Meeting a Sustainable Future

Selwyn and Hinds | Inspiring High Performance, Low footprint farms

Alderbrook Farms Ltd- Karetu Field Day

Jane and Marv Pangborn (Farm Owners) Liam and Lauren Kelly (CM)

1610 North Rakaia Road, Rakaia. SN 37453

4 March 2020

DairyNZ

Meeting a Sustainable Future – Selwyn and Hinds

Inspiring High Performance, Low footprint farms

Through this DairyNZ five-year project, Canterbury dairy farmers will lead the way in showcasing how nitrogen (N) losses can continue to be reduced in order to protect local waterways.

The project focuses on how farms in Hinds and Selwyn can meet N loss limits and maintain profitable businesses under the Canterbury Land & Water Regional Plan (LWRP). Reducing N is a key focus for the project as both catchments have N reduction targets; however, this project also focusses on other aspects of environmental footprint including, Phosphorus and Sediment losses and Green House Gas emissions.

This project builds on sustainable farming initiatives many farmers have already begun and on previous N loss research. It aims to give farmers confidence the limits are achievable. Many farmers have been making changes to reduce N loss for some time and this will continue to build on that.

A key aspect of this project is working alongside partner farms to identify the most appropriate solutions for them, considering their chosen production systems, goals, and aspirations. The information generated from these partner farms is being shared with other farmers and provide a good range of examples and options. In this approach we are also partnering with the rural professionals working with the farmers.

What does success look like?

- Farmers will have confidence in the options available to reduce environmental footprint and an understanding of the implications of these options on the overall performance of their production systems.
- The options will be demonstrated to other farmers as they are implemented.
- Farmers will have clarity on the most profitable options to reduce their environmental footprint in different conditions and farm systems.

How can you get involved?

If you are a farmer, you could become one of the supported farmers or engaged with the range of extension activities.

If you are a rural professional, you can work with the project team to provide research questions and find the most appropriate solutions for your client farmers.

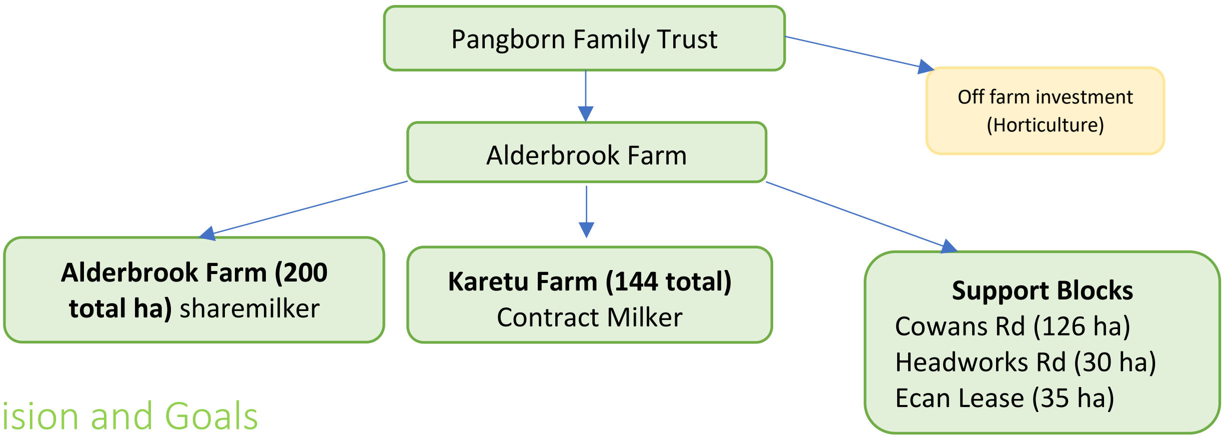
For more information about the project please contact Virginia Serra (021932515/virginia.serra@dairynz.co.nz) Project Lead

Alderbrook Farm Ltd: Goals, Principles and Values

Business Overview

Alderbrook farm Ltd is in the Selwyn catchment, located 12 km northwest of Rakaia in the north bank of the Rakaia river. The dairy business is owned by Jane and Marv Pangborn. They run a self-contained unit with all the winter feed, young stock and baleage coming from their support blocks. There are two dairy units (Alderbrook and Karetu) milking about 1200 cows on roughly 338 effective ha (changes annually due to cropping) and 3 support blocks on 184 effective ha.

Business Structure

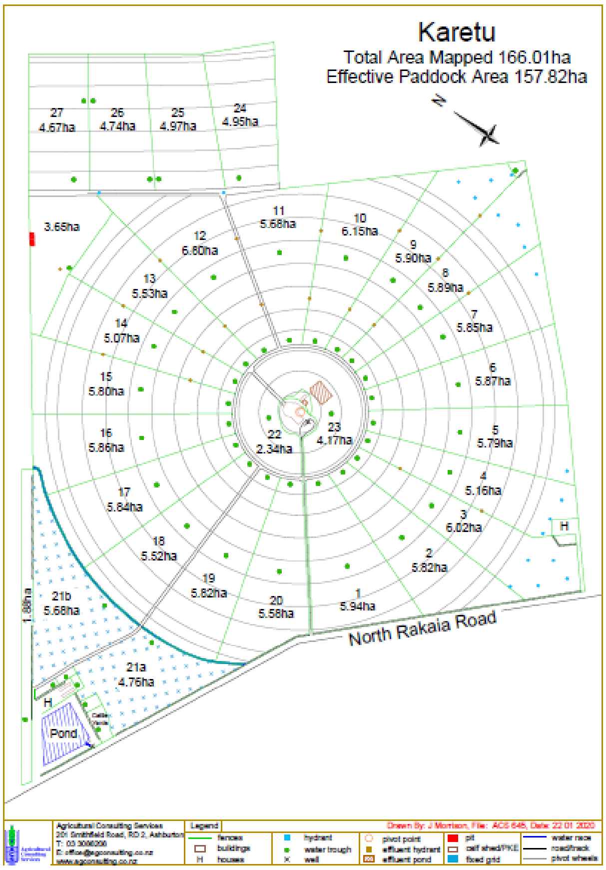


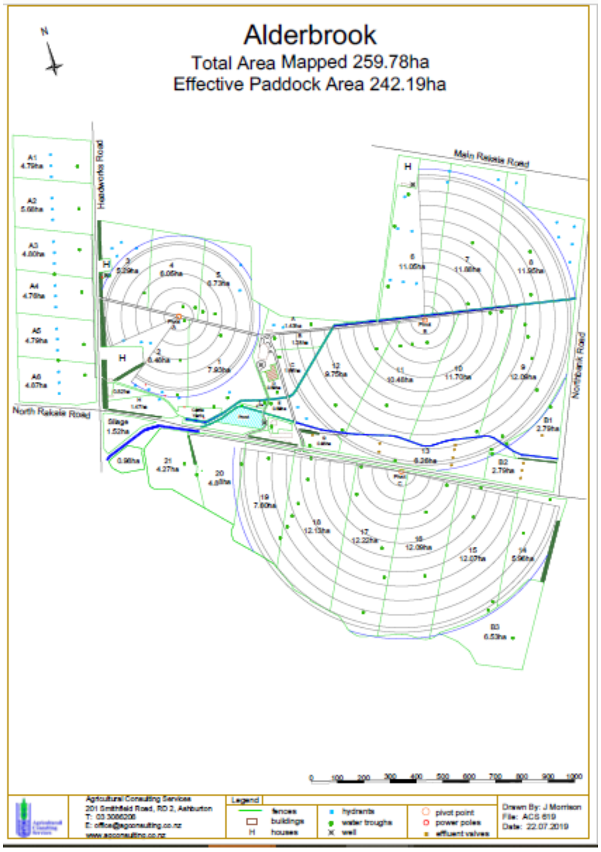
Vision and Goals

To operate a sustainable and diversified business that expands the opportunities of family members

