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Economic Analysis on the Value of Winter Housing for Dairy Farming in Tararua District

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Summary

This study examined the economic impact of a wintering barn facility on a dairy farm in the Tararua District, relative to its ability to reduce nitrogen leaching, as a means of achieving Horizon's proposed nitrogen discharge limit.

The analysis showed that the provision of a wintering facility had a significant impact in reducing nitrogen leaching, down to just above the required limit. The economic cost of this was significant, in the absence of improved payouts or the farmer intensifying the system to cover the cost of the facility. If the farm was intensified in order to cover the cost of the wintering facility, the level of nitrogen leaching rose accordingly.

The study therefore indicates that the provision of a wintering barn as a means of reducing nitrogen leaching is problematic – while it can reduce leaching rates its economic viability is very dependent on payout levels and supplementary feed costs, and intensifying the system to improve the economic viability results in increased leaching rates well above the proposed limits.

1.0 Objective

The objective of this study was to quantify the economic and nitrogen loss impact from a change in farming system within the Horizon's region from a moderately intensive system (System 3) to a highly intensive system (System 5), incorporating a winter housing system for cows.

The intent was to consider the use of a winter housing system for cows as a means to achieve the proposed nitrogen discharge limit for dairying; to analyse the economic impact of this against any changes in nitrogen discharge.

2.0 Methodology

The analysis is an economic cost benefit analysis, using net present value (NPV) calculations. A net cash flow of benefits less the capital and running cost of the winter housing system are discounted at various discount rates and a range of variables.

The study considered an average farm from within the Tararua District, based on LIC (LIC 2012) and DairyBase (Howard pers com) statistics. Initially a winter housing facility was constructed, and the farming system then intensified in order to cover the cost of the winter house.

The farming system was run through the Overseer™ Nutrient Budget model to ascertain the nitrogen leaching under the different scenarios, covering both a sedimentary and a sandy soil type, and under two different rainfall scenarios; 1200mm and 1700mm.

3.0 Discount Rates

Discount rates are a critical component of cost benefit analysis. A discount rate reflects both the cost of capital and a premium for risk over time. The rate used should be commensurate with the overall risk associated with the project: As risk increases so should the discount rate.

The main discount rate used in this analysis was the Treasury Guideline Rate, based on the "government opportunity cost of capital" (Treasury, 2008), is used as the "risk based rate". This gives a default discount rate of 8.0 percent real (deflated for inflation and tax).

A discount rate of 8 percent real could be considered as high, and a range of discount rates are assessed as part of the sensitivity analysis. The discount rate is important in that the higher the rate, the less value future benefits have.

The discount period was 20 years.

4.0 Farm Systems

Details on the farms are shown in Appendix 1.

4.1 Average Farm

Effective area: 119 ha
Cows wintered: 332
Peak Cows milked: 324
Milk production: 113,400 KgMS; 342Kg/cow wintered, 953 Kg/hectare

Cows are grazed off the farm June/July

4.2 Base Scenario

In this scenario the cows are wintered on-farm, in a winter housing facility. The grazing regime over the autumn (February – May) involves the cows grazing pasture in situ for 4 hours in the morning and evening, and then in the winter facility for the remainder of the time. They are then housed in the winter facility for 100 percent of the time over June/July.

Extra feed is required for feeding in the shed, estimated (for the average farm) at 622 tonnes of wet silage, and 207 tonnes of palm kernel expeller (PK), fed as a 50:50 ration. Refer Appendix 2.

4.3 Intensification Scenarios

In this scenario cow numbers are increased, as is feed bought in, in order to make the wintering facility pay its way.

<u>Intensification #1</u>

In this scenario cow numbers on the average farm were increased to 389 (i.e. an increase of 57), and milk production increased to 162,700 KgMS, or 418KgMs/cow wintered, 1,367 KgMS/Hectare.

<u>Intensification #2</u>

In this scenario cow numbers were left as per the intensification #1 scenario, but milk production on the average farm was lifted to 194,500KgMS, or 500Kg/cow wintered, 1,634 Kg/hectare

5.0 Costs

The costs associated with the wintering facility were:

1. Cost of the facility and associated effluent disposal
2. Increased feeding costs
3. Increased labour costs
4. Increased tractor costs
5. Cost of increasing cow numbers
6. Repairs and maintenance on the winter facility

These are outlined in Appendix 3

<u>Wintering facility costs</u>

These were based on actual costs from Southland (Crossley, pers com), as follows;

1. Free stall barns which range from $1,500/cow to $2,000/cow depending on how elaborate the effluent system is. These costs include the cost of infrastructure for the effluent system.
2. Herd homes - $1,800 to $2,000/cow. No effluent system required as these barns have a deep pit and store the effluent below the floor which can be scraped out by a digger and spread on pastures at the appropriate time.

