Monitor farm case study

Canlac Holdings 2014/15 – 2018/19

Forages for Reduced Nitrate Leaching

Case study of Canlac Holdings

Changes implemented and farm performance between 2014/15 and 2018/19

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Forages for Reduced Nitrate Leaching was a DairyNZ-led collaborative research programme across the primary sector delivering science for better farming and environmental outcomes, aimed at reducing nitrate leaching through research into diverse pasture species and crops for dairy, arable and sheep and beef farms. The main funder was the Ministry of Business, Innovation and Employment, with co-funding from research partners DairyNZ, AgResearch, Plant & Food Research, Lincoln University, Foundation for Arable Research and Manaaki Whenua-Landcare Research.

Ministry of Business, Innovation & Employment

DairyNZ

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Plant & Food RESEARCH

Lincoln University

FRNL Monitor Farm Canlac Holdings proves that increased profit and reduced nitrate leaching is possible

Key results

- Significant reductions in nitrate leaching and purchased nitrogen (N) surplus were achieved while profit was maintained using a stepwise approach over five years.
- The local regional council target of a 30% reduction in N leaching from baseline at Good Management Practice (GMP baseline) by 2022 was achieved four years into the Forages for Reduced Nitrate Leaching programme (FRNL).
- Nitrate leaching was reduced by 36% and purchased N surplus was reduced by 52% from the start of FRNL, using a combination of reduced N fertiliser and switching high N feeds (pasture silage) for low N feeds (maize silage and fodder beet).
- A focus on pasture management meant that pasture harvested was maintained despite a 35% reduction in N fertiliser over three years.
- Establishment of fodder beet on the milking platform provided a cheap low N feed in autumn and replaced high N pasture silage normally used as a means of extending round length.
- Catch crops grown after autumn-grazed fodder beet provide additional grazing in early spring. However, establishment of new permanent pasture after grazing the oats, was delayed by eight weeks.
- Plantain/ryegrass/clover pastures appeared to achieve the same production as ryegrass/clover pastures.
- Plantain was successfully established into existing pastures by direct drilling in December. Although plant numbers were low, plantain made up 10-20% of dry matter once the plants were mature.
- Cost control, good pasture management, efficient use of feed and fertiliser, and high net stock income all contributed to maintaining exceptional profitability while making significant reductions in N leaching.

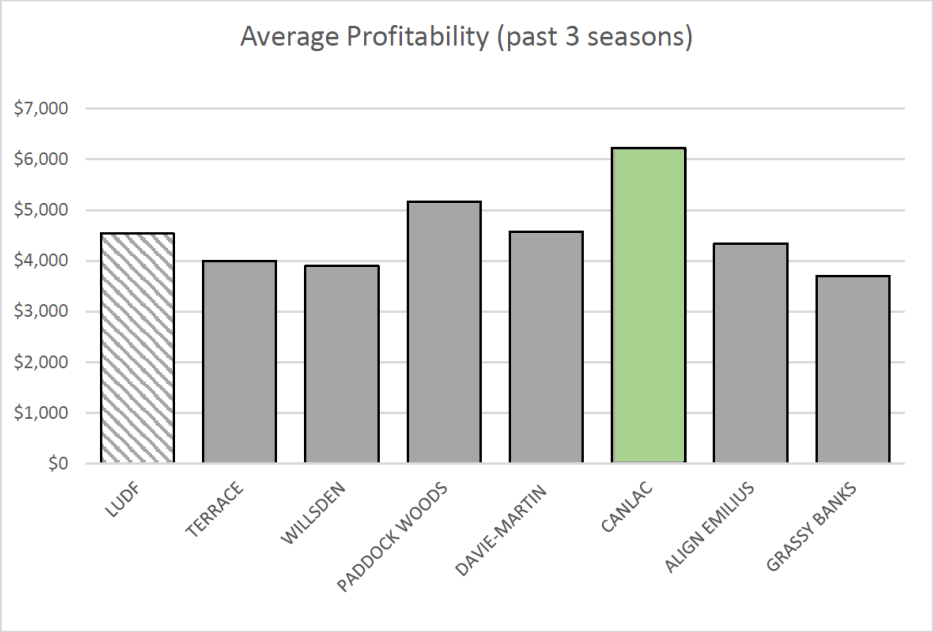
At Canlac Holdings, Tony Coltman and Dana Carver have a vision: "To be leaders in the dairy industry in all areas by excelling with top 5% production, top 5% financial returns, an aesthetically well-presented farm, all environmental standards exceeded, and happy and healthy staff."