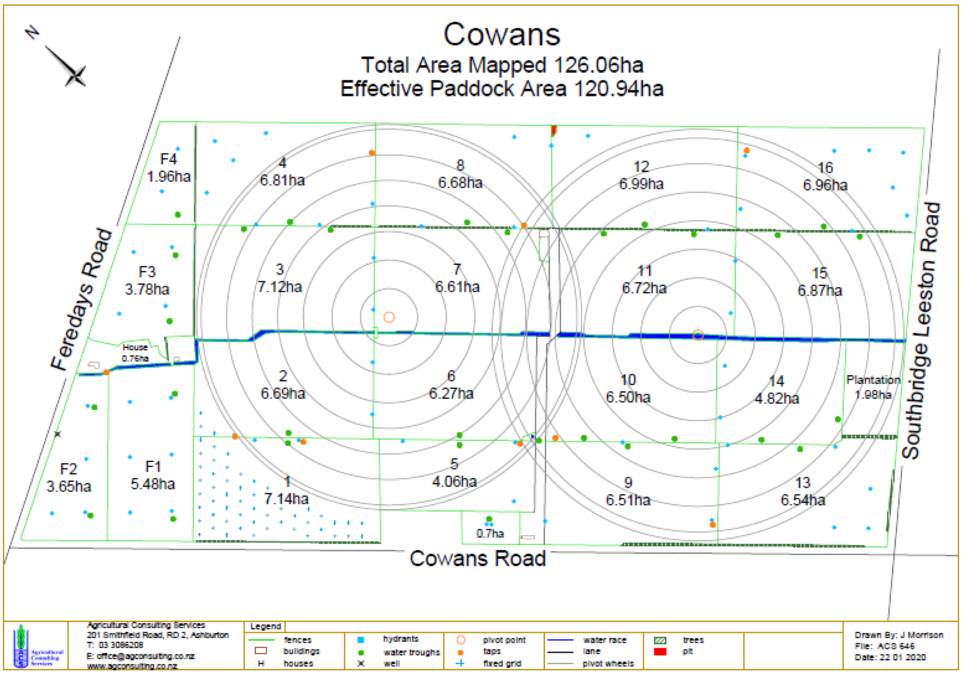
Mission	Operational Excellence	Superior Financial Performance	Compliance	Resiliance	Continous Improvement	People
Core strategies	high performance	achieve financial goals	all consents & plans in place	develop long term business	continous improvement culture	take care of our people
How we will do it.	-knowledge & expertise - early adopters - continous improvement	-focus on low cost production & cost management	- monitor all compliance requirements	- invest in new enterprises -good governance - risk identification	- lean mgmt - real time reporting systems -benchmarking	-be a preferred employer -provide family opportunities
(KPI's) How we will measure it	1750 Kg/Ms/ha 500 Kg/Ms/cow 75% 6 week i.c. <8% empties < 2% Deaths	5% R.O.A. 5% NW Growth int. Coverage > 2 Free Cash > $750,000 debt/ebit of 6 fwe/p+i/capex <-ad $5.75	review H & S policy -no infringements for effluent, shed, an. welfare, water	-advisory board -meet financial targets -risk mgmt strategies -diversity assets	-cattle genetics --pasture genetics -soil fertility -irrigation improvements	- improved housing - training initiatives - goal setting with staff - low turnover -education of next generation -investment funds

Farm Maps: Karetu & Alderbrook





Support Block: Cowans Rd



General Overview – Karetu Farm:

Karetu dairy farm was purchased in 2005. At the time of purchase, 25 ha was a recently harvested forestry block, 10 ha were in trees of various ages and 110 ha was dryland pasture. Since purchase, all forestry has been removed and irrigation added (115 ha pivot, 3 ha long line laterals and 10 ha fixed grid). Increasing Phosphorus levels and raising the pH of soils were a major challenge for the property. The farm was converted to dairy in 2009 and has milked between 490 and 520 cows since (3.6 cows/eff. ha). The farm achieves production of 490-500 kg milksolids per cow or 1750 – 1800 per ha. Twenty neighbouring hectares are leased (lateral irrigator).

Physical Resources – Karetu Farm:

<table>
<tr><th></th><th>Karetu Farm description</th></tr>
<tr><td>Land</td><td>Total area is 166 ha, including 144.7 ha owned and 19.35 ha leased from J & M Foster
The effective area varies slightly every year depending on cropping used for wintering
During the last 4 seasons it has been 144 ha effective
The rest of the area is ineffective or in winter crops.</td></tr>
<tr><td>Soils</td><td>Soil Fertility: pH 5.9, p 27, k 6.2, s 5
Average PAW *: 64 (very free draining and vulnerable to drainage and hence N leaching.
<table>
<tr><th>Soil Types:</th><th>% area</th><th>PAW*(mm)</th><th>Drainage (mm/ha/yr)</th></tr>
<tr><td>Rangitata 11a.1</td><td>43%</td><td>PAW 78</td><td>300 mm (Sprayline)
229 mm (Pivot)
198 mm (Solid Set)</td></tr>
<tr><td>Rakaia 1a.1</td><td>3.8%</td><td>PAW 78</td><td>261 mm (Pivot)
271 (Solid Set)
291 mm (Dryland)</td></tr>
<tr><td>Rakaia 2a.1</td><td>25%</td><td>PAW 54</td><td>433 mm (Sprayline)
305 mm (Pivot)
236 mm (Dryland)</td></tr>
<tr><td>Feredays 3a.1</td><td>17%</td><td>PAW 78</td><td>273 mm (Sprayline)
207 mm (Pivot)
179 mm (Solid Set)</td></tr>
<tr><td>Kyla 14a.1</td><td>11.2%</td><td>PAW 36</td><td>340 mm (Pivot)</td></tr>
</table>
*PAW$_{0-60}$ Is the profile available water in the first 0-60cm. 63mm and 48mm PAW are very low water holding capacity soils
** Drainage as estimated by Overseer</td></tr>
<tr><td>Rainfall</td><td>625 mm/yr</td></tr>
<tr><td>Irrigation</td><td>Owned land 134ha irrigated (116 ha Pivot, 10.4 ha fixed grid, 3.65 ha dry winter oats, 4 ha long line laterals)
Leased land 19.35 ha linear
Water Rights: CRC 060975 65.5 litres per second from a well 100m deep, part of North Rakaia partnership. Bore consent CRC 122201
50 litres per second from Feredays river scheme CRC 146040</td></tr>
<tr><td>Effluent</td><td>Storage for up to 20 days spread onto 33 ha through 2 Plucks irrigators
Effluent consent CRC 091613</td></tr>
<tr><td>Cowshed and Buildings</td><td>50 bale rotary shed, milfos plant (2009), round yard for 600 cows
7 bay hay/calf shed, 4 bay shed, cattle yards / 27 Paddocks</td></tr>
</table>

