

APPLYING PASTORAL 21 FARMLET RESEARCH TO A WHOLE FARM – RESULTS FROM LINCOLN UNIVERSITY DAIRY FARM

Ron Pellow

*South Island Dairying Development Centre, PO Box 85160,
Lincoln University, Christchurch, 7647*
Email: ron.pellow@siddc.org.nz

Abstract:

The P21 research had impressive goals; profitable, simple, adoption-ready systems that lifted production and reduced nutrient loss. Farmlet comparisons were a core component and can be a valuable means of determining, and demonstrating comparative performance. Great farmlet research however does not automatically result in rapid uptake at scale, and results at scale, in a whole farm system may not replicate the farmlet results.

Faced with a choice between significant infrastructure investment, to reduce nutrient losses (primarily N-leaching) or scale up the lower input, high productivity, lower nutrient loss P21 research (LSE), Lincoln University Dairy Farm (LUDF) chose the latter.

Three years of research, two kilometres away, with 29 cows on 8.25 hectares showed that a system based on less N-fertiliser and imported feed, that achieved high production from home grown, grazed pasture could maintain profitability. N-leaching was estimated to be significantly lower, on a like for like soil type / assumption basis.

Transitioning into the system was straight forward, backing out of it, however, if it was not scalable, could be very costly. One of the key changes, for example, was an 11% reduction in cow numbers. While it's relatively easy to sell lower performance animals to reduce herd size, replacing these, if required, would result in purchasing higher value animals.

Modelling of the system confirmed the research results - it looked feasible - though the system was tight on feed supply, and required high levels of overall production to achieve the desired level of profitability. Not initially apparent from the research was the potential impact of regrassing on feed supply, which had been a core part of LUDF's push to lift productivity from pasture.

Now into the third year of running this farm system, experience at LUDF has shown the 'LSE' farmlet system was adoptable and could be profitable while also reducing Overseer® modelled nitrogen nutrient losses. Whilst there were a number of key learnings discovered in the first year, and subsequently refined, the farm's performance clearly shows this research can be applied to a whole farm.

Introduction

Lincoln University Dairy Farm (LUDF) is a commercial demonstration farm owned by Lincoln University and operated by the South Island Dairying Development Centre (SIDDC)¹ to demonstrate profitable sustainable dairying. To meet its strategic objective it chose to adopt one of the research streams emerging from the local Pastoral 21 Phase 2 project, at the time called 'low system efficient' (LSE). Now into its third season implementing this farm system, the results show the research was scalable and the system could meet the farms objective to maintain profitability and reduce nutrient losses.

Background – LUDF

The farm is 160 hectares (effective) and fully irrigated. Through targeted fertiliser application and a regular re-grassing programme it has established good pastures, able to produce high yields of high quality pasture for the majority of the year. The farm has a wider range of soil types than many local farms, ranging from poorly drained to free draining soils.

As a demonstration farm it attracts 3000 - 3500 visitors per year plus approximately 1000 visitors per month to its web-based weekly farm walk notes and Facebook page. Additional details are provided in Appendix 1.

Annual benchmarking of profitability with comparable farms indicates the farm operates in the top 2-5% on profitability. Situated within the Lake Ellesmere – Te Waihora catchment, in the 2017-2021 period, it is required to reduce nitrate nitrogen losses to no more than the 2009-2013 baseline N losses, and then further reduce losses by 30% below the baseline levels from 2022.

The farms objective is:

To maximise sustainable profit embracing the whole farm system through:

- increasing productivity;
- without increasing the farm's total environmental footprint;
- while operating within definable and acceptable animal welfare targets; and
- remaining relevant to Canterbury (and South Island) dairy farmers by demonstrating practices achievable by leading and progressive farmers.
- LUDF is to accept a higher level of risk (than may be acceptable to many farmers) in the initial or transition phase of this project.

Operating within the farms environmental footprint

Determining the farms environmental footprint has largely been dominated by the wider communities focus on nitrogen losses to water, as estimated by Overseer®. Forecasting probable Nutrient losses mid-way through the 2013-14 season estimated, if current onfarm practices continued, the losses for that season would be 10% higher than previously and the farm would therefore exceed its historical environmental footprint. Responding to this, the farm dried off all surplus cows at the beginning of autumn and stopped importing any further feed supplements, so that pasture grown determined stocking rate and productivity (for the remainder of the autumn). The nutrient loss target was subsequently attained, but with less milk available for sale, resulted in an overall cost to the business of \$84,000.