3. Covered deep litter standoff, with drainage and with effluent capture, also in the region of $1,200 to $1,500/cow

For the purposes of the report the base costing of the wintering facility was assumed at $2,000 per cow; in essence a free-stall type facility, which also included the cost of extending the effluent system (increased storage and spray irrigation) to cope with the extra effluent generated. Apart from the effluent requirement, the higher cost was assumed in that a substantive facility would be required given the cows would be housed and feed inside for 100% over June and July.
The depreciation rate on the wintering facility was assumed at 6 percent on the diminishing value, as per the IRD rates (IRD_1 2012).

Increased feed costs

The grazing regime with the winter facility was to graze the cows for four hours in the morning and evening, with the remainder of the time in the facility, over the February – May period, and then for 100 percent of the time in the facility over June and July.

The feeding regime over this period is shown in Table 1.

Table 1. Feeding regime Autumn - Winter

	Percent fed within the shed	Total feeding level (KgDM/Cow/Day)
February	20	15
March	20	15
April	20	15
May	20	14
June	100	11
July	100	11

The supplementary feed fed within the wintering facility was assumed as a 50:50 mix of pasture silage and palm kernel.

Based on this the total amount of supplementary feed fed was:

Table 2 Supplementary feed requirements

	Tonnes Wet Silage	Tonnes Palm Kernel
Base scenario	622	207
Intensification #1		
Wintering facility	729	243
Extra Milk	748	249
Intensification #2		
Wintering facility	729	243
Extra Milk	1490	497

Cost of the feed for the base assumption was; $80/wet tonne for silage (=27c/KgDM), and $280 tonne for PK (=31c/KgDM)

Increased labour costs

The basic assumption was that one full time equivalent labour unit cost $50,000 per year, and that an extra 0.25FTE was required in the base scenario and 0.5FTE was required for the intensive scenarios.

Increased tractor costs

There were two components to this:

1. The capital cost involved.
   The base assumption here was that a larger tractor was required due to the extra feeding out costs; total capital cost in the base scenario was $80,000 of which 25 percent was ascribed to the wintering facility in the base scenario, and a capital cost of $100,000 of which 30 percent was ascribed to the wintering facility in the intensive scenarios.

   It was assumed that the tractor was replaced every 10 years, the cost of which was based on an 8.5 percent straight line depreciation rate (IRD_1 2013) over the 10 year period.

2. Operating costs.
   This covers the cost of fuel, repairs and maintenance, and insurance. The cost of this was assumed at $21 per hour, based on Yule (2012). The assumptions around running time associated with the wintering facility are outlined in Table 3.

Table 3 Tractor running time assumptions

	Hours per day: Base Scenario	Hours per day: Intensification scenarios
February	0.5	1.0
March	0.5	1.0
April	1.0	1.0
May	1.0	1.0
June	2.0	3.0
July	2.0	3.0

Cost of increased cow numbers

This was based on the five year average of the herd values from the IRD livestock tax scheme (IRD_2 2013), being a weighted average for mixed age cows across Friesian and Jersey/Other breeds. Value = $1,711.

Repairs and maintenance on the wintering facility

The assumption behind this was that the R&M costs started at 0.5 percent of the capital cost of the shed in year 2, and increased by 0.5 percent per year through to year 11, at which stage it equalled 5 percent, and then remained at this level thereafter.

6.0 Benefits

The benefits of the wintering facility are:

1. Saved costs of not grazing cows off over winter on contract
2. Increase in pasture production
3. Increased milk production
4. Increased milking period
5. Better cow condition
6. Reduced dry/empty cows
7. Saved cost of not applying fertiliser

These are outlined in Appendix 4

<u>Saved cost of not grazing off</u>

A key assumption for the pre-wintering facility situation was that the farms were grazing all their cows off-farm over the June/July period. A benefit of the wintering facility therefore would be the saving in this cost – estimate at $28 per cow per week for an 8 week period.