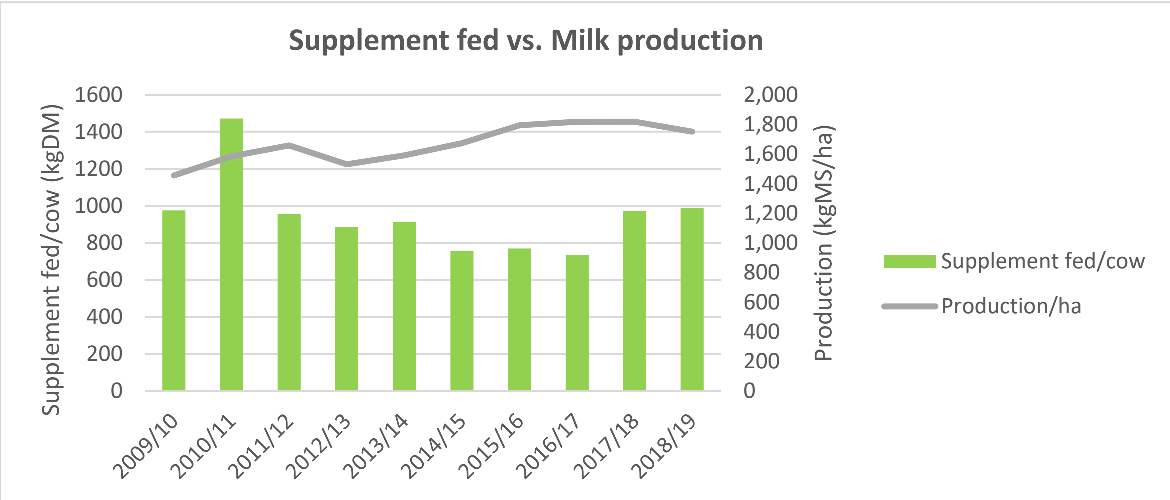
Farm System Overview

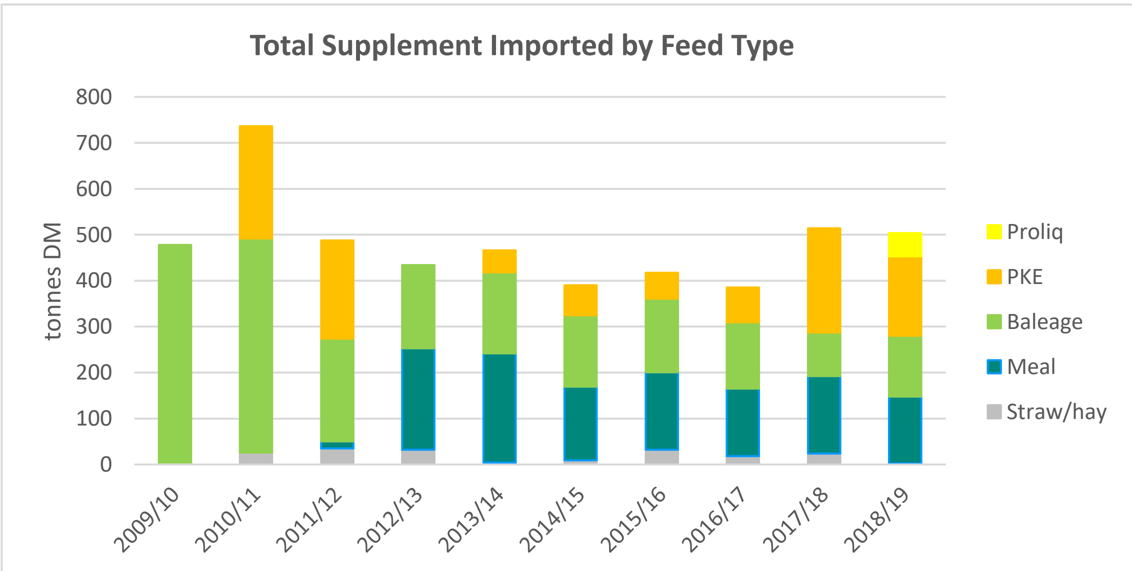
The farm system run at Karetu farm has been reasonable steady, with a stocking rate between 3.5-3.7 cows per ha and above average per cow production. Cows are wintered off the milking platform area but within the Alderbrook business. Cows will be at winter grazing for about 60 days and are offered about 12 kg kale and 2.5 kg baleage DM/cow/day. In the past some of the herd was wintered on the farm on Fodder Beet. Table 1 and 2 present some key trends over time.

The milking platform grows 5 ha of kale for late winter and 5 ha annual ryegrass for early winter. An additional two paddocks are re-grassed each year. Nearly 4 ha of dryland is fallowed and drilled in oats for spring grazing. Fodder beet has been grown in the past with cows wintered on the platform, however this no longer happens.

Table 1: Karetu Farm Ltd Physical Performance Summary from 2009/10 to 2016/17

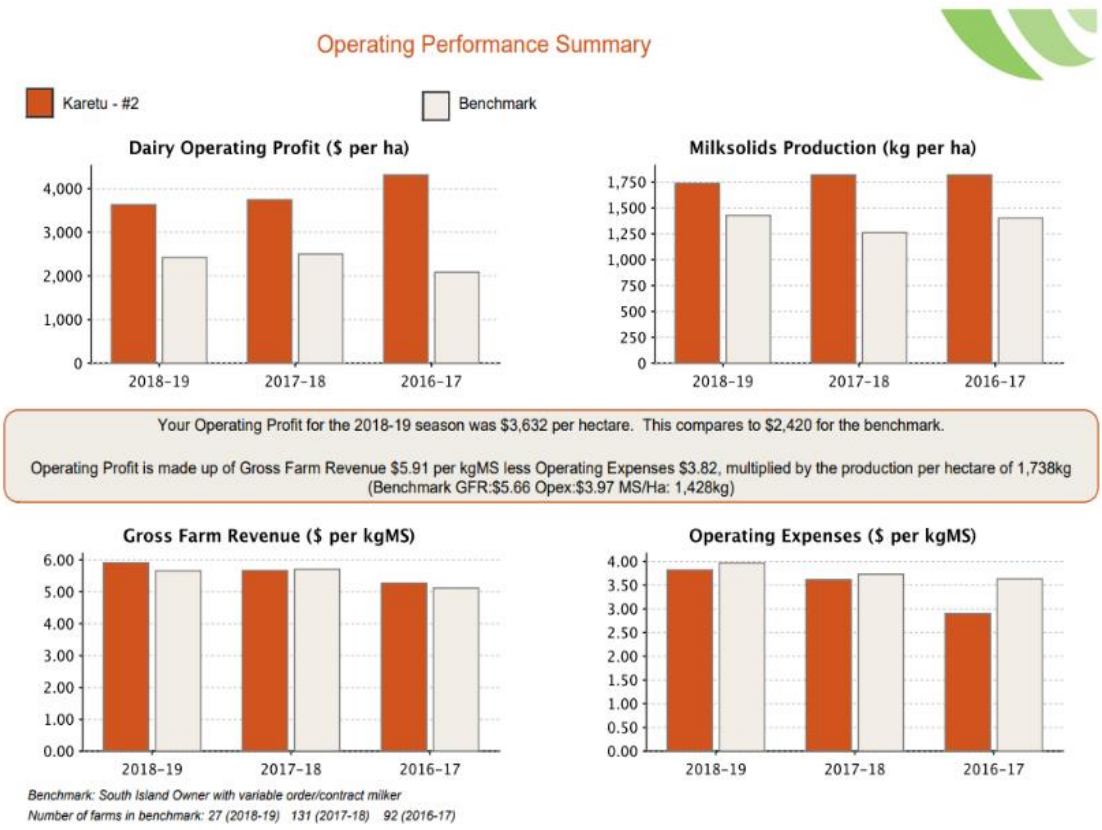
	2009/10	**2010/11**	**2011/12**	**2012/13**	**2013/14**	**2014/15**	**2015/16**	**2016/17**	**2017/18**	**2018/19**
Ha (eff)	136	136	142	147	148	148	144	144	144	144
Cows	490	500	510	490	510	515	515	525	527	510
Cows/ha	3.6	3.7	3.6	3.3	3.5	3.5	3.6	3.7	3.7	3.5
Kg MS	197,932	215,600	234,996	224,897	235,281	247,701	258,563	261,787	261,829	253,767
Kg MS/ha	1,455	1,585	1,659	1,530	1,590	1,674	1,795	1,817	1,818	1,750
Kg Ms/cow	404	431	461	459	461	481	502	499	497	498

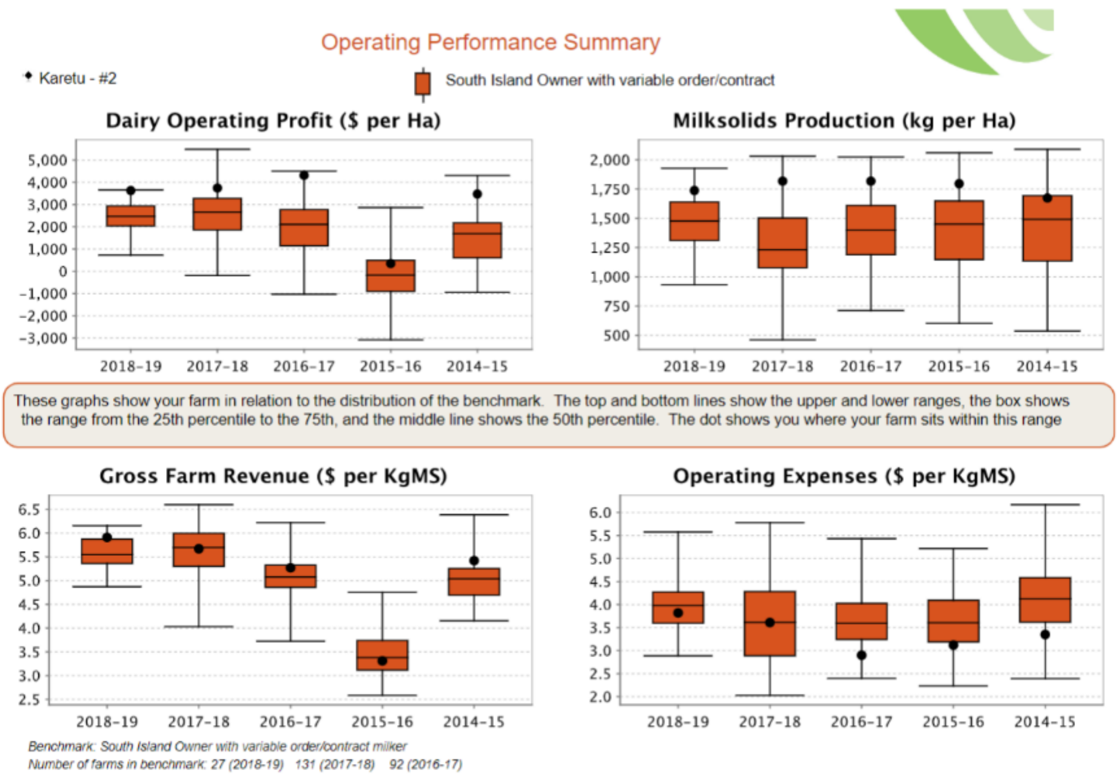




Financial Performance

Information as entered on DairyBase





Fertility Focus 2019: Seasonal

Alderbrook Farm Ltd - Karetu # 2

Report date:	19/02/20
PTPT:	FRDB
Herd Code:	6/34239
No of cows included:	527
These cows calved between:	14/06/19 and 20/12/19
Mating start & end date: (based on AB or pregnancy test data)	22/10/19 - 10/01/20
Next planned start of calving:	30/07/20
Duration of mating:	81 days
Duration of AB period:	81 days

incalf FERTILITY FOCUS

Version 3.01

DairyNZ

LIC

1 Overall herd reproductive performance

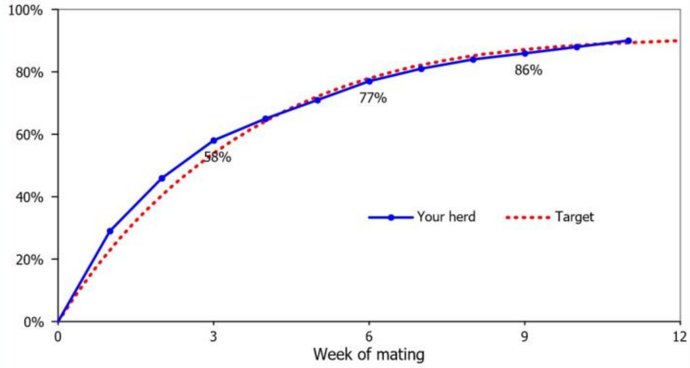
6-week in-calf rate
Percentage of cows pregnant in the first 6 weeks of mating