¹ SIDDC is a partnership between Lincoln University, DairyNZ, Ravensdown, LIC, Plant & Food Research, AgResearch and SIDE (the South Island Dairy Event). SIDDC harnesses the complimentary capabilities of the partners to advance South Island Dairying.

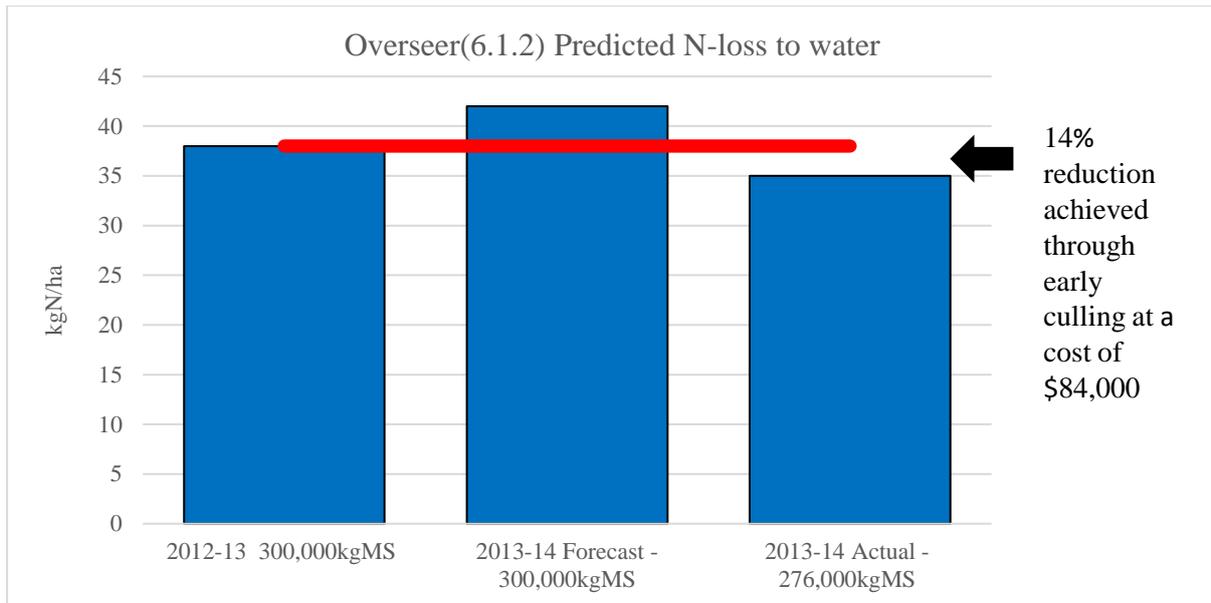


Figure 1: Estimated N-losses to water, Overseer (6.1.2), February 2013.

Choices – Adopt P21 research or mitigate N-losses through capital investment

Seeking to regain the lost profit of 2013-14 season, but maintain or lower the farms nutrient losses (and total environmental footprint), the available choices were narrowed down to:

1. A major capital investment (effectively creating off paddock facilities to reduce nutrient deposition from grazing), or
2. Upscale the P21 ‘LSE’ research that showed improved efficiency of a grazed pastoral system. Nearly three years of data was available at this point showing high production per cow and per hectare was achievable with low inputs of N fertiliser and brought in feed, and together the combination appeared to result in lower nitrogen losses but comparable profit.

The P21 results were however only from small scale, farmlet research (conducted with 29 cows on 8.2 ha). Questions remained as to the scalability of this research – could the research outcomes be replicated at scale with a full farm operating this system?

	LSE	HSE
Milk Production MS (kgMS per cow / ha)	511 / 1789	458 / 2290
Operating costs (\$/kg MS)	\$3.93	\$4.43
Operating profit (\$/ha, \$6.00/kgMS milk income)	\$4860	\$5061
Nitrate leached (kg N/ha) [Overseer 6]	19	35

Table 1: Preliminary data for years 1 and 2 of the low stocking rate efficient system (LSE) compared to the alternative P21 treatment of high stocking rate efficient system (HSE).

Additionally, while the system was relatively easy to transition into, it would be more difficult and costly to reverse out of, if the efficiencies identified in the farmlet research results could not be realised at scale. Failure to achieve the same level of results at LUDF would not only reduce profitability but put the farms reputation at risk.

Considerations

Modelling of the farm system for LUDF identified it was highly vulnerable to the volume of milk production achieved. Very few costs would change if production was even 10% lower, but operating profit could nearly half with relatively small changes in production.

