Meeting a Sustainable Future

Canterbury | Inspiring High Performance, Low footprint farms

Farming with a N Fertiliser Cap

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DairyNZ

N fertiliser policy Lincoln University Dairy Farm (LUDF)

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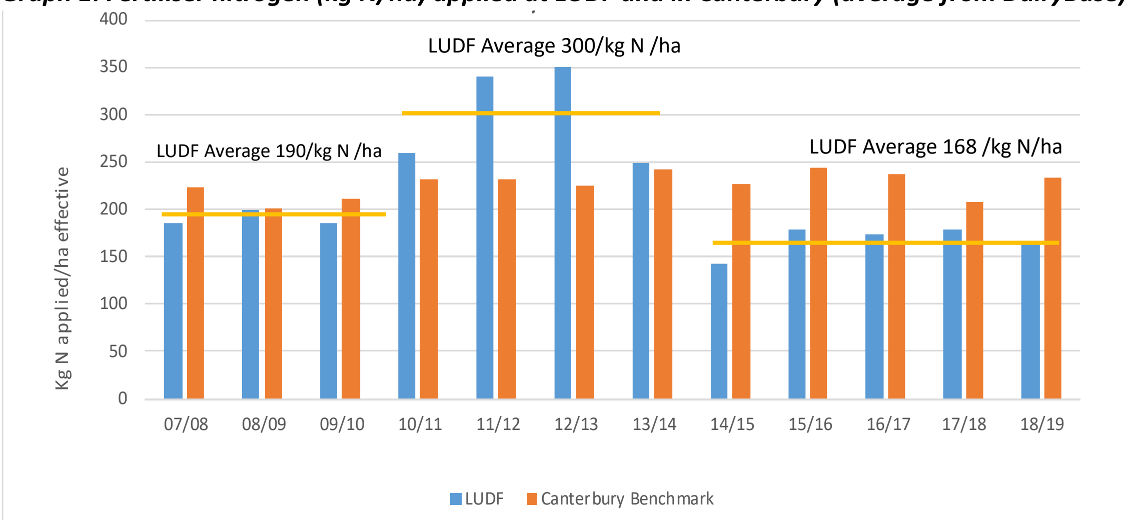
1. Nitrogen management

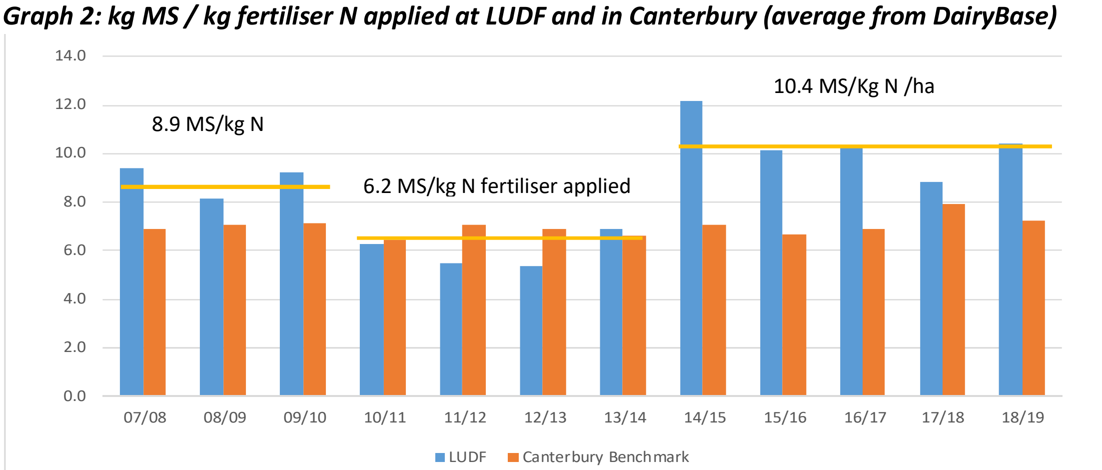
The Lincoln University Dairy Farm had a significant change in the nitrogen (N) use strategy over the last few years. The spread of the clover root weevil in Selwyn in the early 2010s decimated clover on many local farms including LUDF, prompting an increase in N fertiliser use from around 190 kg N/ha between 2003/4 and 2009/10 seasons, to 250 – 350 kg N/ha between 2010/11 and 2013/14 seasons. DCD (Eco-N) was used during this latter period to reduce the risk of N leaching until it was removed from the market in 2013. From the 2014/15 season when the farm implemented the principles from the Pastoral 21 research project, N from fertiliser was reduced to the current N use of around 170 kg N/ha. Graph 1 shows N fertiliser use for LUDF and the average for Canterbury.