Your herd	77%	☆☆☆☆☆
Aim above	78%	

Not-in-calf rate
Percentage of cows not pregnant after 81 days of mating

Your herd	9%	☆☆☆☆☆
Aim for	10%	

% of herd in calf
Cumulative by week of mating



2 Drivers of the 6-week in-calf rate

3-week submission rate
% of cows that were inseminated in the first 3 weeks of mating

Your herd	94%	☆☆☆☆☆
Aim above	90%	

Non-return rate
% of inseminations that were not followed by a return to heat

Your herd		
Aim above		

Conception rate
% of inseminations that resulted in a confirmed pregnancy

Your herd	60%	☆☆☆☆☆
Aim above	60%	

3 Key indicators to areas for improvement

Calving pattern of first calvers
Well managed heifers get in calf quickly and calve early.

Calved by	Week 3	Week 6
Your herd	79%	91%
Aim above	80%	95%
	☆☆☆☆☆	☆

Calving pattern of whole herd
Did late calvers reduce in-calf rates?

Calved by	Week 3	Week 6	Week 9
Your herd	65%	86%	98%
Aim above	67%	88%	98%
	☆☆☆	☆☆☆	☆☆☆☆☆

Pre-mating heats
A high % of well managed cows will cycle before the start of mating.

Your herd	63%	☆
Aim above	85%	

3-week submission rate of first calvers
Well managed heifers cycle early

Your herd	95%	☆☆☆☆☆
Aim above	90%	

Heat detection
A high % of early-calved mature cows should be inseminated in the first 3 weeks of mating.

Your herd	95%	☆☆☆☆☆
Aim above	95%	

Non-cycling cows
Treated non-cyclers get in calf earlier.

Treated	By MSD	Wks 1-3	Wks 4-6
Your herd	0%	0%	0%

Rating	What does it tell me?	What should I do?
☆☆☆☆☆	Top result	Ideal - keep up the good work!
☆☆☆	Above average	Getting there - focus on getting the details right.
☆	Below average	Plenty of room to improve - seek professional advice.
	No result	Not enough information provided - seek help with records.

Performance after week 6
Expected not-in-calf rate helps assess management affecting performance after week 6 (including bull management and herd nutrition).

	Not-in-calf rate	
Your herd	9%	OK
Expected	12%	

N Loss Targets and Mitigation strategies Karetu (AgriMagic)

N Leaching loss Alderbrook farm

Overseer modelled leaching losses from the bottom of the root zone during the baseline period of 2009-12 was 98 kg N per hectare. Current losses remain the same as the baseline for this farm. In the Selwyn-Waihora catchment, dairy farms are required to reduce N loss by 30% by 2022. Because Karetu is farmed in conjunction with other properties in the Selwyn Catchment, the farming land use consent conditions relating to reductions required are for the whole farming enterprise. Because other properties in the portfolio have made reductions greater than 30%, collectively the business is on track to achieve reductions, however Karetu does not contribute to the reduction.

All OverseerFM modelling and scenario analysis have been done by AgriMagic Limited. The information contained in this section has been extracted from the modelling work and reports produced by AgriMagic.

Table 2: N Loss for all farms Included on Enterprise consent

	2009/10	2010/11	2011/12	2012/13	BL Av	2017/18
Alderbrook Kg N Toral /yr	39,247	34,958	21,946	22,723	29,719	17,538
Alderbrook av Kg N/ha/yr	165	147	92	95	125	68
Alderbrook addition Kg N Toral /yr					2,890	
Alderbrookaddition Av Kg N/ha/yr					173	
Karetu Kg N Toral /yr					16,069	16,069
Karetu Av Kg N/ha/yr					98	98
Cowans Road Kg N Toral /yr	5,372	n/a	5,825	7,882	6,360	5,933
Cowans Road Av Kg N/ha/yr	49	n/a	53	72	58	55
Feredays Road Kg N Toral /yr					562	169
Feredays Road Av Kg N/ha/yr					35	10
Total Enterprised Kg N Toral /yr					55,590	39,709
Total Enterprised Av Kg N/ha/yr					102	72
% Reduction Required by 2022						**27%**
% Reduction achieved						**29%**

Table 2 shows the detail of the N loss from all farms included in the enterprise consent. The whole business (dairies and support) require a reduction of 27% from the baseline, and it has achieved 29% already.

N Leaching loss Karetu Farm (proof of concept)

If this farm was forced to operate on a standalone basis for N leaching, then it would no longer be possible to operate the present system. Over the years, several scenarios have been modelled to reduce losses at Karetu. Reducing cow numbers from 527 cows to 500 cows would result in a reduction of 3 kg/ha. Adding additional storage to the effluent system reduced N loss by 2 kg/ha. Reducing crops grown and thus less wintering on the property reduced N by 5 kg/ha (partially adopted for this winter). Increasing the effluent area and reducing nitrogen applications would also make small reductions. Although these changes did indicate a reduction in modelled N loss, the gains were not enough to meet the target. Housing cows during "high risk" period could allow the farm to meet the reduction targets for this property and enable it to stand alone in the future if the rules change.

Composting Barn Scenario

Housing comes with a new set of potential problems, these include:

- Cost of infrastructure (including R&M) and its effect on profitability
- Animal welfare if cattle spend long periods on concrete or other hard materials
- Potential for increased levels of mastitis if sheds are not managed properly
- Developing operating systems that still take advantage of pasture while incorporating housing of stock during key N leeching months

Anecdotal evidence suggests that composting barns are more animal friendly and less costly to build. The purpose of this analysis is to develop a system that incorporates a composting barn into this farm, to assess the environmental effects and predict the profitability of the new farming operation. The owners of the farm do not wish to milk the year round; thus, the purpose of this analysis is to develop a barn system while maintaining the advantages of the NZ seasonal production system.

Composting Barn System Parameters

There will be a total of 545 cows and heifers to calve each spring (an increase of 30 cows over the present system). Losses (5) and culling (about 90) will reduce the herd size before April 1st each season. Calves born will leave the property in December of their year of birth and not return until July 20th before calving as 2-year olds. The R2 replacement heifers will not be on the property over winter.

- Composting barn to house 450 cows at night from March 1, hospital cows will remain on pasture
- The 450 milking cows in the barns (150 per barn) will graze pastures for 8 hours (8 kgDM) and fodder beet for 2 hours (3-4 kgDM) and then be in the shed at night with silage (4 kgDM). Concentrates are fed in the milking shed (2 kgDM).
- Cows milked twice a day
- No cows are milked from June 1 to August 1.
- All cows dried off on May 31st and 20 culled to have a wintering herd in barns of 430 cows.
- When the herd is dried off cows are housed in the shed 24 hours per day receiving 4 kgDM grass silage (37.5 cents/kgDM) and 5 kgDM of maize silage or fodder beet (lifted) and remain in the barn over the winter. It is estimated that maize silage or lifted fodder beets costs 28 cent/kgDM
- The first half of cows (272) to calve in August will be housed for 31 days. They will graze pasture for 10 hours (10 kgDM), be in the sheds at night with silage (6 kgDM) and receive 2 kgDM supplement in the milking shed. Later calving cows will graze kale.

Table 3: Capital costs:

Infrastructure	Cost	Amortization
Barns	675,000	
20-year amortisation (5%)		54,169
Extra machinery	100,000	
10-year amortisation (5%)		12,950
Total Cost	775,000	**67,119**

Capital costs consist primarily of the housing structure. The cost of the barn was sourced from a rural building contractor at $1,500 per cow (450 cows x $1,500 = $675,000). There will be 3 barns built each housing 150 cows and measuring 120 x10 m. Alternative systems are estimated at costing up to $3,000 per cow. These barns include concrete shed aprons and a silage/beet storage facility. The system proposed for this operation will require a silage wagon, a larger tractor than at present and a small tractor and implement for 'working' the compost, with a total estimated cost of $100,000.