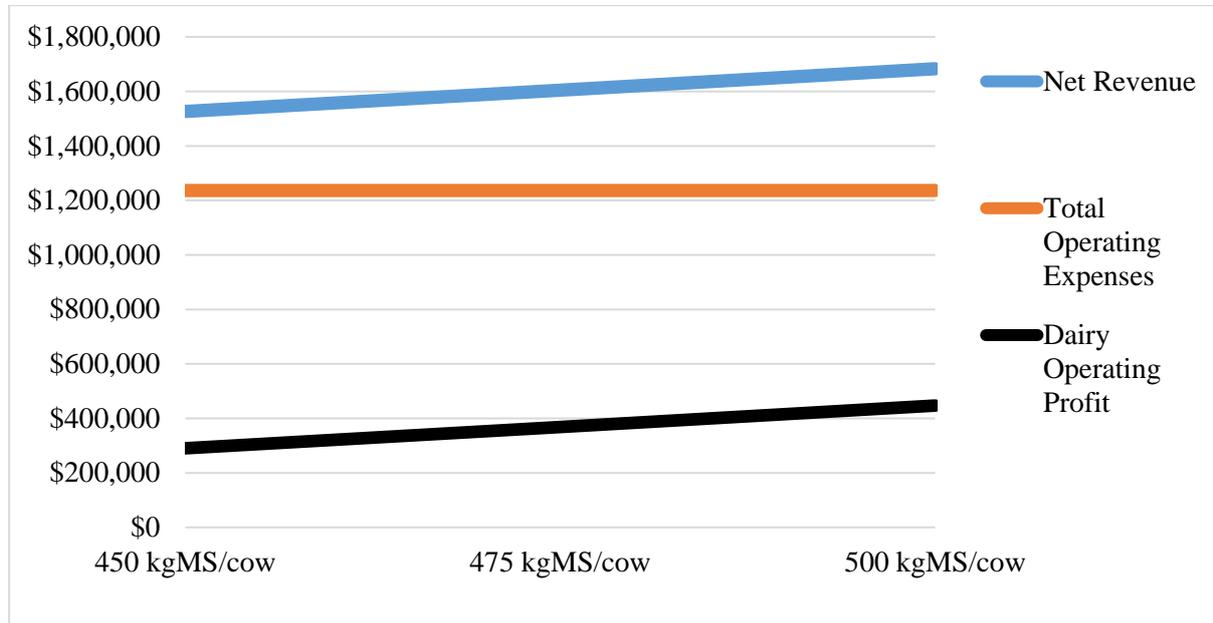


Figure 2: Sensitivity to Production.

The farm determined it would adopt the P21 research system, renaming it a ‘Nil Infrastructure – low input’ farm system, and recognised it needed to begin with the mindset that the management required would be ‘different’ not ‘difficult’. Local regulators had been briefed on the above results and held the view dairy research had solutions for farmers – so LUDF identified it needed to either prove the system was scalable, or remove this from the options considered for farming with reduced nitrogen losses.

Pasture management would be different with the new system, and the management team, while learning from the researchers, would also need to learn and adapt as they implemented this system across the whole farm. Equally, the farm was prepared to exit the system if it was clearly not feasible. Balancing this however was the knowledge that if this Nil Infrastructure – low input system was not scalable, it would result in a large capital investment and / or equivalent reduction in profitability, creating high motivation to succeed.

Further investigation of the system identified the relatively high level of pasture renovation occurring at LUDF (15% per annum over past seasons) to lift pasture performance was at odds with the P21 research which had been conducted with no regrassing. Calculating feed demand across the season identified this created a risk to implementation as it effectively lifted the demand for imported feed by over 40% (per cow).

Successful implementation of this system would not only reduce N-losses for LUDF and its supporting land (for wintering, youngstock and replacements) but would reduce the volume of support land required. This raised the risk that total catchment N-losses would be impacted by whatever the alternate use for that land was. Ideally it would need to be directed into a low N-loss, highly profitable land use.