Graph 1: Fertiliser nitrogen (kg N/ha) applied at LUDF and in Canterbury (average from DairyBase)



Graph 2 presents the N use efficiency (kg MS/kg N fertiliser applied) for LUDF and the average for Canterbury. For LUDF there was a significant increase in N use efficiency (10.4 versus 6.2 kg MS/kg N fertiliser), a remarkable improvement in the overall system efficiency and a key step toward reducing the N footprint of the farm. For Canterbury farms the average milk solids production per kg N applied, for the last 12 years, was 7 kg MS/kg N ranging from 6.5 to 7.9 (source Canterbury- DairyBase).

Graph 2: kg MS / kg fertiliser N applied at LUDF and in Canterbury (average from DairyBase)

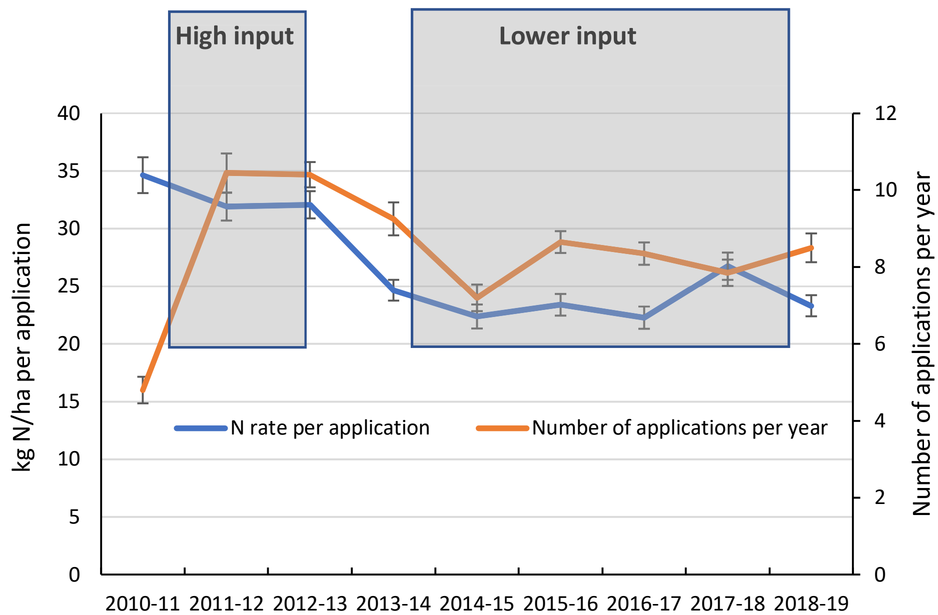


The reduction in N fertiliser was implemented using two main methods:

- Changing the frequency and amount of N applied at each event – contributing to 85% of the overall reduction in N applied
- Markedly reducing N fertiliser applied to the effluent areas – contributing to 15% of the reduction in total N applied

Key features of the change in fertiliser management were: 2.4 fewer applications per year, and an average of 8 kg N/ha less N applied at each fertiliser spreading event. Graph 3 shows how this worked.

Graph 3. Average rate of N applied per application, and number of applications per year on non-effluent areas at LUDF



2. Pasture growth

As expected, pasture grown was lower in the 'lower input' years from 2014-15 to 2018-19 compared with the 'high input' years of 2011-12 and 2012-13. The average reduction was 1.5 t DM/ha per year (Table 1), as a result of applying 167 kg N/ha less in the 'lower input' years.