<u>Increase in pasture production</u>

There are two aspects to this:

1. Reduced pugging damage.

   Pugging and compaction can result in damage to pasture reducing utilisation by 20–40 percent, and a reduction in future pasture yield to between 20–80 percent for 4–8 months, depending on soil type, as well as greater fertiliser requirements and sediment run-off (DairyNZ, 2006). However, it is difficult to accurately determine an "average" benefit for wintering facilities given the variations between farms and between years.

   De Klein (2010) found that the positive effect of eliminating pugging damage on pasture production was largely out-weighed by the negative effects of increased machinery traffic (in conserving feed or topping pastures).

   In the restricted grazing assumed for this study, while there would be an increase in mechanical harvesting of feed, this would not be overly significant and an assumption was made to allow for a 2 percent increase in pasture production over the whole farm.

2. Increased effluent application

   De Klein (2010) estimated a 3-8 percent increase in pasture dry matter production in a restricted grazing system using a wintering facility, as a result of a more even application of effluent (i.e. nitrogen) over the farm.

   For the average farm however, the normal rate of nitrogen fertiliser application is 150 Kg N per hectare (DairyBase - S Howard pers com). The increased feeding as a result of the wintering facility resulted in a greater area of the farm having effluent applied to it. The effluent area was calculated on the basis of a maximum application of 150 Kg N per hectare. In this situation, while the effluent return may have been more even relative to grazing animals, the effective application of effluent nitrogen simply substituted for the fertiliser nitrogen, and in this respect no increase in pasture production was allowed for.

   The value of any increased pasture production was valued assuming 15KgDM consumed equated to 1 kg milksolids, at a value of $6.20/KgMS (5 year average milk payout).

<u>Increased milk production</u>

This relates to the increased number of cows, and the move to a more intensive feeding regime in order to make the wintering facility pay its way. This was calculated as the increase in milk production over the base scenario, costed at the average milk payout ($6.20), less the gross margin operating expenditure per cow for the increased cow numbers (5 year average, DairyBase 2013).

<u>Increased milking period</u>

Often farmers who build such wintering facilities end up milking cows for longer, due to a combination of factors, particularly better feeding maintaining cows in better condition, and a desire to re-coup costs of the wintering facility.

Within the study this was assumed 70 percent of the herd was milked for 3 weeks longer, at a gross margin of $10 per cow per week.

<u>Better cow condition</u>

As a result of the better feeding regime, and a lower body maintenance requirement due to the shelter of the shed, cows are often in a better body condition score at calving.

Within the study the assumption was that cows average 0.5 body condition score better, which equated to an increase of 7.5 Kg milksolids per cow (DairyNZ 2013).

Reduced dry/empty cows

The better condition/better feeding regime also often results in a reduction in empty cows. This in turn can lead to efficiencies in replacement rates. Within the study it was assumed that there was a 2 percent improvement – for example that replacement heifer numbers could be reduced from 20% of the milking cows, to 18 percent.

This was valued at $902 per heifer, being the 5 yearly average value of a rising 1 year heifer in the IRD herd value scheme (IRD_2 2013).

Saved cost of not applying fertiliser

With the increased feeding regime applicable to both the wintering facility and the increased milk production, the amount of effluent required to be spread around the farm increases accordingly. The area required for effluent disposal, for the average farm, increases from 16.2ha in the base scenario, up to 72ha in the 500KgMS per cow scenario, based on the maximum application of 150Kg N per hectare.

The net result of this is a significant reduction in fertiliser required; a direct reduction of the 150Kg N per hectare of fertiliser nitrogen (costed at $825/tonne applied) and a reduction of phosphatic fertiliser equivalent of 500Kg/hectare of Super 10 7K (costed at $539/hectare applied).

7.0 Other Key Figures

Other key assumptions used in the analysis were:

Table 4 Key Assumptions

Average dry matter production (KgDM/Ha)	13,750
Efficiency of utilisation of pasture dry matter via grazing	80%
Efficiency of utilisation of dry matter of supplementary feed within the wintering facility	90%
KgDM per KgMS	15

8.0 Economic Results

The results of the economic analysis is summarised in Table 4.

Table 5. Base economic results

Scenario	NPV at 8% ($ 000)	KgMS/Cow
Average farm base	-770	342
Average farm intensification #1	-440	418
Average farm intensification #2	160	500

This shows that the wintering facility is uneconomic unless production is increased significantly to cover its cost.