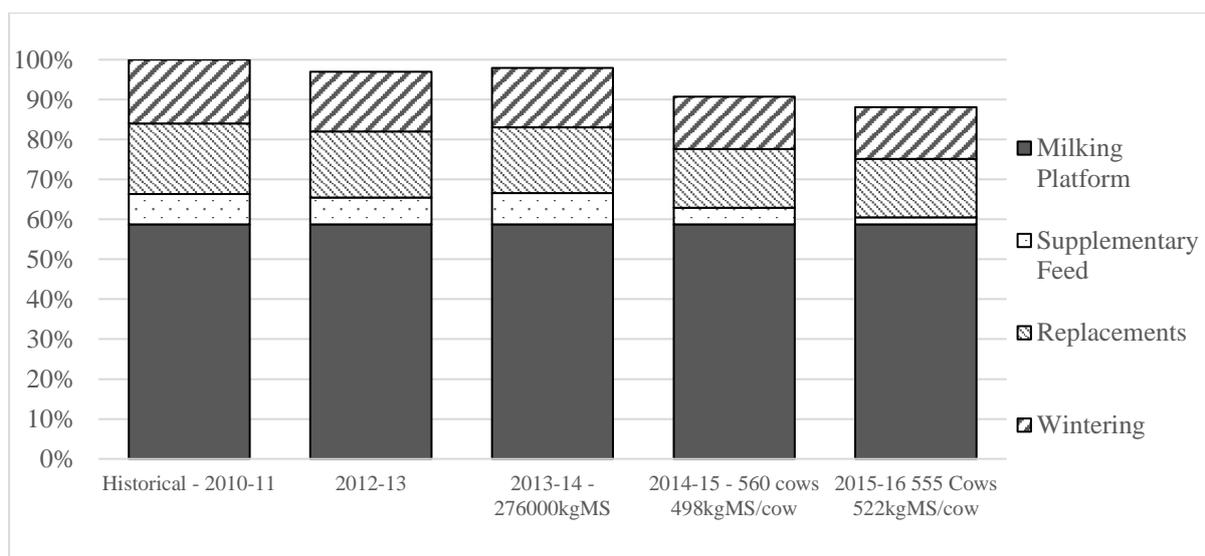


Figure 3: Total Land Required by farm segment - relative to Historical LUDF land use

Results to date

Year to year performance is always impacted by the interaction of climate, milk income and costs, meaning care is required in direct comparisons between individual seasons. Nevertheless, in a commercial demonstration farm such as LUDF, or for most individual farm businesses, it remains one of the standard means of comparing performance, and particularly comparative performance when the farm system has changed.

Data from the two preceding seasons (2011-12 and 2012-13) along with the 2013-14 season, and the initial two seasons operating a Nil-infrastructure low input system are shown below. Allowing for some natural variation year to year, it's clear the most recent two seasons have largely achieved the goals of the P21 research – i.e. high productivity from low inputs, resulting in lower N-leaching as estimated by Overseer®. Fortunately, with reduced inputs (costs) and high productivity, profitability was also largely maintained, if using a standardised milk payout across seasons.

	2011/12	2012/13	2013/14	2014/15	2015/16
Peak Cows Milked	632	630	628	560	555
Ave. Milk Prod / cow (kgMS/cow)	471	477	440	498	522
Ave. Milk Prod / ha (kgMS/ha)	1861	1878	1725	1742	1812
Nitrogen Fertiliser applied (KgN/ha)	340	351	252	143	179
Imported Suppl (kgDM/cow)	359	434	507	300	126
Farm working exps (\$/kgMS)	\$3.91	\$3.84	\$4.28	\$3.87	\$3.47
Est. N leaching (Overseer® 6.2.3)	42	47	29	25	29