Canlac has achieved the highest operating profit in the Canterbury Benchmark Group since it began in 2014-15, while at the same time reducing nitrate leaching to 48% below their baseline at Good Management Practice. Here we look at the key drivers to their success.

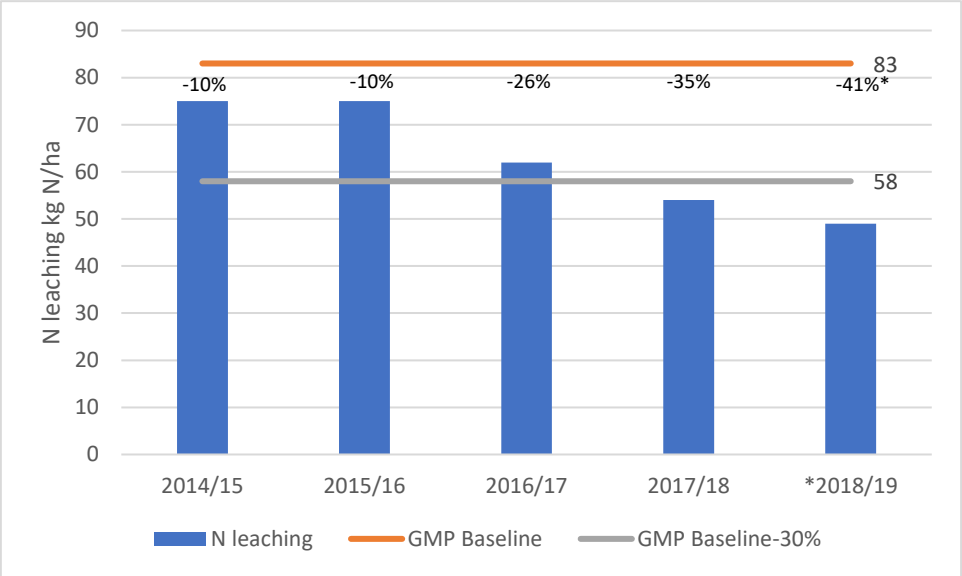
Farm Facts

See benchmark table on page 8 for 2014-2019 farm production and financial data.

- **Location:** 5 km west of Dunsandel in the Selwyn Catchment, Canterbury.
- **Farm owners/managers and staff:** Tony and Dana have been running Canlac Holdings since 2013 after Tony spent several years in off-farm roles and farming in the USA. Tony oversees all operations with a team of eight staff.
- **Farm area:** Canlac is 348.5 ha with 335 ha effective. In March 2018, a second property and shed (Quantum Dairy) was added to the business, expanding the effective area to 510ha. A 155-hectare leased support block is run as a separate business, charging commercial rates for feed and grazing.
- **Cows:** Peak cow numbers were between 1367 and 1437 from 2014-2018, and were stocked at 4.1-4.3 cows/ha. In 2018-19, peak cow numbers were 2,058 and stocking rate 4.0 cows/ha with the addition of Quantum Dairy. Cows weigh around 490 kg and produce about 500 kg milksolids (MS)/cow. Cows are Friesian cross with BW 99/44 and PW 144/49 (at May 2019).
- **Soils:** Most of the milking platform comprises well-draining Lismore/Mayfield soils with PAW_{60} of 86/88mm (Profile Available Water for the top 60 cm soil)
- **Irrigation:** Canlac: two large pivots (82% of the farm area), one rotorainer (9%), and sprinklers (9%). Quantum: four pivots (98% of the farm), rest sprinklers. Canlac is irrigated from Central Plains Water (CPW) Irrigation Scheme and from bores when necessary. Quantum has land use consent under CPW but is irrigated from bore water only.
- **Effluent:** Canlac: a two-pond system with 90-day storage, applied to 66% of the milking platform (increased from 21% in 2013). Quantum: a two-pond system with 120-day+ storage and all the pivots spread effluent, so can be applied on 98% of the area.
- **Feed pad:** Built in autumn 2016 and used from the 2016/17 season onwards to maximise utilisation of purchased feeds at Canlac (around 3 t DM/ha).



