2018.pdf

https://www.agfirst.co.nz/wp-content/uploads/2018/07/Central-NI-Hill-Country-Report-2018.pdf

13.1 Waikato/BoP Dairy Farm (2017/18)

	2017/18			2018/19 budget		
	Whole farm ($)	Per cow ($)	Per kg of milksolids ($)	Whole farm ($)	Per cow ($)	Per kg of milksolids ($)
Revenue						
Milksolids	815 747	2 406	6.43	863 431	2 555	6.67
Capacity Adjustment	32 350	95	0.26	39 467	117	0.31
Cattle	53 872	159	0.42	49 273	146	0.38
Other farm income	6 500	19	0.05	6 700	20	0.05
Less:						
Cattle purchases	6 568	19	0.05	6 748	20	0.05
Net cash income	**901 901**	**2 660**	**7.11**	**952 124**	**2 817**	**7.36**
Farm working expenses	**516 300**	**1 523**	**4.07**	**530 675**	**1 570**	**4.10**
Cash operating surplus	**385 601**	**1 137**	**3.04**	**421 448**	**1 247**	**3.26**
Interest	140 901	416	1.11	135 022	399	1.04
Rent and/or leases	0	0	0.00	0	0	0.00
Stock value adjustment	- 11 005	- 32	-0.09	0	0	0.00
Minus depreciation	30 755	91	0.24	34 015	101	0.26
Farm profit before tax	**202 941**	**599**	**1.60**	**252 411**	**747**	**1.95**
Income equalisation	0	0	0.00	0	0	0.00
Taxation	48 809	144	0.38	65 135	193	0.50
Farm profit after tax	**154 132**	**455**	**1.21**	**187 276**	**554**	**1.45**
Allocation of funds						
Add back depreciation	30 755	91	0.24	34 015	101	0.26
Reverse stock value adjustment	11 005	32	0.09	0	0	0.00
Drawings	79 924	236	0.63	80 228	237	0.62
Farm surplus for reinvestment[1]	**115 967**	**342**	**0.91**	**141 063**	**417**	**1.09**
Reinvestment						
Net capital purchases	53 040	156	0.42	45 000	133	0.35
Development	0	0	0.00	0	0	0.00
Principal repayments	53 765	159	0.42	80 952	240	0.63
Farm cash surplus/deficit	**9 163**	**27**	**0.07**	**15 111**	**45**	**0.12**
Other cash sources						
Dividend on wet shares[2]	29 126	86	0.23	28 453	84	0.22
Dividend on dry shares[2]	401	1	0.00	0	0	0.00
Introduced funds	0	0	0.00	0	0	0.00
New borrowings	0	0	0.00	0	0	0.00
Off-farm income	0	0	0.00	0	0	0.00
Net cash position	**38 690**	**114**	**0.30**	**43 564**	**129**	**0.34**
Assets and Liabilities						
Farm, forest and building (opening)	4 892 500	14 432	38.56	4 798 125	14 196	37.08
Plant and machinery (opening)	187 850	554	1.48	209 673	620	1.62
Stock valuation (opening)	562 129	1 658	4.43	551 124	1 631	4.26
Dairy company shares	766 599	2 261	6.04	692 896	2 050	5.35
Other farm related investments (opening)	0	0	0.00	0	0	0.00
Total farm assets	**6 409 078**	**18 906**	**50.52**	**6 251 817**	**18 497**	**48.31**
Total liabilities (opening)	**2 533 830**	**7 474**	**19.97**	**2 440 065**	**7 219**	**18.86**
Total equity (assets-liabilities)	**3 875 248**	**11 431**	**30.55**	**3 811 752**	**11 277**	**29.46**