Table 2: Inputs and farm performance – 2011/12 to 2015/16

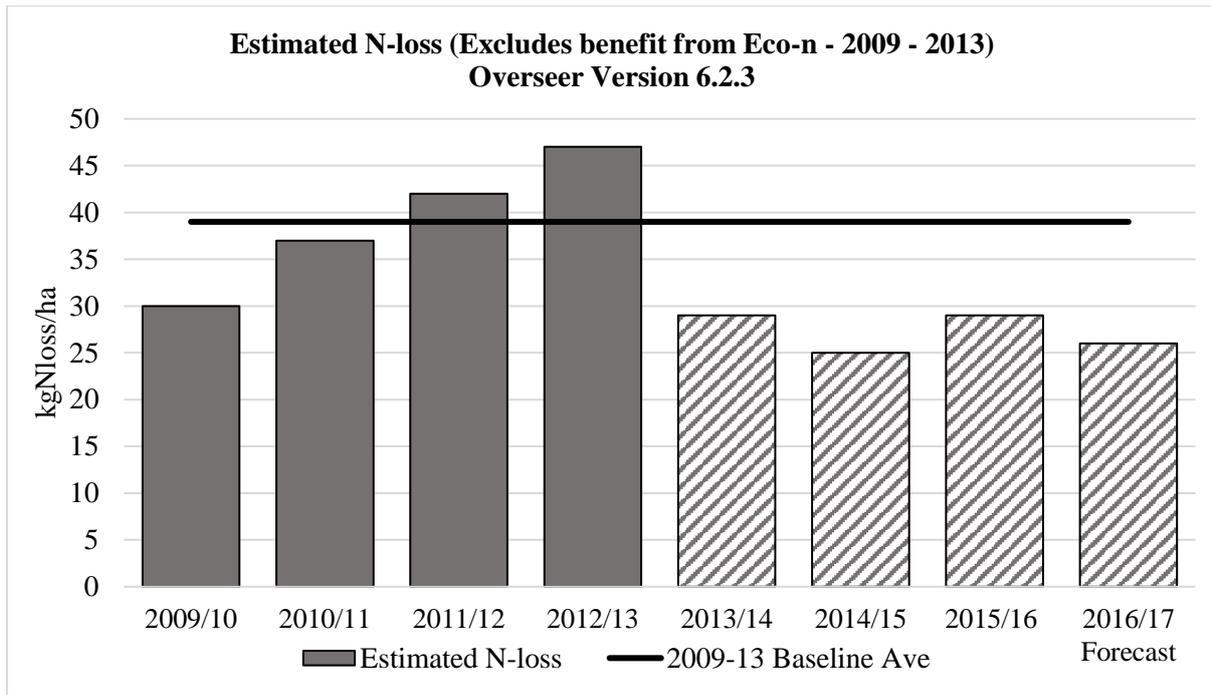


Figure 4: Estimated N-loss per hectare as calculated by Overseer®

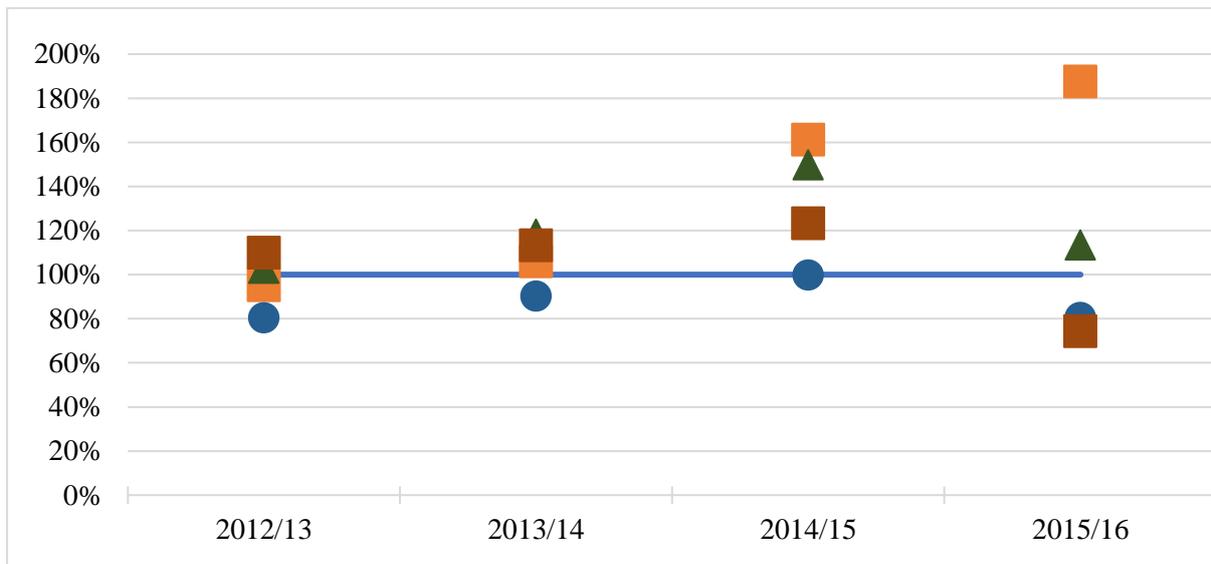


Figure 5: Relative operating profit of a range of Canterbury dairy farms, compared to LUDF (100%)

LUDF undertakes an annual profitability comparison with a range of highly profitable Canterbury dairy farms, to provide a comparison of profitability within the season. It enables a better comparison of profitability and performance over time as it compares farms that have largely all had to operate with the same mix of climatic and economic variables. Comparing performance as a percentage against LUDF also takes out the absolute volatility these farms have endured through this time, and allows one to see where LUDF is tracking compared to these properties. In general it shows LUDF was nearer the bottom of this group on profitability

in 2013-14 and 2014-15, but having refined the learnings from year one of implementing the P21 research (2014-15), it has lifted its relative profitability in the second year of scaling up this research.