Canterbury Benchmark Group operating profit/ha average for 2016/17, 2017/18 and 2018/19



Selwyn catchment rules: From 2017, the farm must be operating at Good Management Practice (GMP) Baseline. GMP baseline is the calculated average N leaching for the years 2009/10-2012/13, assuming the farm is implementing GMP. Click here for more information on GMPs.

From 2022, a further 30% nitrate leaching reduction is required

N leaching at Canlac compared to the GMP baseline (orange line) and the GMP baseline minus 30% target (grey line)

**The new farm Quantum Dairy was included in the figures for 2018/19. The percentage reduction given is compared with the GMP baseline of Canlac only. The combined GMP baseline is 94 kg N/ha and the reduction from the combined baseline in 2018/19 was 48%.*

Strategies which maintain profit and drive nitrate leaching down

Canlac took a stepwise approach to reduce N surplus and N leaching. This enabled the farm and staff to adjust to the changes and helped to maintain production and profit. The measures taken were:

1. Improving irrigation system and management
2. Improving effluent system and effluent N and water use efficiency
3. Substituting high N supplements (pasture silage) for low N options (maize, fodder beet)
4. Reducing N fertiliser rates while maintaining pasture harvested (this continued to improve as steps 5 and 6 were implemented)
5. Introducing a catch crop following grazed crop
6. Introducing plantain in pasture

A summary of the changes made to N inputs and outputs can be found in the *Farm efficiency diagram* (page 9).

Improving irrigation and effluent system and management

In 2013/14, a second pivot replaced rotorainers on the west side of Canlac, and effluent area was increased from 21% to 41% of farm area. These changes resulted in higher pasture growth, greater efficiency from water and nutrients, and reduced nitrate leaching (Overseer estimated) from 83 kg/ha to 75 kg N/ha.

Reducing N inputs – fertiliser and feed

Efficient use of nutrients and replacing high N feeds (pasture silage) with low N feeds (maize silage and fodder beet) resulted in purchased N surplus (the gap between N brought onto the farm and exported in product) being reduced from 231 kg N/ha in 2015/16 to 165 kg N/ha in 2017/18 while production and profit was maintained. This was achieved despite an increase in stocking rate from 4.1 c/ha to 4.3 c/ha, and corresponding increase in purchased supplement from 3.0 t/ha to 3.9 t/ha. Purchased N surplus was further reduced to 114 kg N/ha with the inclusion of Quantum Dairy and further reductions in supplement and N fertiliser.

N fertiliser was reduced from 292 kg N/ha in 2015/16 to 191 kg N/ha in 2018/19 while pasture harvested was maintained. This was achieved with a slower round length and therefore reduced number of applications, and reducing the rate of each application.

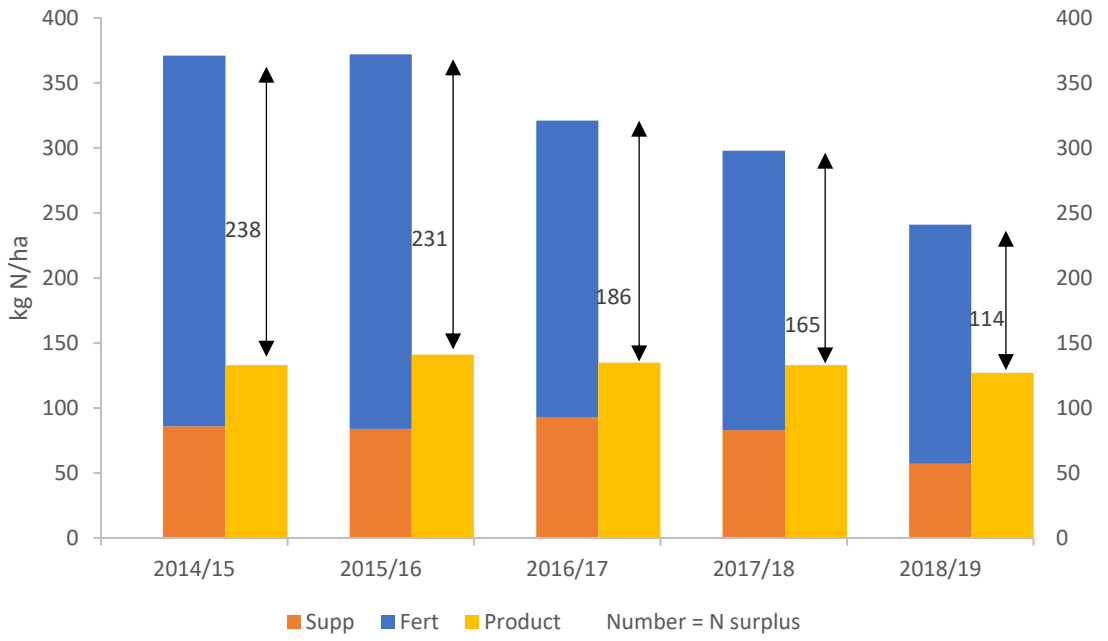
Fertiliser applied at Canlac Holdings 2015-2019