Table 4 Feeding systems costs:

feed - both systems				
grain	$ 32,800			
silage	$ 45,870			
pke	$ 42,250			
fodder beet	$ 20,250			
kale	$ 10,200			
calf grazing	$ 24,375			
yearling grazing	$ 81,250			
total	$ 256,995			
winter grazing - as is	$ 70,000	$25/cow/week for 7 weeks		
barn wintering	$ 34,572	winter silage	4kg/cow/day	
	$ 36,120	maize/fodder beet	5kg/cow/day	
total	$ 70,692	$ 130	per cow/cow/day	
august milkers	kg silage in shed is the same as what would be fed outside			

The amount of supplementary feed required for the "as is" systems is based on Farmax modelling of the system run in the 2017-18 season (Savage 2018). Feed has been costed at commercial rates. The farm grazes young stock and winters cows on a support block owned by the farm. However, in this case market rates are charged for animals grazed away from the dairy farm.

In the 'barn fed' system, more cows are milked, and the feed costs have been adjusted proportionally on a per cow basis. The per cow feed cost for the milking season is $511/cow for both systems.

The cost of grazing the herd off the property in winter in the "as is" system is very similar to the extra cost of the level of feed used during winter in the barn system.

There is an additional cost for bedding in the composting barn. Bedding is estimated to cost $80 per cow or $36,000.

Table 5: Whole farm budget:

	as is		barn	
cows wintered June 1 - August 1	400	*	430	*
peak cows	515		545	
cows milked (barn) April 1 - May 31	450		450	
cows in barn August 1 - August 31	225		225	
area	144		144	
total production	257,500		272,500	
per cow	500		500	
stocking rate	3.58		3.78	
gross milk sales	$ 1,545,000		$ 1,635,000	
less levies	$ 18,025		$ 19,075	
stock sales	$ 100,000		$ 105,800	
other income	$ 20,000		$ 20,000	
total	$ 1,646,975		$ 1,741,725	
		per cow		
labour	$ 175,000	$ 340	$ 175,000	
animal health	$ 56,650	$ 110	$ 59,950	
herd improvement	$ 32,445	$ 63	$ 34,335	
farm dairy	$ 20,000	$ 39	$ 21,165	
shed power	$ 10,000	$ 19	$ 10,583	
feed expense -season	$ 256,995	$ 499	$ 271,966	
feed expense - winter	$ 70,000	$ 136	$ 70,692	
fertiliser	$ 36,030	$ 70	$ 36,030	**
nitrogen	$ 77,506	$ 150	$ 71,026	***
irrigation	$ 54,806	$ 106	$ 54,806	
regrassing	$ 28,961	$ 56	$ 28,961	
weed & pest	$ 20,250	$ 39	$ 20,250	
vehicles - bikes, utes	$ 10,000	$ 19	$ 10,000	
fuel	$ 7,500	$ 15	$ 9,000	
r&m - land + buildings	$ 79,015	$ 153	$ 89,015	
r&m - plant + eqpt.	$ 16,407	$ 32	$ 21,407	
bedding	$ -	$ -	$ 34,400	
freight	$ 2,252		$ 2,252	
administration	$ 32,096	$ 62	$ 32,096	
insurance	$ 14,602	$ 28	$ 19,602	
rates	$ 12,243	$ 24	$ 13,500	
total	$ 1,012,758		$ 1,086,035	
ebitd	$ 634,217		$ 655,690	
less depreciation - present assets	$ 75,797		$ 75,797	
less present interest	$ 178,085		$ 178,085	
p + I for barn and machinery			$ 65,113	
taxable income	$ 508,556		$ 383,576	
tax	$ 142,396		$ 107,401	
free cash	$ 313,736		$ 305,091	
based on 2017-18 year expenses				
* 125 r 2 Year heifers grazed off prior to calving				
** capital fertilizer cost not reduced by using shed bedding				
** * N usage reduced by compost spreading of $6480				

Effect on Profitability

Comparative budgets suggest that free cash is about $8,000 lower in the barn system. The extra 30 cows milked in the barn system increases production from 257,500 kg ms to 272,000 kg ms for the season. This increases income at a milk price of $6/kgms by nearly $95,000. However, the barn system increases some working expenses that are associated to with animal numbers due to increased cow numbers (feed, farm dairy, power, vehicle, fuel and repairs & maintenance). Bedding at $34,000 is a significant barn cost. A credit for nitrogen from the shed reduces nitrogen fertilizer costs by $6,480. The increased interest and principal paid for the shed and machinery further reduces the free cash result.

Overseer Modelling

OVERSEER modelling has been carried out to represent the composting barn scenario. Farm inputs have been based on the 2017-18 farm system previously modelled and updated to match information provided in the composting barn parameters above.

- Structure was a covered wintering pad
- Barn lined with sawdust
- All effluent exported except for off feeding apron to represent effluent being composted. Effluent off feeding apron was included as part of the existing effluent system
- Compost reimported as fertiliser to represent annual clean out of sawdust. Spread @1.2 T/ha (37% DM with Nitrogen content of 0.67%) Nitrogen = 3 kg/ha. Then the total N value from compost is $6480 (modelling of compost barn based on Durie, 2018).

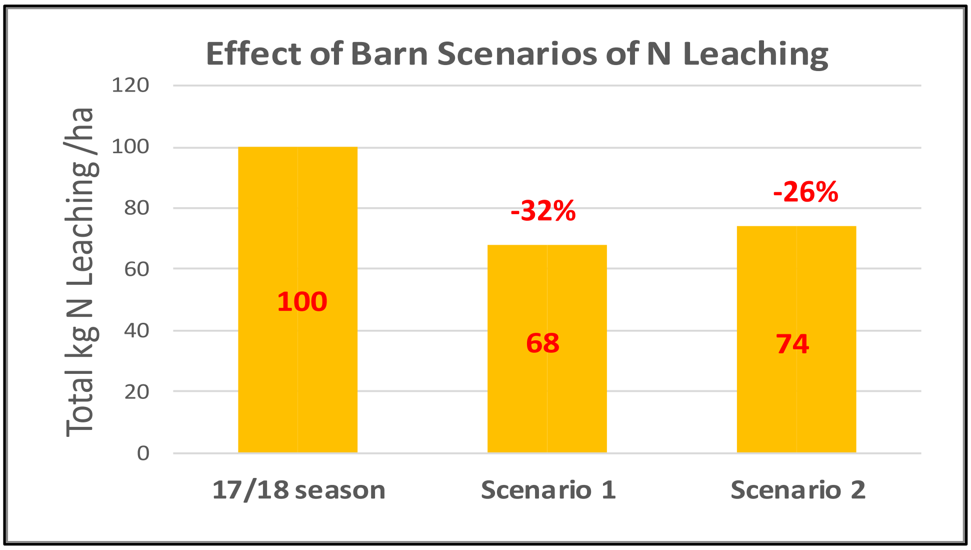
N Leaching in OVERSEER

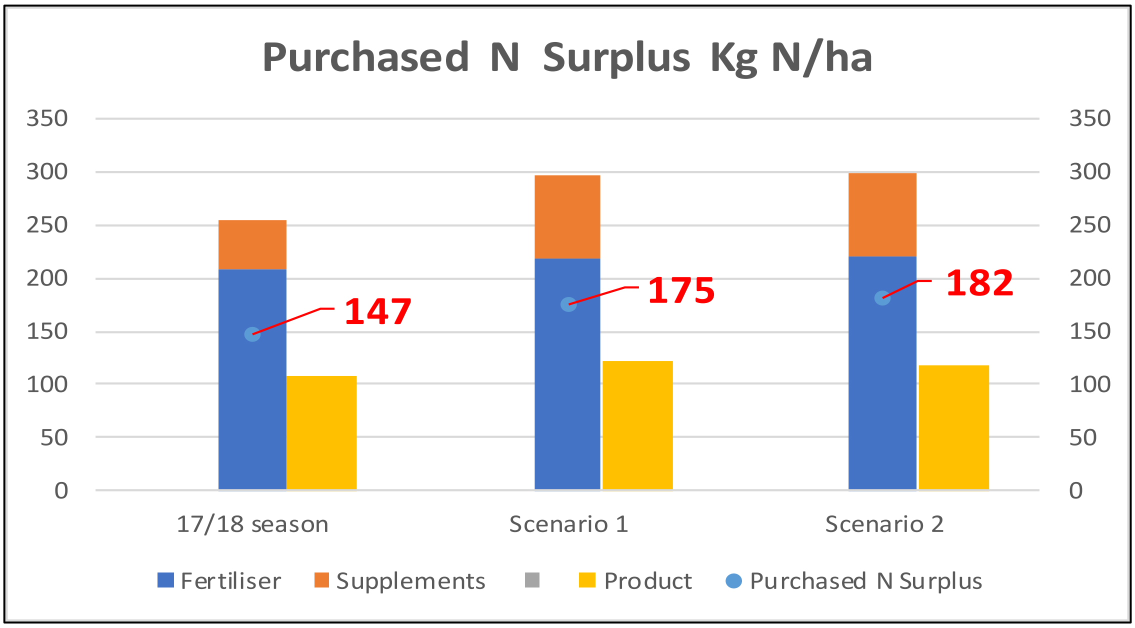
- The Baseline (2009-13) nitrogen loss in OVERSEER V6.3.1 was 98 kg N/ha/yr
- 2017/18 nitrogen loss in OVERSEER V6.3.2 was 100 kg N/ha/yr
- Composting barn scenario has reduced nitrogen losses to 68 kg N/ha/yr (V6.3.2).