9.0 Sensitivity Analysis

9.1 Altering the discount rate

The base discount rate of 8 percent real could be considered relatively high. Reducing this had the following results:

Table 6. Impact on NPV of altering the discount rate ($ 000)

Scenario	NPV at 4% discount ($000)	NPV at 5% discount ($000)	NPV at 6% discount ($000)	NPV at 7% discount ($000)	NPV at 8% discount ($000)
Average farm base	-800	-800	-790	-780	-770
Average farm intensification #1	-270	-320	-370	-400	-440
Average farm intensification #2	560	440	330	240	160

While altering the discount rate has little overall impact on the base and intensification #1scenarios, it does affect the intensification #2 scenario – the lower the discount rate the higher the NPV's, as could be expected.

9.2 Altering the milk payout

Assuming a range of milk payouts give the following results:

Table 7. Varying milk payout (NPV $ 000)

Scenario	$5.50/KgMS	$6.20/KgMS (base)	$7.00/KgMS	$8.00/KgMS
Average farm base	-1,580	-770	150	1,300
Average farm intensification #1	-810	-440	-20	510
Average farm intensification #2	-430	160	830	1,700

This shows the obvious; at a higher payout, the greater the likelihood is of a positive, and higher, NPV across all scenarios. The base farm scenario improves rapidly at a higher payout, as no extra costs are involved compared to the intensification scenarios.

9.3 Altering the capital cost of the wintering facility

If the capital cost of the facility and accompanying effluent system are varied, the results are as follows:

Table 8. Varying the capital cost of the wintering facility (NPV $000)

Scenario	$1200/cow	$1500/cow	$2000/cow (base)	$2500/cow
Average farm base	-440	-560	-770	-980
Average farm intensification #1	-40	-190	-440	-690
Average farm intensification #2	560	410	160	-90

Again this directly reflects that as the cost increases, the NPV of the proposition decreases.

9.4 Feed Costs

Profitability levels are very sensitive to feed costs, as illustrated below.

Table 9. Impact of increased feed costs on NPV ($000)

Scenario	Base	Feed Costs + 10%	Feed Costs +20%
Average farm base	-770	-880	-985
Average farm intensification #1	-440	-735	-1,035
Average farm intensification #2	160	-275	-705

Also, while the very intensive scenario (Intensification #2) is (mostly) positive, this study has used average costs and benefits. A truer examination of the worth or otherwise of the intensification scenarios would be via a marginal cost/benefit analysis, but this was outside the scope of this study.

9.5 Best case scenario

While there could be a number of "best-case" scenarios, this could be illustrated via the following:

- Discount rate of 4%
- Winter Facility cost of $2,000/cow
- Milk payout of $7.00/Kg

Given this, the NPVs are:

Table 10. Best case scenario NPVs ($000)

Base Scenario	Intensification #1	Intensification #2
470	310	1,500

10.0 Environmental Impact

The various scenarios for the average farm were run through the Overseer™ Nutrient Budget programme to ascertain any changes in nutrient discharge, particularly nitrogen. This was done on two soil types; sedimentary and sandy, and for two rainfall parameters; 1200mm and 1700mm. Refer Appendix 5

The results are as follows:

Table 11. Nutrient discharge (kg/Ha) for a sedimentary soil

	Base			Base with no grazing off			Housing (with no increase in production)			Housing Intensification #1 (400KgMS/cow)			Housing Intensification#2 (500KgMS/cow)		
Rainfall	N	P	NCE (%)	N	P	NCE (%)	N	P	NCE (%)	N	P	NCE (%)	N	P	NCE (%)
1200mm	27	0.9	35	29	0.9	32	19	1.1	31	23	1.2	37	27	1.2	30
1700mm	40	1.5	33	42	1.5	32	33	1.7	31	39	1.8	37	44	1.8	30

Table 12. Nutrient discharge (kg/Ha) for a sandy soil

	Base			Base with no grazing off			Housing (with no increase in production)			Housing Intensification #1 (400KgMS/cow)			Housing Intensification#2 (500KgMS/cow)		
Rainfall	N	P	NCE (%)	N	P	NCE (%)	N	P	NCE (%)	N	P	NCE (%)	N	P	NCE (%)
1200mm	27	1.0	34	30	1.0	31	20	1.1	31	23	1.2	37	27	1.3	30
1700mm	42	1.7	33	44	1.7	31	35	1.8	31	42	1.9	37	46	2.0	30

The "base" scenario outlined in the above Tables shows the nitrogen and phosphate losses in the current situation, where the cows are grazed off the farm over June/July.