Learnings

Adopting the P21 ‘LSE’ research enabled the farm to harness previously unrealised efficiency gains in the farm system. A significant contributing part of this was the refocus on pasture management, including the ‘three leaf principle’ for ryegrass management. Removing the flexibility previously utilised through additional Nitrogen fertiliser and imported feed required operating with higher pasture covers to carry more feed on farm in the form of actively growing, yet high quality pasture.

Calculations suggest increasing the interval between grazings (by a few days) so that the ryegrass plant is more typically grazed at 2.5 - 3.0 leaf stage, rather than 2.0 - 2.5 leaf stage is likely to produce another 750 – 1000kgDM/ha/year (similar to the total amount of imported supplementary feed LUDF targets for lactation). This results in higher pregraze pasture masses, which still need to be eaten down to a low and consistent grazing residuals in a timely manner. LUDF’s previous focus on establishing tetraploid pastures has been extremely beneficial in this aspect as tetraploids can typically still be well grazed at pregrazing covers up to 3600kgDM/ha (assuming low and consistent grazing residuals in prior grazings) whereas diploid pastures are normally better grazed at less than 3300 kgDM/ha.

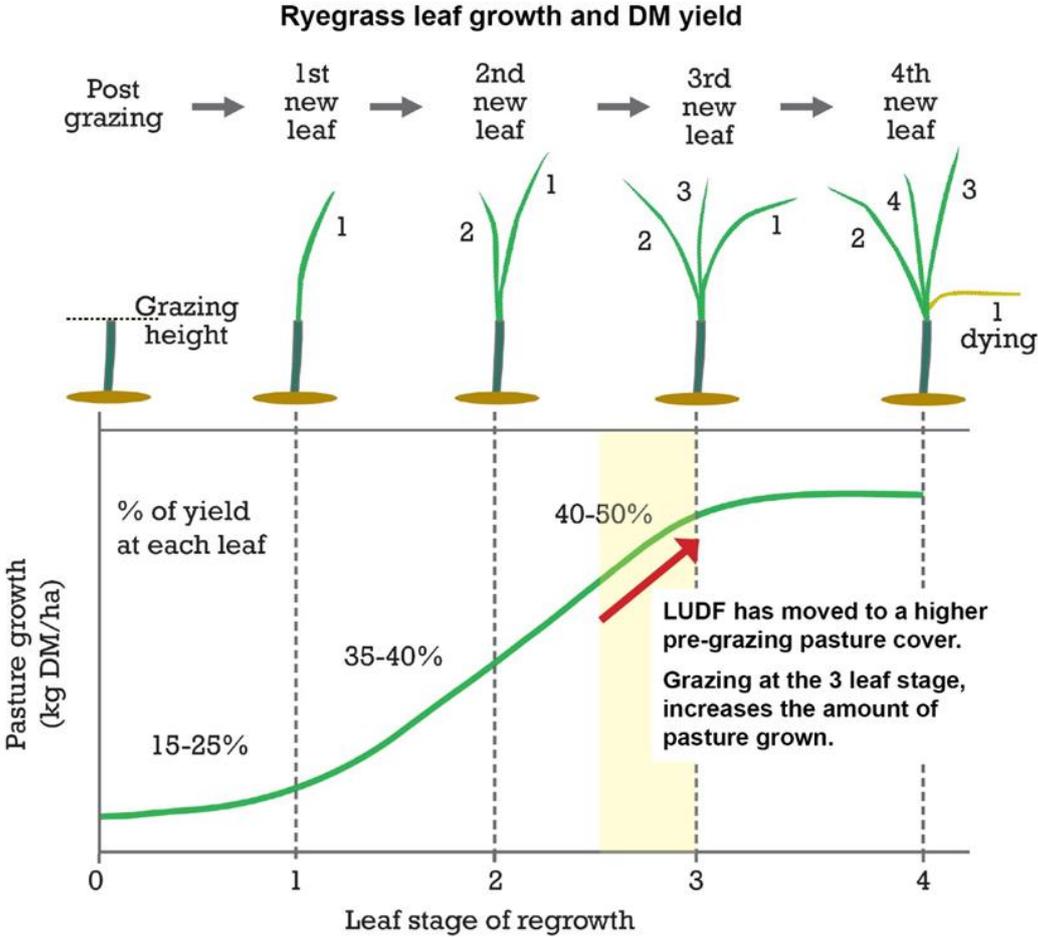


Figure 6: Ryegrass leaf stage and DM yield

A consequence of less N fertiliser was the dung and urine patches were more evident across the paddock, so that pregrazing yields became more variable, and similarly pasture quality was more variable. Dung and urine patches from a previous grazing typically have higher pregraze mass, and are prone to some decay in the base, while the surrounding pasture is still actively growing. This is displayed in Figure 7, which shows a paddock with an average pregraze average pasture cover of 3000kgDM/ha, but a range from less than 2500 kgDM/ha to more than 3500 kgDM/ha.