Season	2014/15	2015/16	2016/17	2017/18	2018/19
Avg fertiliser application rate (kg N/ha)	33	30	29	28	26
Number of applications	8.3	9.9	8.3	7.9	7.4
Total N fertiliser applied (kg N/ha)	271	292	243	224	191
N Effluent applied (kg N/ha)	n/a[+]	22	33	36	n/a[#]
Total N (kg N/ha)	n/a[^]	315	276	260	n/a[^]
Pasture harvested	17.8	18.5	18.6	18.3	18.2

[+]Detailed collection of effluent application events began part way through the season

[#]Could not be determined, an unknown volume of effluent applied via pivot

[^]Could not be calculated due to an unknown total of effluent N



Purchased N surplus at Canlac Holdings 2014-2019

As a comparison, the Low Input system (3.5 cows/ha) in the Pastoral 21 trial at Lincoln University Research Dairy Farm had a purchased N surplus of 47 kg N/ha while the High Input system (5.0 cows/ha) had a purchased N surplus of 243 kg N/ha. The Pastoral 21 farmlets were managed to achieve maximum profit while minimising N loss.

The average purchased N surplus for system 1 to 5 farms in DairyBase was 3, 68, 88, 124 and 147, respectively (Pinxterhuis et al. 2019).

2018-19 changes to stocking rate, fertiliser and supplement

In 2018-19, with the inclusion of Quantum Dairy, supplement was reduced by 42% to 2.2 t/ha, and fertiliser was reduced by 15% from 224 kg N/ha to 191 kg N/ha. Stocking rate was 4.0 c/ha compared to 4.3 c/ha on Canlac the previous year. The resulting N surplus and N leaching was again reduced and is now well below the 2022 target. Pasture harvested was maintained at the levels achieved on Canlac, and production per cow was also maintained at 99% of liveweight. However, production per hectare was 10% lower compared to the 2017/18 Canlac result (possibly due to fewer cows and them already producing at near potential and less supplement used).

Fodder beet and catch crop

Fodder beet was established on 12.4 ha of the milking platform in the 2016-17 season as a cheap source of low-N autumn feed, replacing high-N pasture silage which was normally used as a means of extending round length. The crop yielded 24 t DM/ha and was grazed by two herds of cows milked once a day (OAD) from the 20th of April. Two strips were lifted and fed on the feed pad to a herd of cows milked twice a day (TAD). In-milk carry-overs continued to graze the crop until the end of July and it was sown to permanent ryegrass/clover/plantain in October. The use of cultivation rather than spray and direct drill contributed to an infestation of fat hen which was difficult to control with plantain in the pasture. This was dealt with by mowing. In subsequent years, fodder beet was sown on 12.4 (2017/18) and 18.4 ha (2018/19) of the milking platform.

In 2018/19, a **catch crop** of oats was used to utilise the residual N in the soil and manage weeds following fodder beet. The crop was sown in July 2018, a month later than planned due to wet weather. It was grazed in October. The yield wasn't good due to late sowing (plated cover was 3750 kg DM/ha). This year (2019) the oats went in in late May/early June and will be grazed in October at a better yield. However, Tony is considering using Italian ryegrass as an alternative to minimise the time out of pasture.

For a summary of monitor farm experiences with fodder beet, catch crops and plantain, click here.

Plantain

FRNL trial results have shown that nitrate leaching could be reduced by incorporating plantain into the cow's diet at a rate of 30% of total dry matter intake. Further reductions may be possible as it appears plantain is more N efficient – requiring a lower fertiliser input for the same dry matter production.