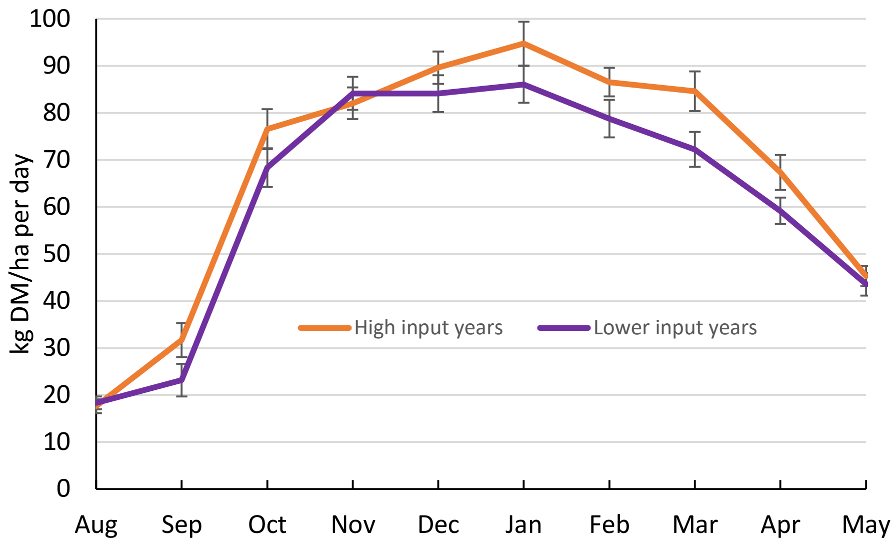
Table 1 suggests the N response efficiency in the LUDF system was about 9.5 kg pasture DM grown per kg N applied.

Table 1. Comparison of pasture grown at LUDF in the 'high input' and 'lower input' years

	High input years	Low input years	Difference
N fertiliser applied (kg N/ha per year)	325	167	- 158
Pasture grown (t DM/ha per year)	20.4	18.9	- 1.5
'Apparent N response efficiency' (kg DM/kg N)			9.5

Growth was reduced in most months, as shown in Graph 4.

Graph 4. Average pasture growth rates at LUDF in the 'high input' and 'lower input' years