	2016/17			2018/19 budget		
	Whole farm ($)	Per cow ($)	Per kg of milksolids ($)	Whole farm ($)	Per cow ($)	Per kg of milksolids ($)
Farm working expenses						
Permanent wages	88 140	260	0.69	88 218	261	0.68
Casual wages	7 458	22	0.06	8 126	24	0.06
ACC	2 918	9	0.02	2 887	9	0.02
Total labour expenses	**98 516**	**291**	**0.78**	**99 231**	**294**	**0.77**
Animal health	31 595	93	0.25	31 434	93	0.24
Breeding	21 696	64	0.17	20 956	62	0.16
Dairy shed expenses	7 865	23	0.06	8 764	26	0.07
Electricity	17 628	52	0.14	18 590	55	0.14
Feed (hay and silage)	40 700	120	0.32	43 200	128	0.33
Feed (feed crops)	17 500	52	0.14	17 500	52	0.14
Feed (grazing)	44 356	131	0.35	46 202	137	0.36
Feed (other)	48 000	142	0.38	60 000	178	0.46
Fertiliser	40 735	120	0.32	42 660	126	0.33
Lime	0	0	0.00	0	0	0.00
Freight (not elsewhere deducted)	5 153	15	0.04	5 949	18	0.05
Regrassing costs	10 238	30	0.08	8 382	25	0.06
Weed and pest control	3 678	11	0.03	3 343	10	0.03
Fuel	9 153	27	0.07	9 464	28	0.07
Vehicle costs (excluding fuel)	16 103	48	0.13	15 717	47	0.12
Repairs and maintenance	44 643	132	0.35	39 627	117	0.31
Total other working expenses	**359 042**	**1 059**	**2.83**	**371 788**	**1 100**	**2.87**
Communication costs (phone and mail)	2 390	7	0.02	2 887	9	0.02
Accountancy	5 763	17	0.05	6 202	18	0.05
Legal and consultancy	3 837	11	0.03	3 380	10	0.03
Other administration	3 970	12	0.03	4 533	13	0.04
Water charges	0	0	0.00	0	0	0.00
Rates	18 984	56	0.15	19 604	58	0.15
Insurance	9 411	28	0.07	10 816	32	0.08
ACC Employer	4 480	13	0.04	4 480	13	0.03
Other expenditure[1]	9 907	29	0.08	7 754	23	0.06
Total overhead expenses	**58 742**	**173**	**0.46**	**59 656**	**176**	**0.46**
Total farm working expenses	**516 300**	**1 523**	**4.07**	**530 675**	**1 570**	**4.10**
Calculated Ratios						
Economic farm surplus (EFS[2])	258 842	764	2.04	302 433	895	2.34
Farm working expenses/NCI[3]	57%			56%		
EFS/total farm assets	4.0%			4.8%		
EFS less interest and lease/equity	3.0%			4.4%		
Interest+rent+lease/NCI	15.6%			14.2%		
EFS/NCI	28.7%			31.8%		

13.2 Central North Island Sheep & Beef Hill Country (2017/18)

	2017/18			2018/19 budget		
	Whole farm ($)	Per ha ($)	Per stock unit[1] ($)	Whole farm ($)	Per ha ($)	Per stock unit[1] ($)
Revenue						
Sheep	294 368	516	95.34	287 605	504	93.15
Wool	36 007	63	11.66	42 604	75	13.80
Cattle	242 181	424	127.90	223 630	392	118.10
Grazing income (including hay and silage sales)	0	0	0.00	0	0	0.00
Other farm income	5 710	10	1.15	3 426	6	0.69
Less:						
Sheep purchases	6 000	11	1.94	6 600	12	2.14
Cattle purchases	64 413	113	34.02	51 750	91	27.33
Net cash income	**507 854**	**889**	**101.96**	**498 915**	**874**	**100.16**
Farm working expenses	**276 958**	**485**	**55.60**	**297 483**	**521**	**59.72**
Cash operating surplus	**230 895**	**404**	**46.36**	**201 432**	**353**	**40.44**
Interest	95 495	167	19.17	93 695	164	18.81
Rent and/or leases	0	0	0.00	0	0	0.00
Stock value adjustment	0	0	0.00	- 22 437	- 39	-4.50
Minus depreciation	24 473	43	4.91	24 893	44	5.00
Farm profit before tax	**110 927**	**194**	**22.27**	**60 407**	**106**	**12.13**
Income equalisation	0	0	0.00	0	0	0.00
Taxation	19 318	34	3.88	8 611	15	1.73
Farm profit after tax	**91 609**	**160**	**18.39**	**51 796**	**91**	**10.40**
Allocation of funds						
Add back depreciation	24 473	43	4.91	24 893	44	5.00
Reverse stock value adjustment	0	0	0.00	22 437	39	4.50
Drawings	68 520	120	13.76	71 375	125	14.33
Farm surplus for reinvestment[2]	**47 562**	**83**	**9.55**	**27 751**	**49**	**5.57**
Reinvestment						
Net capital purchases	25 000	44	5.02	0	0	0.00
Development	4 568	8	0.92	5 425	10	1.09
Principal repayments	0	0	0.00	0	0	0.00
Farm cash surplus/deficit	**17 994**	**32**	**3.61**	**22 326**	**39**	**4.48**
Other cash sources						
Off-farm income	0	0	0.00	0	0	0.00
New borrowings	0	0	0.00	0	0	0.00
Introduced funds	0	0	0.00	0	0	0.00
Net cash position	**17 994**	**32**	**3.61**	**22 326**	**39**	**4.48**
Assets and liabilities						
Farm, forest and building (opening)	4 800 000	8 406	963.66	5 100 000	8 932	1,023.89
Plant and machinery (opening)	147 500	258	29.61	150 375	263	30.19
Stock valuation (opening)	939 553	1 645	188.63	939 553	1 645	188.63
Other produce on hand (opening)	0	0	0.00	0	0	0.00
Total farm assets (opening)	**5 887 053**	**10 310**	**1,181.90**	**6 189 928**	**10 841**	**1,242.71**
Total assets (opening)	**5 887 053**	**10 310**	**1,181.90**	**6 189 928**	**10 841**	**1,242.71**
Total liabilities (opening)	1 679 000	2 940	337.08	1 659 000	2 905	333.07
Total equity (farm assets - liabilities)	**4 208 053**	**7 370**	**844.82**	**4 530 928**	**7 935**	**909.64**