The "base with no grazing off" scenario shows the nutrient discharge when the cows are wintered on-farm, but with no wintering facility to get them off the pasture over June/July

The "housing with no increase in production" shows the scenario where the cows are now grazed on the on-off system over the autumn and 100 percent in the wintering facility over June/July, but no increase in cow numbers or production has been attempted.

The "housing with intensification" scenarios show the nutrient discharges following the relative intensification regime.

The analysis shows that nitrogen discharges rise as the cows are brought home over the winter and then drop significantly given the autumn on-off grazing and wintering in the facility. Nitrogen leaching then increases again as the farm intensifies its system. Phosphate run-off also follows a similar pattern.

As could be expected, discharges increase with higher rainfall, and in the sandy soil relative to the sedimentary soil type.

11.0 Discussion

The study shows that a wintering facility can provide a significant gain in reducing nitrogen leaching, and assisting farmers to meet proposed nutrient discharge limits (18 Kg N per hectare). However, there is something of a catch-22 situation.

The provision of a wintering facility will reduce nitrate leaching provided no intensification of the farming system. But this can come at a significant cost, dependant on the level of pay-out. If the farm system is then intensified as a means to ensure a greater likelihood of profitability, the nitrate leaching level then increases again to well above the proposed limits. And in order for the farm system to move into a more stable level of profitability, the analysis indicates that a high level of intensification is more profitable than a moderate level of intensification.

The system is also very sensitive to supplementary feed costs; an increase in such costs can rapidly push the system into a negative profitability situation.

The level of reduction in nitrate leaching is significant (34%) as a result of introducing a wintering facility, prior to any intensification. This is in line with the results obtained by de Klein and Ledgard (2010), but who also noted that total nitrogen losses *increased* in nil or restricted grazing systems if the loss of gaseous nitrogen (i.e. NO_2 – a greenhouse gas) was also included.

The NO_2 emission profiles for the wintering scenarios are outlined below:

Table 13 NO_2 emissions expresses as CO_2 equivalents (Kg)

	Sandy		Sedimentary	
	1200mm	1700mm	1200mm	1700mm
Base	1533	2748	1511	2699
No Grazing off	1645	2856	1621	2808
Housing	2095	2960	2077	2919
Housing Intensification #1	2604	3587	2583	3537
Housing Intensification #2	2648	3561	2626	3516

Calculated via Overseer 6™

As can be seen from this, there is a 62 percent increase in CO_2 equivalent emissions as a result of the intensification strategies relative to the no grazing off scenario. Even the provision of the wintering barn, without intensification, results in a 27% increase in emissions due to the fact that effluent is deposited in the shed, and therefore there is less breakdown relative to effluent being deposited on soils (Defra 2009)

13.0 Other Issues

13.1 Up-skilling of farmers

Implicit within the analysis is the idea that farmers readily have the skills to manage a more intensive farming operation. While most would adapt to the new system, this would (a) take time, and (b) require an extension effort to ensure that the necessary skills were taken up.

13.2 Capital Requirements

The capital requirements around developing a wintering facility are $685,000 - $900,000 for the different scenarios. For the vast majority of farmers, this level of capital would need to be borrowed. Given the level of debt currently existing within dairy farming, many farmers would be reluctant to increase debt levels, and again this would significantly slow down the adoption of the practice.

Acknowledgements

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Appendix 1 Farm System Details