At Canlac, two paddocks of plantain mix were established in October and December 2016 on a total of 25 ha (7% of the milking platform). Paddocks were established via direct drilling into a sprayed-out paddock, without cultivation. The mix contained 1 kg/ha of plantain seed and the resulting sward was 25-26% plantain in both paddocks. In 2017/18 plantain was added to the permanent pasture mix sown after fodder beet (12 ha). Fat hen proved problematic due to limited herbicides being available to use with plantain. This was eventually overcome through mowing. No further regrassing occurred in 2018/19 as the fodder beet paddock was double cropped.

The plantain paddocks were managed the same way as ryegrass/clover paddocks. Tony observed that the paddocks looked visually untidy in late spring/summer when the plantain went to seed, and he had to resist the temptation to top them.

Effects of plantain, fodder beet and catch crop are not yet reflected in Overseer, so at this stage are not visible in the Overseer estimates of N leaching for Canlac.

Plantain Establishment Trial

It will be difficult to achieve the levels of plantain needed to reduce N leaching through pasture renewal alone. A trial was run to investigate the cost-effectiveness of different methods of establishing plantain into existing pastures, on Canlac and two other monitor farms, and a small plot trial was also run at Lincoln University Research Dairy Farm (Bryant et al. 2019). Results from a survey on plantain establishment are presented in Dodd et al. 2019.

At Canlac, a paddock was direct drilled with plantain post grazing at the end of December 2016 at a rate of 8 kg/ha, and three different grazing treatments were applied.

Plantain percentage of total dry matter for three under-sowing methods at Canlac

Grazing treatment	Oct 2017	Apr 2018	Aug 2018	Apr 2019
Graze at 21 days post sowing	4%	19%	7%	12%
Pre-graze mow at 21 days post sowing	16%	14%	15%	14%
Pre-graze mow at 30 days post sowing	4%	25%	16%	20%

From the results observed on all four sites, the study concluded that:

- Establishing plantain into existing pastures is not likely to result in plantain making up greater than 30% of dry matter.
- Direct drilling is more effective than broadcasting, although the difference is not large

Low plantain density can contribute a significant proportion of dry matter once the plants are fully established.

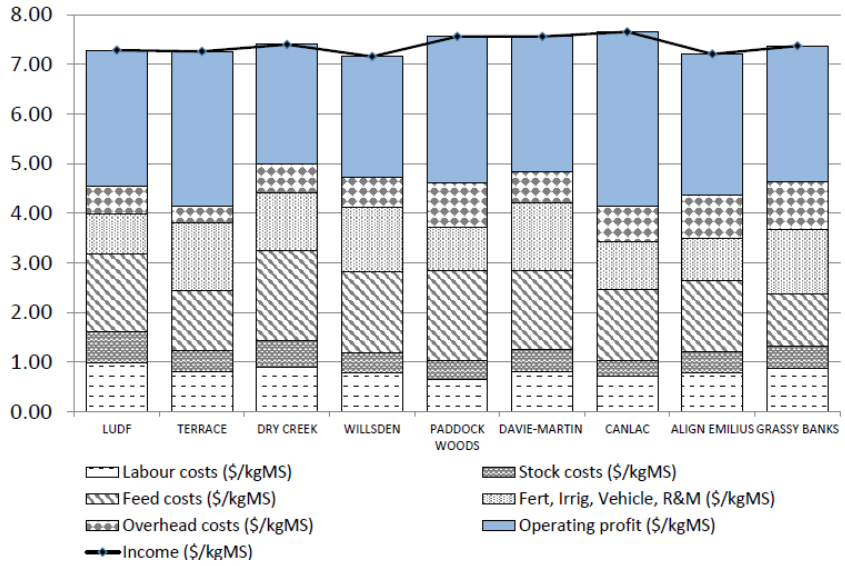
"It looks like plantain persists better in a diploid paddock than a tetraploid. I'm not sure why, perhaps it doesn't get grazed so hard or shaded as much with diploids?"

Key Profit Drivers

Canlac Holdings has achieved its nitrate leaching targets while maintaining a highly profitable business. Key strategies for maintaining high profit were as follows.

Focus on achieving a return from every dollar invested

Canlac operating expenses were between $3.81 and $4.19/kg MS in 2014/15 to 2017/18, compared to $4.45 and $5.08/kg MS Canterbury average over the same years (DairyNZ Economic surveys), and were the lowest in the LUDF Benchmarking Group.