	2017/18			2018/19 budget		
	Whole farm ($)	Per ha ($)	Per stock unit[1] ($)	Whole farm ($)	Per ha ($)	Per stock unit[1] ($)
Farm working expenses						
Permanent wages	0	0	0.00	0	0	0.00
Casual wages	17 130	30	3.44	19 985	35	3.83
ACC	601	1	0.12	620	1	0.12
Total labour expenses	**17 731**	**31**	**3.56**	**20 605**	**36**	**3.95**
Animal health	29 121	51	5.85	30 263	53	5.80
Breeding	0	0	0.00	0	0	0.00
Electricity	6 852	12	1.38	6 852	12	1.31
Feed (hay and silage)	5 139	9	1.03	6 281	11	1.20
Feed (feed crops)	0	0	0.00	0	0	0.00
Feed (grazing)	0	0	0.00	0	0	0.00
Feed (other)	2 284	4	0.46	2 855	5	0.55
Fertiliser	61 600	108	12.37	64 400	113	12.35
Lime	0	0	0.00	0	0	0.00
Cash crop and forestry expenses	0	0	0.00	0	0	0.00
Freight (not elsewhere deducted)	6 852	12	1.38	7 709	14	1.48
Regrassing costs	1 713	3	0.34	2 000	4	0.38
Shearing expense	23 411	41	7.58	29 264	51	8.81
Weed and pest control	7 423	13	1.49	7 994	14	1.53
Fuel	6 281	11	1.26	7 423	13	1.42
Vehicle costs (excluding fuel)	17 701	31	3.55	18 272	32	3.50
Repairs and maintenance	37 115	65	7.45	38 257	67	7.33
Total other working expenses	**205 492**	**360**	**41.26**	**221 569**	**388**	**42.47**
Administration	14 846	26	2.98	15 417	27	2.96
Rates	18 843	33	3.78	19 414	34	3.72
Insurance	10 278	18	2.06	10 849	19	2.08
ACC employer	4 629	8	0.93	4 629	8	0.89
Other expenditure	5 139	9	1.03	5 000	9	0.96
Total overhead expenses	**53 735**	**94**	**10.79**	**55 309**	**97**	**10.60**
Total farm working expenses	**276 958**	**485**	**55.60**	**297 483**	**521**	**57.03**
Calculated ratios						
Economic farm surplus (EFS[2])	131 422	230	26.38	79 102	139	15.88
Farm working expenses/NCI[3]	55%			60%		
EFS/total farm assets	2.2%			1.3%		
EFS less interest and lease/equity	0.9%			-0.3%		
Interest+rent+lease/NCI	18.8%			18.8%		
EFS/NCI	25.9%			15.9%		

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