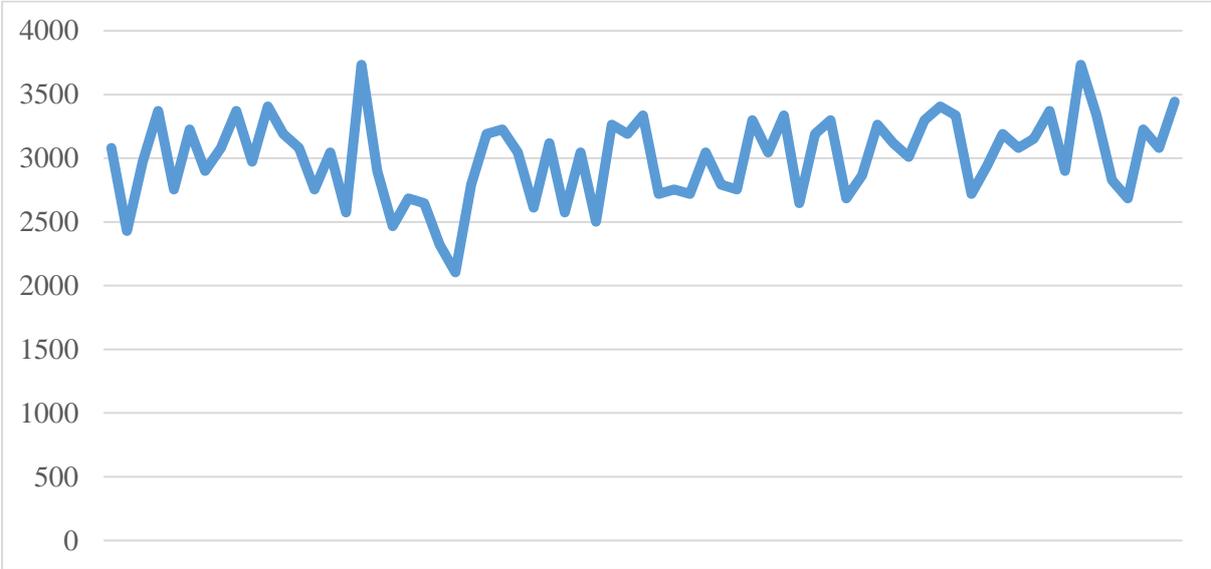


Figure 7: Variability in Pregraze Pasture Mass.

Modelling of the total catchment losses of Nitrogen from the total land required to support LUDF (the combined area for the milking platform, youngstock, wintering and imported supplements) shows the estimated total Nitrogen losses have decreased, compared to the previous position, while profitability, and total milk production have largely held in the scaling up of the P21 research at LUDF.