LUDF Benchmarking Group 2017-18 profit and expenses as a proportion of income/kg MS

With the inclusion of Quantum in 2018/19 income/ha decreased 15%; slightly over half of that was due to less milksolids (58%) and slightly under half due to less stock revenue (42%). Operating expenses were reduced by 2%, resulting in a 31% decrease in operating profit/ha relative to 2017/18.

Some caution is needed in comparing 2018/19 to previous years due to conversion and Quantum Dairy.

Maximise pasture and crop eaten

Pasture harvested has increased from 15.7 t DM/ha in 2013/14 to 17.8-18.6 t DM/ha over the following five years. Pasture harvested at Canlac is 3.0-3.5 t DM/ha more than the average for Canterbury. Using contractors for all machinery work enables the farm team to specialise in producing milk from grass. Weekly farm walks, the use of a feed wedge, a rotation length to maximise pasture growth and quality, timely irrigation and effective use of N fertiliser all contribute to maximise pasture eaten.

High stock income

Stocking rate at Canlac was relatively high at 4.1-4.3 cows/ha (2014/15-2017/18) compared to 3.5 cows/ha for the Canterbury average. This contributes to high income from stock sales (plus 6% retained stock). Use of beef bulls for late calvers also increases the return from calves from $20-30 per bobby calf to $100-200 per four-day old dairy/beef cross calf.

Canlac Holdings Physical and Financial Performance

Farm Description	2014/15	2015/16	2016/17	2017/18	2018/19
Milking Platform (eff. ha)	335	335	335	318*	510^
Support Block (leased ha)	155	155	155	155	155
Cows (peak numbers)	1,371	1,391	1,437	1,367	2,058
Stocking Rate (cows/ha)	4.1	4.2	4.3	4.3	4.0
Kg Live weight per ha	1,964	1,993	2,106	2,175	1,942
FTE total	7.3	7.5	7.5	8	11.7
Cows/FTE	188	185	192	171	176
Kg MS/FTE	93,822	93,016	95,893	84,748	83,855
Milk Production Efficiency					
Kg MS Total	684,740	697,625	719,198	677,984	981,102
Kg MS/cow	500	502	500	496	477
Kg MS/ha	2,044	2,082	2,147	2,128	1,925
Kg MS/kg LW	104%	104%	102%	98%	99%
Feed use and Efficiency					
Pasture Harvested (TDM/ha)	17.8	18.5	18.6	18.3	18.2
Imp. Supp. Lactation (TDM/ha)	3.3	3	3.9	3.8	2.2
Imp. Supp. Lactation (kg DM/cow)	805	714	907	884	551
Winter Grazing (T DM/ha)	2.9	3.2	3	3.2	2.3
Total Feed Eaten (T DM/ha)	23.8	24.4	25.3	24.9	22.4
Nitrogen applied (kg N/ha)	271	292	243	224	191
Economics					
Milk Income ($/ha) **	13,286	13,533	13,956	13,832	12,513
Stock Income ($/ha)	1,075	1,139	708	1,370	431
Operating Expenses ($/ha)	7,774	8,723	8,831	8,648	8,435
Operating Profit ($/ha)	**6,587**	**5,949**	**5,833**	**6,554**	**4,509**
Milk Income ($/kg MS)	6.50	6.50	6.50	6.50	6.50
Net Stock Income ($/kg MS)	0.53	0.55	0.33	0.64	0.22
Operating Expenses ($/kg MS)	3.81	4.19	4.11	4.06	4.38
Operating Profit ($/kg MS)	3.22	2.86	2.72	3.08	2.34
Farm Working Expenses ($/Kg MS)	3.53	3.74	3.57	4.03	3.74
Nutrient budget					
N leaching Overseer 6.3.1 (kg N/ha)	76	75	63	55	49
% Reduction from GMP baseline	8%	10%	24%	34%	48%^^
Purchased N surplus (kg N/ha)	238	231	186	165	114
Purchased N Conversion Efficiency (%)	36	38	42	45	53
N surplus Overseer 6.3.1 (kg N/ha)	376	389	354	331	302
N Conversion Efficiency Overseer 6.3.1 (%)	26	26	28	29	30

* The area was reduced to reflect the area taken out for setting up Quantum Dairy for 2018/19.