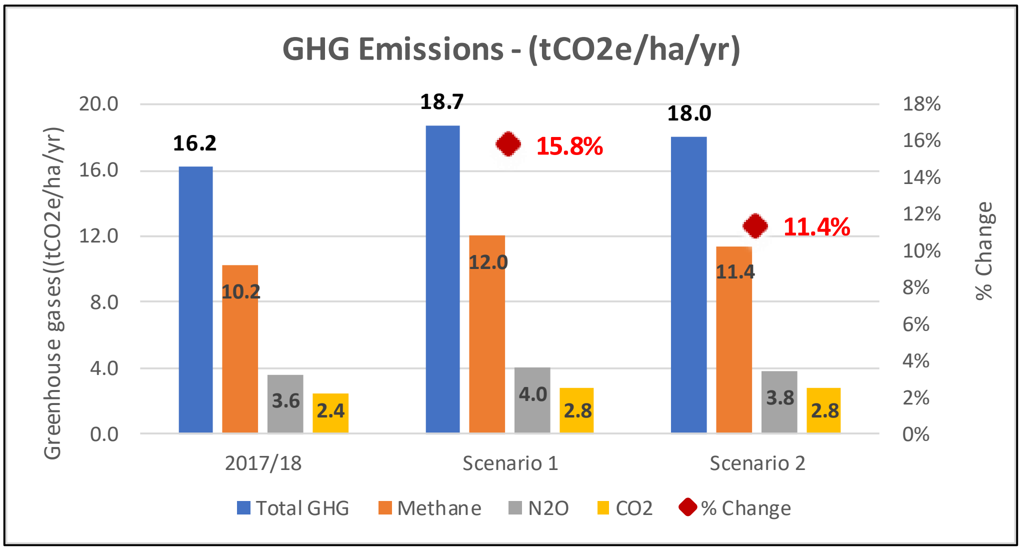
N Leaching from the root Zone (0-60 cm)

Table 6 Scenario impact on environmental footprint

	Season 17/18	Scenario 1	Scenario 2
Farm parameters			
Total area (ha)	164.2	164.2	164.2
Effective area (ha)	159.9	159.9	159.9
Production (kg ms)	261,829	289,400	274,402
Nitrogen			
Total Farm N Loss (kg N)	16,468	11,110	12,145
N Loss/ha (kg N/ha)	100	68	74
N Surplus^{OSFM} (kg N/ha)	292	278	289
N conversión efficiency (%)	27%	43%	39%
Greenhouse gases			
Total GHG (kgCO2e/ha/yr)	16,164	18,721	18,002
Methane (kg CO2e/ha/yr)	10,171	11,980	11,425
N2O (kg CO2e/ha/yr)	3,634	3,965	3,822
CO2 (kg CO2e/ha/yr)	2,389	2,776	2,755
Change from 18/19			
N leaching (%)		-32%	-26%
GHG losses (%)		+15.8	+11.4


Effect of Barn Scenarios of N Leaching
Total kg N Leaching /ha
120
100
80
60
40
20
0
100
-32%
68
-26%
74
17/18 season
Scenario 1
Scenario 2


Purchased N Surplus Kg N/ha
350
300
250
200
150
100
50
0
147
175
182
17/18 season
Scenario 1
Scenario 2
Fertiliser
Supplements
Product
Purchased N Surplus


GHG Emissions - (tCO2e/ha/yr)
Greenhouse gases((tCO2e/ha/yr)
20.0
16.0
12.0
8.0
4.0
0.0
16.2
10.2
3.6
2.4
18.7
15.8%
12.0
4.0
2.8
18.0
11.4%
11.4
3.8
2.8
18%
16%
14%
12%
10%
8%
6%
4%
2%
0%
% Change
2017/18
Scenario 1
Scenario 2
Total GHG
Methane
N2O
CO2
% Change

People and animals

Traditional dairy farming systems in New Zealand have featured cows living outside and have kept capital costs for NZ dairy farms lower than competitor dairy industries. Outside systems have been conducive to lower levels of health issues in NZ cattle. It has been suggested that in the future, NZ dairy farmers will receive premiums for operating grass-based systems – this could be affected by incorporating barns. The ability to take a two-month break from milking has been advantageous for recruiting staff and for enticing future farm owners to the industry. The break not only 'recharges batteries', but also allows for repairs and improvements to be made to farms and for staff to have holidays during a period of lower levels of activities. Other areas of concern are for sourcing bedding material and the maintenance of the compost system in the barn.

Conclusions

This analysis projects that N leaching can be reduced from 100 kg/ha to 68 kg per/ha through the incorporation of a barn into this farming system. The reduction meets the 30% reduction required for N leaching in the Selwyn Waihora zone of Canterbury. The proposed barn system has been able to maintain the seasonal, pasture-based system as per the farmer 's desires. However, the farm will incur more debt and the servicing of this debt means that the free cash result will be lower than the current system (-$8,000). Debt levels are a concern for the NZ dairy industry and for some farms borrowing additional capital may not be an option. A 'lower' cost barn system was modelled however, the cost could easily be double the figure used. Likewise, the volatility in milk prices over the past decade would be more difficult to manage if a barn system was financed by additional debt.

With experience in using a barn, farmers may find adaptations to improve profitability – if that is the focus of the business. Experience also suggests that once barns are in place, some enterprises reduce their focus on maximising home-grown feed harvested and profitability declines. It would take discipline to retain the profit focus.

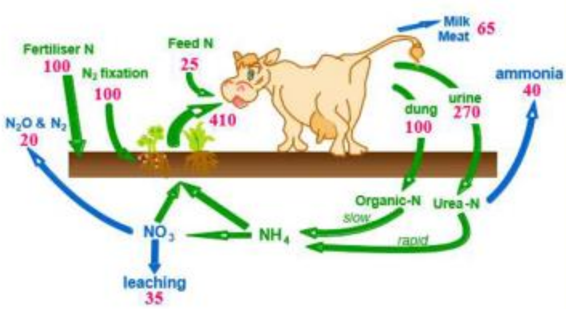
Having cows under cover during adverse weather events (rain, snow, heat) is an animal welfare gain that is difficult to quantify. However, there could be other potential difficulties associated with diseases such as mastitis, pneumonia and other infectious diseases more prevalent in-house systems than grazing systems. The shed could also have other uses, such as a calving shed or for preventing pugging of pastures during cold, wet weather by temporarily housing the milking herd.

If the owner was willing to operate a split calving system and winter milk, the system could be more profitable than the 'as is' system however this was not fully investigated as it is not the preferred option for the current owners.

In the end, this analysis has proven that N leeching can be reduced to meet requirements, but under the proposed system profitability is negatively affected.

Principles of N Leaching

Principles of N Loss – kg N leached/ha



N loss calculated per hectare

1. The cow does not create N; the cow concentrates surplus N mostly in the urine patch
2. Annual N surplus kg/ha strong driver of N loss
3. Timing – need a surplus soluble N & drainage to get N leached

Timing

Reducing N eaten autumn
Lower demand; less N fertiliser especially aut/winter; low N supplement/crop; catch crops; winter active species; plantain to lower N concentration urine

Mineral N

(at Risk of leaching)
Sources: Purchased N Surplus
N released from cultivation

Drainage

Efficient irrigation that doesn't cause drainage

N lost to water

Purchased N Surplus

Purchased N Surplus is a KPI that is strongly correlated to N leaching. It is easily calculated (do not need Overseer) and is under management control.