	Average Farm	
Effective area (ha)	119	
Total area (ha)	131	
Effluent area (ha)		
Peak cows milked	324	
Cows wintered		
Breed	Crossbred	
Replacement rate	22%	
Liveweight (kg)	474	
Stocking rate	2.72	
Total MS production	113,407	
kgMS/ha	953	
kgMS/cow	350	
kgMS/kg liveweight	0.74	
N fertiliser application kgN/ha	150	
% imported feed	5%	
Rainfall (mm)	1200	
Soil	Waimakariri, deep stoneless silty loam, well drained	
Planned Start of Calving	26-Jul	
BCS at PSC	5	
Dry-off date		
Wintered off - June	100%	
Wintered off - July	100%	
Current PKE (tDM)		
Current pasture silage (tDM)		
Current other (tDM)		
Current total imported (tDM)	69	
Current imported kgDM/cow	213	
Current home-grown feed eaten kgDM/cow	4,040	
Current home-grown feed eaten kgDM/ha	11,000	
Total feed kgDM/cow	4,253	
Total feed	1,377,895	
Wintered off	100%	
N leached kgN/ha		
	On/off grazing (house) - Ave.	Intensification with on/off grazing (house) - Ave
Stocking rate	2.72	3.2
Peak cows milked	324	381
kgMS/liveweight	0.74	0.9
kgMS/cow	350	427
kgMS/ha	953	1365
Feeding levels **excluding** June/July	5%	Increased
Lactation		Extended
Grazing hours per day February - flexibility	8	8
Grazing hours per day March - flexibility	8	8
Grazing hours per day April - flexibility	8	8
Grazing hours per day May - flexibility	8	8
Cows inside June	100%	100%
Feed offered kgDM/hd/day June	11 (half pasture silage, half PKE)	11 (half pasture silage, half PKE)
Cows inside July	100%	100%
Feed offered kgDM/hd/day July	11 (half pasture silage, half PKE)	11 (half pasture silage, half PKE)
Wintered off	0	0
N leached LUC target	18	18

Appendix 2 Wintering Barn Feeding Levels – Average Farm

Feed cost		$/KgDM	Percent of ration		
Palm Kernel $/T	$280	$0.31	50%		
Pasture Silage $/T (wet)	$80	$0.27	50%		
Feed wastage	10%				
Time in barn	Percentage feeding in-shed:	Feeding level (KgDM/Day)		Tonnes Silage	Tonnes PK
February	20%	15		51	17
March	20%	15		57	19
April	20%	15		55	18
May	20%	14		51	17
June	100%	11		201	67
July	100%	11		208	69
				622	207

Appendix 3 Costs

Costs								
Wintering facility cost per cow:	$2,000							
Total cost:	$664,000							
Grade up to bigger tractor	Tractor use attributable to shed:			25%				
- total capital value:	$80,000	Replace every 10 years			Repairs and Maintenance			
					Assume	0.5%	of capital cost in Year 2	
Depreciation rates:	6.0%	Diminishing Value on the shed			increasing at		0.5%	per year through
	8.5%	Straight Line on the tractor			to year 11, and flat thereafter			
							R&M rate	
Consent cost	$1,518	per farm				Yr 2	0.5%	
						Yr 3	1.0%	
						Yr 4	1.5%	
						Yr 5	2.0%	
Extra part-time labour unit	$12,500	(1 FTE for 3 months)				Yr 6	2.5%	
						Yr 7	3.0%	
Feed cost		$/KgDM	Percent of ration			Yr 8	3.5%	
Palm Kernel $/T	$280	$0.31	50%			Yr 9	4.0%	
Pasture Silage $/T (wet)	$80	$0.27	50%			Yr 10	4.5%	
						Yr 11	5.0%	
Feed wastage	10%							

Time in barn	Percentage feeding in-shed:	Feeding level (KgDM/Day)		Tonnes Silage	Tonnes PK
February	20%	15		51	17
March	20%	15		57	19
April	20%	15		55	18
May	20%	14		51	17
June	100%	11		201	67
July	100%	11		208	69
				622	207

Extra tractor running costs	Hrs/day	Hrs/Month
February	0.5	14
March	0.5	15.5
April	1.0	30
May	1.0	30
June	2.0	60
July	2.0	62
Operating costs (fuel/R&M/insurance)		$21

Appendix 4 Benefits (1)

1. Saved grazing fees				2. Increase in DM production		
With winter factilities, no need to graze cows off the farm over the winter.				DM production can be increased via more even effluent application		
Assume 100% of cows off the farm for	8	weeks (June/July)		and reduced pugging		
Grazing fee =	$28	per cow/week		Increase in DM production from reduced pugging:		2%
				Increase in DM production from effluent application		0%
				KgDM per Kg MS	15	
Yr 1	$74,368			Yr 1	$10,821	
Yr 2	$74,368			Yr 2	$10,821	
Yr 3	$74,368			Yr 3	$10,821	
Yr 4	$74,368			Yr 4	$10,821	
Yr 5	$74,368			Yr 5	$10,821	
Yr 6	$74,368			Yr 6	$10,821	
Yr 7	$74,368			Yr 7	$10,821	
Yr 8	$74,368			Yr 8	$10,821	
Yr 9	$74,368			Yr 9	$10,821	
Yr 10	$74,368			Yr 10	$10,821	
Yr 11	$74,368			Yr 11	$10,821	
Yr 12	$74,368			Yr 12	$10,821	
Yr 13	$74,368			Yr 13	$10,821	
Yr 14	$74,368			Yr 14	$10,821	
Yr 15	$74,368			Yr 15	$10,821	
Yr 16	$74,368			Yr 16	$10,821	
Yr 17	$74,368			Yr 17	$10,821	
Yr 18	$74,368			Yr 18	$10,821	
Yr 19	$74,368			Yr 19	$10,821	
Yr 20	$74,368			Yr 20	$10,821	