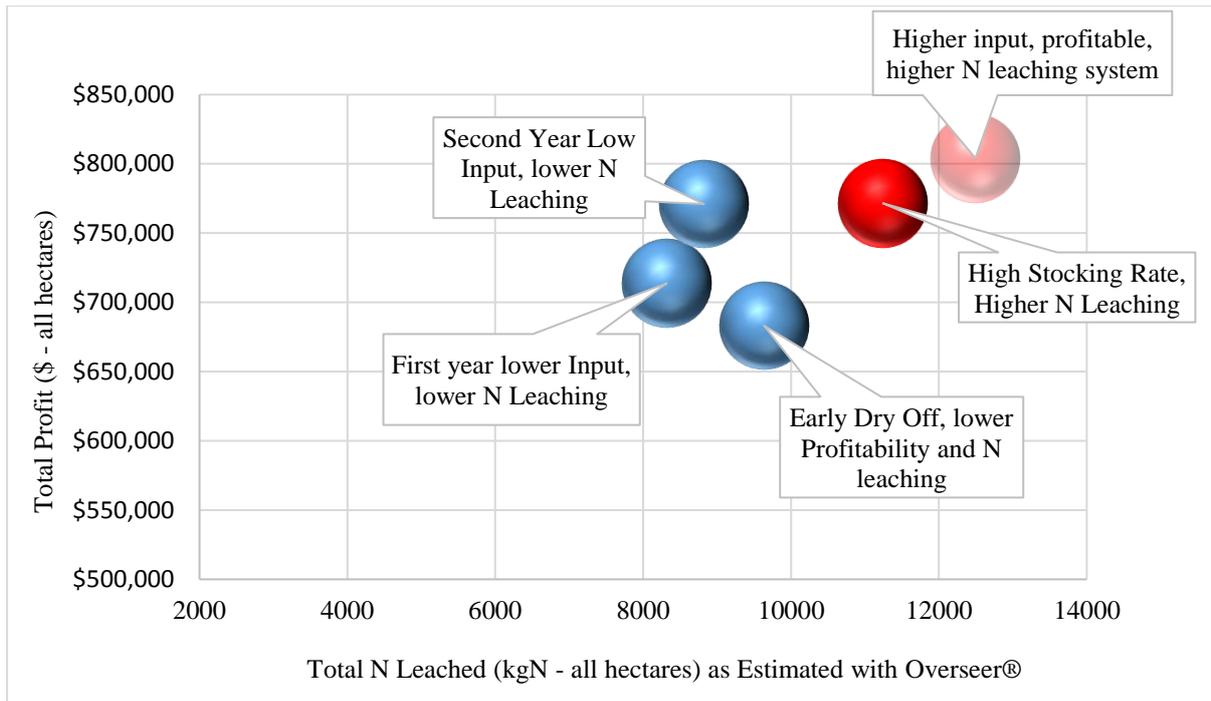


Figure 8: The catchment effect, total profit compared to total nitrogen leached from LUDF across seasons.

Conclusions

The Canterbury P21 – LSE farmlet research can be scaled up and applied to a whole farm as demonstrated at LUDF, with similar or better results in overall farm performance, profitability and reductions in nutrient losses.

The scaling up of this research also raised the question, what other unrealised efficiency gains are awaiting discovery and uptake in pastoral New Zealand Agriculture? Further research must continue to challenge the current thinking and normal expectations to discover and quantify future opportunities across all resources used within the farming system.

Acknowledgements

The South Island Dairying Development Centre, on behalf of New Zealand Agriculture, would like to thank the scientists, technicians and funders of the P21 Research Programme Phase 2, for their insight in creating a programme that has delivered profitable, simple, adoption-ready systems that lifted production and reduced nutrient losses.

Additionally, SIDDC would like to also thank the visionary scientists who initially proposed pasture fed cows in NZ could produce over 500kgMS/cow at 3.5 cows per hectare. Similarly, SIDDC thanks those who doubted this and in doing so, inspired success.

Appendix 1

Further background information on LUDF

History:

The 186 hectare irrigated property, of which 160 hectares is the milking platform, was a former University sheep farm until conversion in 2001. The spray irrigation system includes two centre pivots, small hand shifted lateral sprinklers, and k-lines. The different soil types on the farm represent most of the common soil types in Canterbury.

Stage 1: 2001/2 and 2002/3

The farm initially wintered approximately 630 cows, peak milking just over 600 and producing about 1400kgMS/ha from 200kgN/ha and up to 550kg DM/cow of imported feed. The milk payout (income) in 2002/3 was \$4.10/kgMS.

Stage 2: 2003/4 through to 2010/11

The stocking rate increased to between 4 and 4.3 cows per ha or 654-683 cows peak milked. Production averaged 1700kgMS/ha and 411kgMS/cow. LUDF ran a single herd, the focus was simple systems, low and consistent grazing residuals.

Stage 3: 2011/12 to 2013/14

The strategic objective (below) was implemented in a move into 'Precision Dairying'. This focused on minimum standards not averages, two herds, higher productivity and initially higher profitability from a similar environmental impact. Production lifted to 1878kgMS/ha or 477kgMS/cow from 630 cows. The temporary suspension of Eco-n (DCD) in 2013 required a change in farm practice in 2013/14 in the attempt to hold nitrogen losses without the mitigation effect of Eco-n.

Stage 4: 2014/17

LUDF has adopted the 'Nil-Infrastructure, low input' farm system emerging from the P21 (Pastoral 21) research programme, in partial response to the tightening environmental requirements of some catchments across NZ. Average results for the first two seasons include 1777kgMS/ha or 510kgMS/cow from 3.5 cows/ha, produced from (on average) 161kgN/ha and 213kgDM/cow imported supplement.

LUDF Strategic Objective

To maximise sustainable profit embracing the whole farm system through:

- increasing productivity;
- without increasing the farm's total environmental footprint;
- while operating within definable and acceptable animal welfare targets; and
- remaining relevant to Canterbury (and South Island) dairy farmers by demonstrating practices achievable by leading and progressive farmers.
- LUDF is to accept a higher level of risk (than may be acceptable to many farmers) in the initial or transition phase of this project.