Purchased N Surplus = N in fertiliser + N supplements - N in product (milk and meat) – N exported supplement

Selwyn Hinds Partner Farm Results

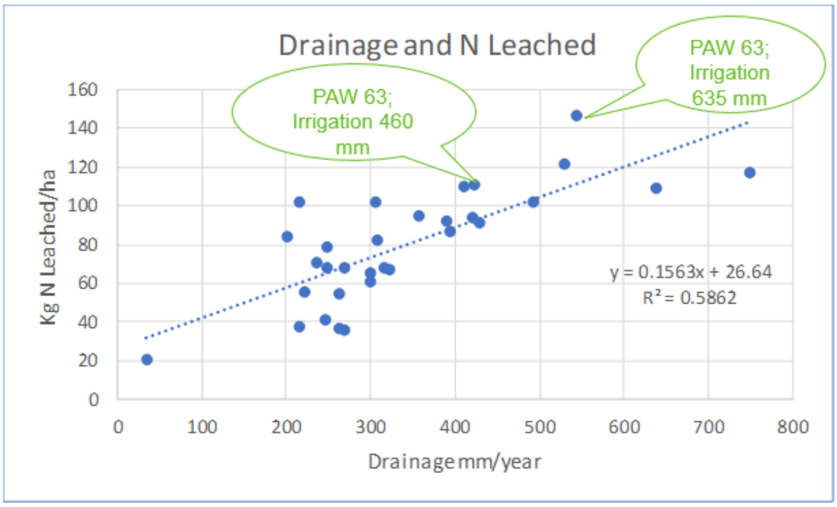
Over the last year we have been working alongside a few farmers in the Selwyn and Hinds catchment to identify the options to reduce the environmental footprint of their farms while maintaining profitability. This section of the handout presents a summary of the information collated so far.

Drainage and N Leaching.

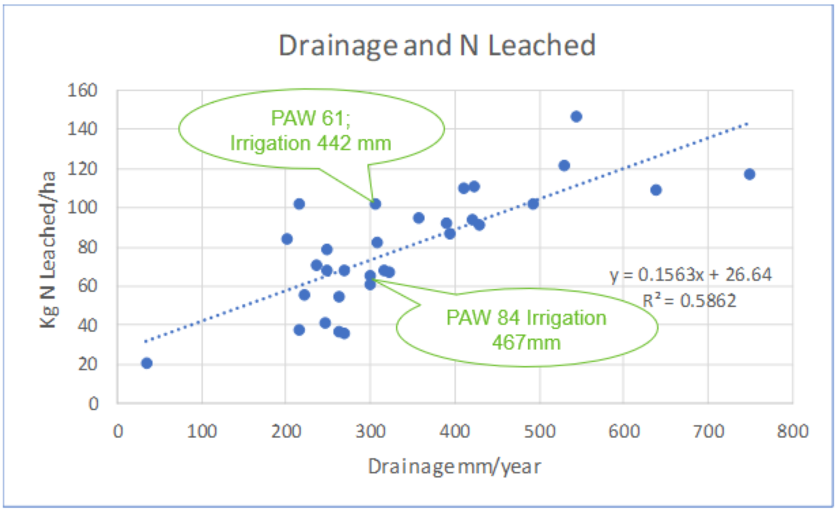
There is a high correlation between N leaching and drainage. The higher the drainage the higher the risk of N leaching given all other conditions are the same. Drainage is mainly driven by rainfall and irrigation. On irrigated farms drainage can be reduced by improving irrigation efficiency. Soil type has a big influence (especially Profile Available Water = PAW). For farms with similar annual drainage but lighter soils (lower PAW), the leaching will be higher.

Drainage (0-60 cm root zone) = Rainfall + Irrigation – Run off – AET (actual Evapotranspiration)

N Leaching and Drainage Hinds and Selwyn Partner Farms



These two farms have soils with the same PAW of 63 but Irrigation applied is significantly different at 460 and 635 mm/ha/year resulting in different N leaching number. There are also other factors influencing the difference in N leaching for these two farms such as the amount of N in the system at risk of being leached.



In contrast, these two farms receive similar amount of irrigation water and hence similar drainage (as rainfall is similar) but have different soil types and consequently, different N leaching /ha.

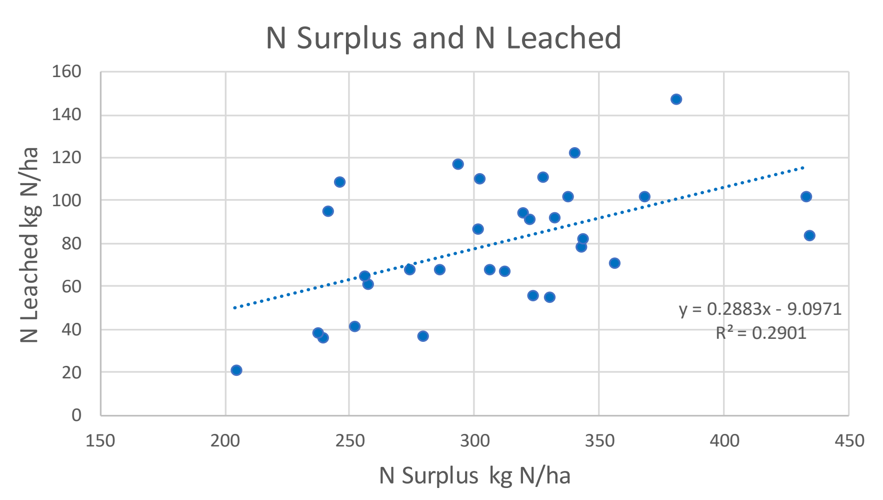
N Surplus (Overseer) and N Leaching.

There is a high correlation between N Surplus and N leaching. N surplus is estimated by Overseer and it is the difference between N in Inputs and N in Outputs.

N Surplus = N Inputs (N Fertilizer + N Supplements + N Irrigation + N Clover) – N Output (N in meat and milk + N in exported feed)

The higher the N surplus the higher the risk of leaching but there are other farm specific factors such as drainage (rain, irrigation and AET) and soil characteristics (PAW) that will affect this relationship.

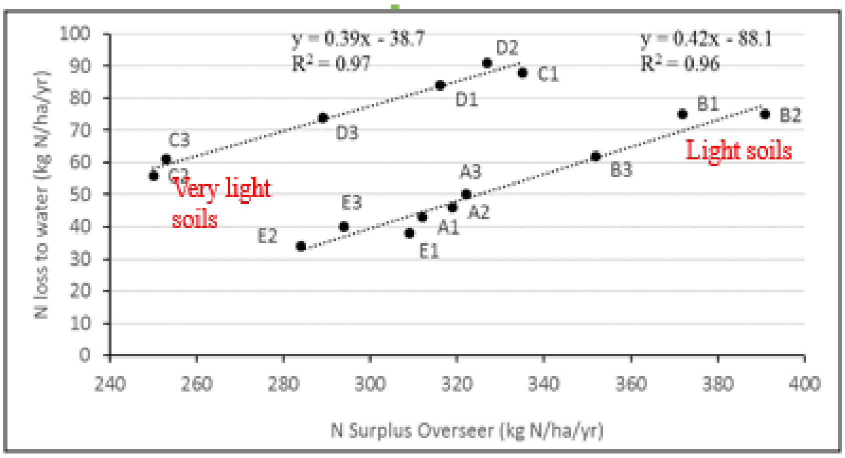
Overseer N Surplus and N Leaching – Hinds and Selwyn Partner Farms



N leaching range from 20 kg N/ha/year to 145 kg N/ha/year. This dataset contains data from more than one year for some farms. R^2 is lower as there are other factors influencing this result. Similarly, the range on N surplus is quite wide from 200 to 440 kg N/ha/yr.

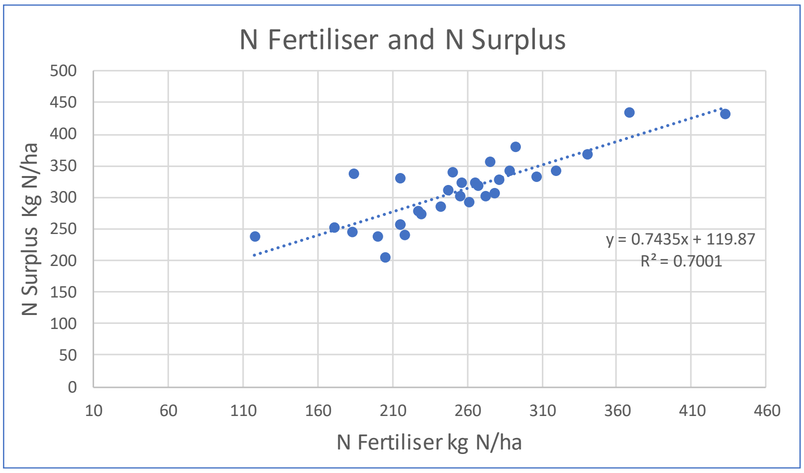
The correlation is very strong (as can be seen in the graphs below) if we consider N surplus for the same farm across years or for group of farms in similar location and similar soil characteristics.