** Milk income was calculated by multiplying the kg MS produced during the season by a standard milk price ($6.50/kg MS including dividends) and net of the DairyNZ levy.

^Farm area is larger due to merger with Quantum Dairy in the 2018-19 season

^^GMP baseline for Canlac is 83 and for Quantum 114 kg N/ha. Therefore, the new farm's GMP baseline is 94 kg N/ha.

Canlac Holdings Ltd

Notes
- Milking platform only
- Supplement and pasture is reported as 11 MJME/kg DM equivalent
- Overseer nitrogen numbers (red and green diamonds) include non-effective land, other metrics use effective area

Nitrogen summary	Calculation	14/15	15/16	16/17	17/18	18/19
Purchased N surplus	+ Fert N + Supplement N – Product N – Stored supplement N	238 kg N/ha	231 kg N/ha	186 kg N/ha	165 kg N/ha	114 kg N/ha
N leaching	Overseer v6.3.1	76 kg N/ha	75 kg N/ha	63 kg N/ha	55 kg N/ha	49 kg N/ha
Purchased N use efficiency	Product N Stored supplement N Fert N Supplement N	36%	38%	42%	45%	53%

Farm characteristics

Soils

Soil family	Lismore Mayfield
PAW60	86 mm 88 mm

Climate

	14/15	15/16	16/17	17/18	18/19
Rainfall	436 mm	702 mm	584 mm	744 mm	604 mm
Evapo-transpiration	919 mm	919 mm	919 mm	919 mm	919 mm

Irrigation

	14/15	15/16	16/17	17/18	18/19
Irrigation applied	657 mm	486 mm	467 mm	364 mm	399 mm

Fertiliser

	14/15	15/16	16/17	17/18	18/19
Nitrogen applied (effective)	271 kg N/ha	292 kg N/ha	243 kg N/ha	224 kg N/ha	191 kg N/ha
	285	288	228	215	184

Farm management

Stock

	14/15	15/16	16/17	17/18	18/19
Peak cows	1371	1391	1437	1367	2058
Stocking rate	4.1 cows/ha	4.2 cows/ha	4.3 cows/ha	4.3 cows/ha	4.0 cows/ha
Live weight	480 kg/cow	480 kg/cow	491 kg/cow	507 kg/cow	481 kg/cow

Feed

Pasture

	14/15	15/16	16/17	17/18	18/19
Pasture eaten	17.8 t DM/ha	18.5 t DM/ha	18.6 t DM/ha	18.3 t DM/ha	18.1 t DM/ha
Fertiliser efficiency	66 kg DM/kg N	63 kg DM/kg N	77 kg DM/kg N	82 kg DM/kg N	95 kg DM/kg N
Water efficiency	16 kg DM/mm	16 kg DM/mm	18 kg DM/mm	17 kg DM/mm	18 kg DM/mm

Supplement

	14/15	15/16	16/17	17/18	18/19
Supplement per ha	3.3 t DM/ha	3.0 t DM/ha	3.9 t DM/ha	3.8 t DM/ha	2.2 t DM/ha
Supplement per cow	802 kg DM/cow	729 kg DM/cow	905 kg DM/cow	878 kg DM/cow	551 kg DM/cow
	86	84	93	83	57

Farm production

Products

	14/15	15/16	16/17	17/18	18/19
Productivity	2044 kg MS/ha 500 kg MS/cow	2082 kg MS/ha 502 kg MS/cow	2147 kg MS/ha 500 kg MS/cow	2128 kg MS/ha 496 kg MS/cow	1925 kg MS/ha 477 kg MS/cow
Milk from pasture	84%	86%	83%	82%	89%
Fertiliser efficiency	7.5 kg MS/kg N	7.1 kg MS/kg N	8.8 kg MS/kg N	9.5 kg MS/kg N	10.1 kg MS/kg N
MS as % of liveweight	104%	104%	102%	98%	99%
	128	134	132	127	120

Stored supplement

	14/15	15/16	16/17	17/18	18/19
Harvest crop area	0 ha	0 ha	0 ha	0 ha	0 ha
% of farm cut for silage	22%	19%	11%	23%	22%
Stored or exported feed	87 t DM	134 t DM	67 t DM	96 t DM	183 t DM
	5	7	3	6	7