3. Increased milking period			4. Improved cow condition			
Assume	70%	of herd	Assume cows are $^1/_2$ condition score better at calving			
milked for	3	weeks extra	1 condition score =		15	KgMS
GM/Cow	$10.00	per week				
Yr 1	$6,972		Yr 1	$15,438		
Yr 2	$6,972		Yr 2	$15,438		
Yr 3	$6,972		Yr 3	$15,438		
Yr 4	$6,972		Yr 4	$15,438		
Yr 5	$6,972		Yr 5	$15,438		
Yr 6	$6,972		Yr 6	$15,438		
Yr 7	$6,972		Yr 7	$15,438		
Yr 8	$6,972		Yr 8	$15,438		
Yr 9	$6,972		Yr 9	$15,438		
Yr 10	$6,972		Yr 10	$15,438		
Yr 11	$6,972		Yr 11	$15,438		
Yr 12	$6,972		Yr 12	$15,438		
Yr 13	$6,972		Yr 13	$15,438		
Yr 14	$6,972		Yr 14	$15,438		
Yr 15	$6,972		Yr 15	$15,438		
Yr 16	$6,972		Yr 16	$15,438		
Yr 17	$6,972		Yr 17	$15,438		
Yr 18	$6,972		Yr 18	$15,438		
Yr 19	$6,972		Yr 19	$15,438		
Yr 20	$6,972		Yr 20	$15,438		

Appendix 4 Benefits (2)

5. Reduced dry/empty cows		
Assume replacement rate drops by	2%	
(ie from 20% to 18%)		
Value of R 1 yr Heife	$902	(5 yr Herd Scheme Av)
Yr 1	$5,989	
Yr 2	$5,989	
Yr 3	$5,989	
Yr 4	$5,989	
Yr 5	$5,989	
Yr 6	$5,989	
Yr 7	$5,989	
Yr 8	$5,989	
Yr 9	$5,989	
Yr 10	$5,989	
Yr 11	$5,989	
Yr 12	$5,989	
Yr 13	$5,989	
Yr 14	$5,989	
Yr 15	$5,989	
Yr 16	$5,989	
Yr 17	$5,989	
Yr 18	$5,989	
Yr 19	$5,989	
Yr 20	$5,989	

6. Saved Fertiliser		
Effluent area expanded from 16.2 ha to 54ha to accommodate extra effluent from shed		
Saved fert = 150Kg/ha of N, & 500 Kg/ha Super 10		
Nitrogen applied:	$825	per T
Super 10 7K applied:	$539	per T
Yr 1	$20,353	
Yr 2	$20,353	
Yr 3	$20,353	
Yr 4	$20,353	
Yr 5	$20,353	
Yr 6	$20,353	
Yr 7	$20,353	
Yr 8	$20,353	
Yr 9	$20,353	
Yr 10	$20,353	
Yr 11	$20,353	
Yr 12	$20,353	
Yr 13	$20,353	
Yr 14	$20,353	
Yr 15	$20,353	
Yr 16	$20,353	
Yr 17	$20,353	
Yr 18	$20,353	
Yr 19	$20,353	
Yr 20	$20,353	

Appendix 5 Farm Parameters used for the Overseer analysis: Base farm prior to wintering facility/intensification

Area	119ha
Effluent area	16.2 ha
Cow numbers	324 cows
Production	113407kgMS
Supplement imported	61tDM PKE
N Fertiliser use	150kgN/ha applied to non-effluent area (118kgN/ha over the whole farm)
Winter grazing	All cows grazed off for June and July
Rainfall	1200mm
Effluent system	Holding pond, spray regularly on selected blocks, ponds emptied every two years
Soil Type	Waimakariri (Recent)