Overseer N Surplus and N Leaching – FRNL Monitor grouped by soil type



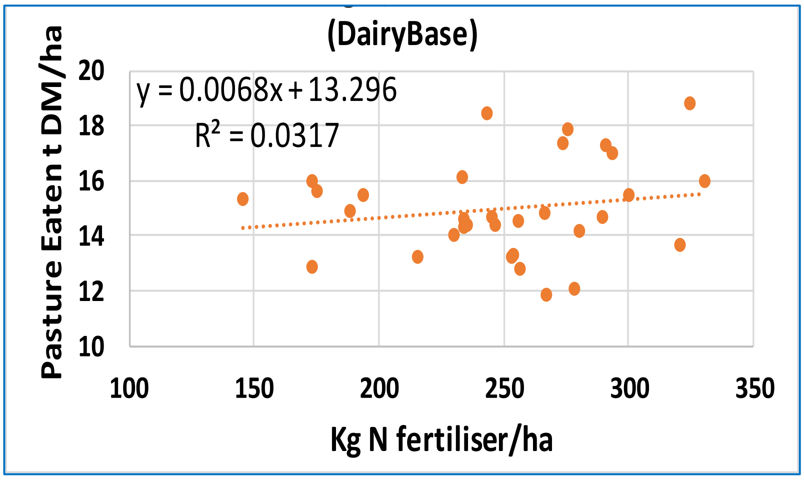
There is a strong relationship between N surplus and N leaching and the correlation is stronger for lighter soils (as N surplus is at higher risk of being lost to water given the same drainage.

N Fertiliser Use and N Surplus (Overseer) – Hinds and Selwyn Partner Farms



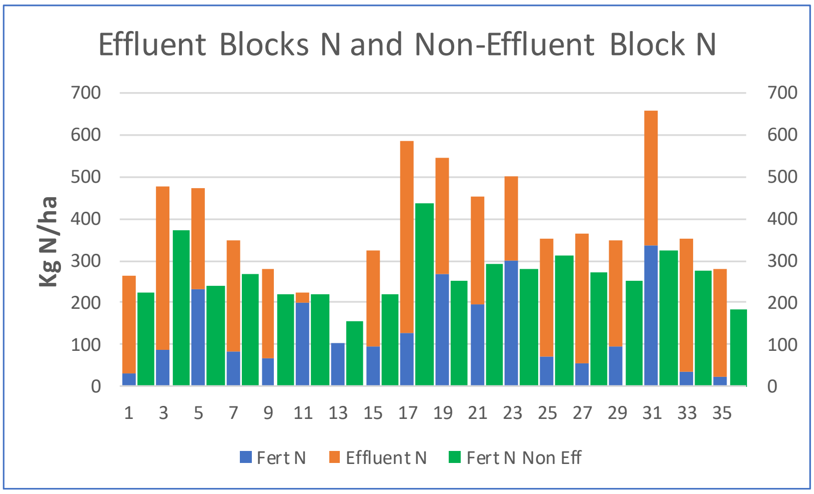
There is a strong relationship between N Fertiliser and N Surplus. The biggest driver of N surplus is N in Inputs (including N in fertilisers). Unless there Is a significant change in production system, it is not likely to change N surplus by changing N in Products.

N Fertiliser Use and Pasture Harvested (TDM/ha) Canterbury Data 2017/18 (Dairy Base)



There is nearly no correlation between N input from fertiliser and pasture eaten per ha which shows an opportunity to grown and harvest more pasture with less N applied in some farms.

Effluent Block N and Non-Effluent Block N – Hinds and Selwyn Partner farms

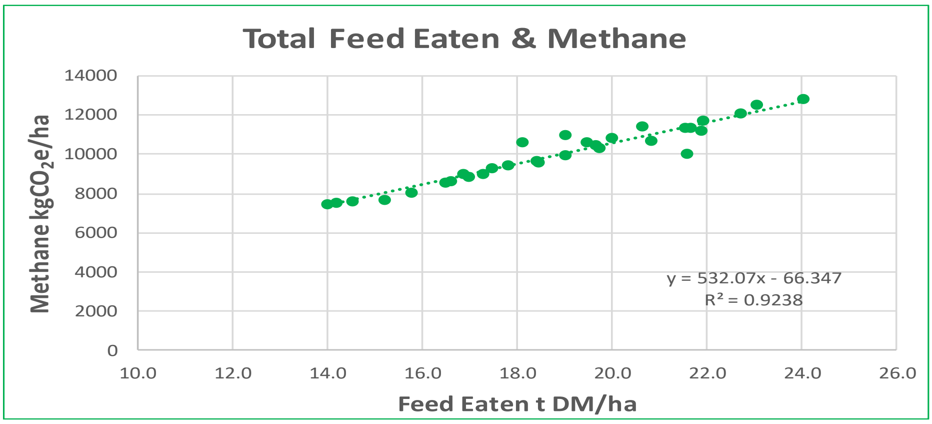


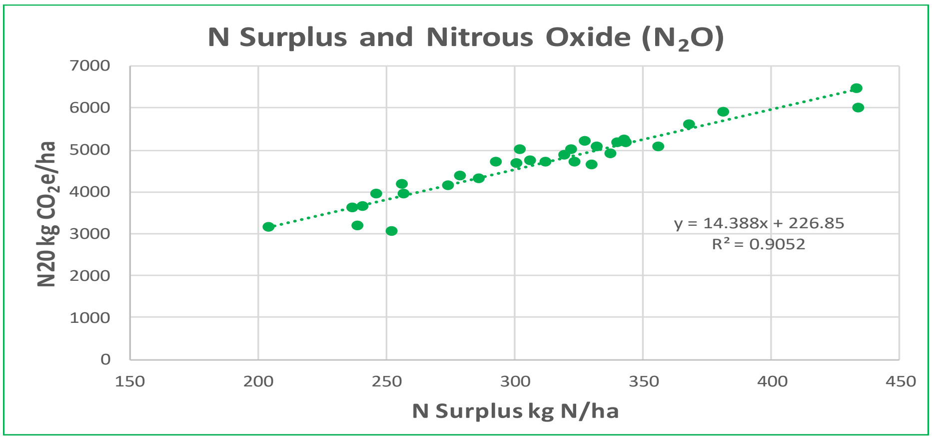
One of the opportunities to reduce N fertiliser and maintain pasture production is better utilisation of N from effluent and reducing N inputs on these blocks.

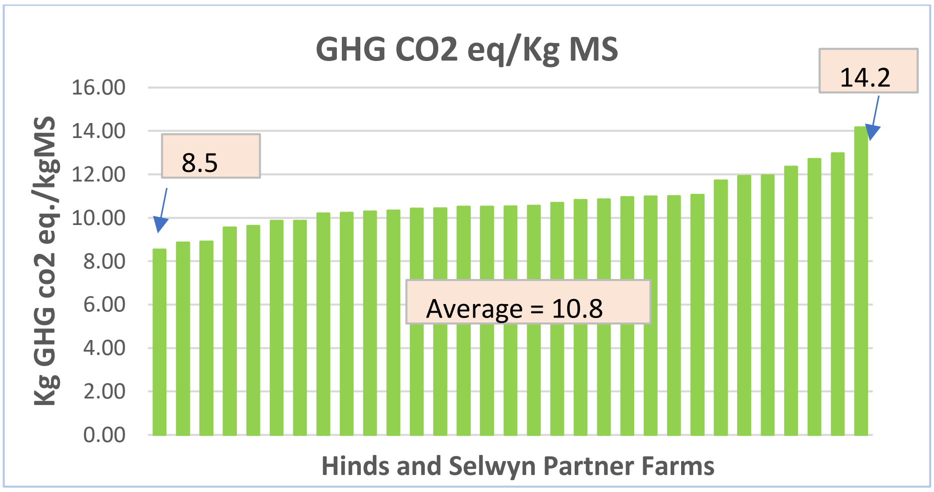
GHG

The main contributor in a dairy farm of GHG is methane which in turn is driven by dry matter intake (DMI). This is directly related to milks solids production.

The other GHG that farmers can influence in nitrous oxide (N2O). The main driver of N2O is N surplus and N intake, hence N fertiliser and N in supplement.







KEY MESSAGES

1. Know the numbers for your farm
2. Understand your regulation requirements
    a. Consents
    b. Audit
    c. Nutrient limits e.g. Selwyn 30% reduction in N loss for dairy farmland by 2030
3. Understand the key drivers for your farm for N and P loss
4. Explore your options and understand the reduction in N leached of each mitigation (not a bundle of mitigations where possible)
5. Develop a plan when you have identified the changes selected for your farm to be compliant by deadline as:
    a. Investments take time to plan, finance and implement
    b. Changes in farm system (e.g. stocking rate and N fertiliser use) need time to be imbedded
6. Stay focused on profit as profit is essential to having a sustainable business to:
    a. Be able to make changes to reduce environment footprint and
    b. Meet your goals
7. Effluent need system that meets consent and makes it easy to reduce fertiliser N applied (i.e. not part paddocks)
8. Use effluent N as a fertiliser to reduce N leached (recycling of Nitrogen)
9. With GHG on the horizon know your:
    a. GHG CO2 eq. /ha
    b. GHG CO2 eq./kg MS
10. Know the numbers for the key drivers of GHG for your farm
    a. Dry matter intake (as calculated by overseer) and
    b. N Surplus/Purchased N Surplus