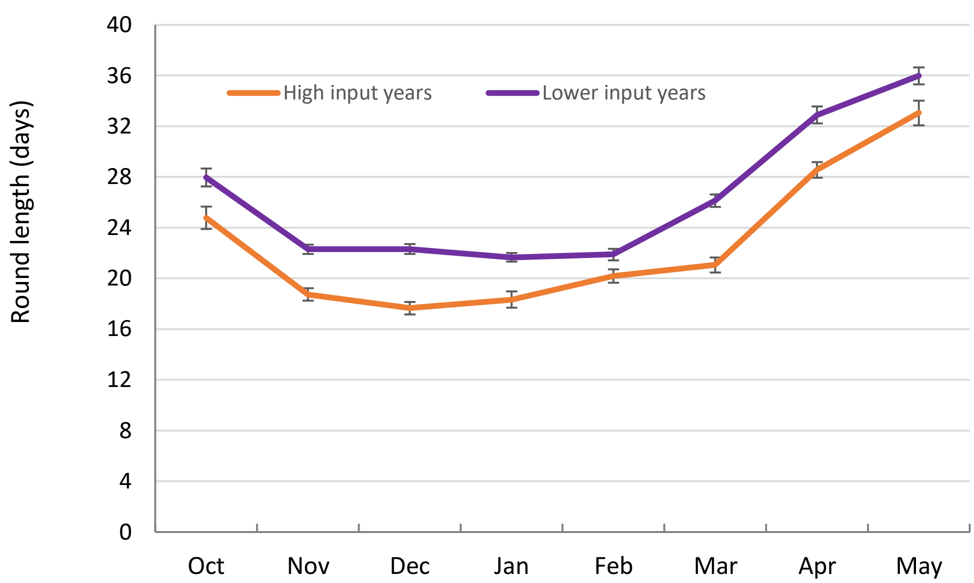


3. Grazing management

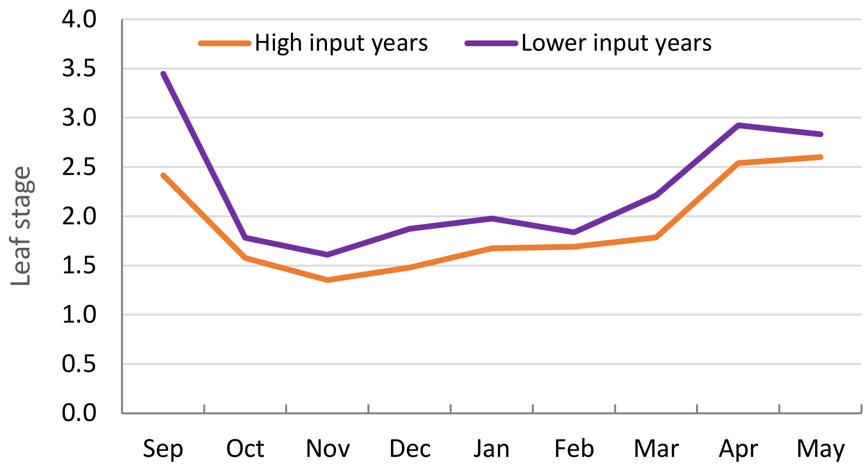
Compared with the 'high input' years, when less N was applied from 2014-15 onwards:

- there were 1.7 fewer grazings per year reflecting a mean 4-day increase in round length (Graph 5)
- The increase in round length resulted in an increase in leaf stage at grazing of ~ 0.4 leaves/grazing (Graph 6), which was estimated to have recouped about 1.1 t DM/ha of the expected reduction in pasture growth resulting from removing N fertiliser.

Graph 5. Average round length at LUDF in the 'high input' and 'lower input' years



Graph 6. Average leaf stage at grazing at LUDF in the 'high input' and 'lower input' years



Why did round length differ between the 'high input' and 'lower input' years? We are not 100% certain but it is likely a result of the lower growth rates, which meant:

- It takes longer to reach pre-graze pasture cover targets
- Which in turn means that, once the round length is extended, then pre-graze cover targets will creep up in order to sustain that longer round.

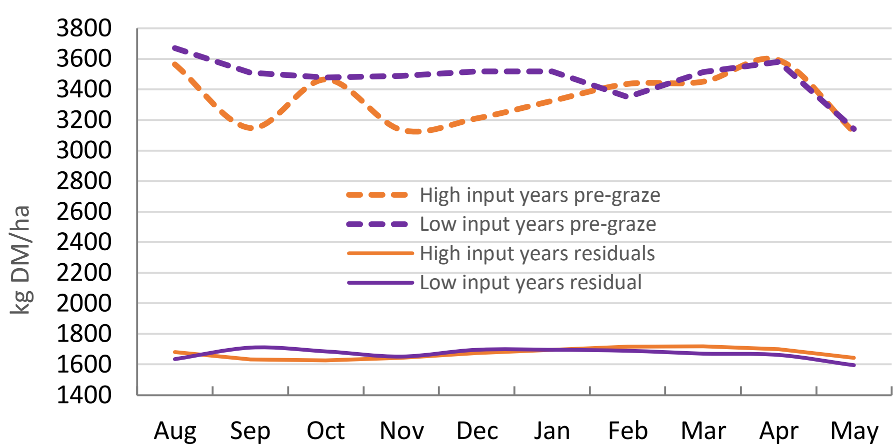
Farmers should anticipate this sequence of events happening if making large reductions in N fertiliser inputs.

Graph 7 shows what the pre- and post-grazing covers looked like at LUDF during the two phases.

Generally-good control of post-graze residuals from high pre-graze covers during the lower input years was assisted by:

- a progression toward tetraploid ryegrass cultivars in pastures (in 2010, about 20% of paddocks contained tetraploids: by 2019, this had increased to 95%); and
- use of pre-graze mowing.

Graph 7. Average pre- and post-grazing cover at LUDF in the 'high input' and 'lower input' years



4. Pasture quality

Compared with the high N fertiliser years, the average ME of pasture across the full lactation was about 2% lower, and the crude protein content of pasture about 11% lower, in the 'lower input years' (Table 2).

Overall, this would have improved the balance between energy (ME) and nitrogen (crude protein) in the pasture eaten by cows during the lower input years. In turn, this should have reduced the amount of N excreted in urine. But we have no way of confirming this – urinary N wasn't measured, nor is this effect included in Overseer.

Table 2. Comparison of pasture metabolizable energy (ME) and crude protein in pasture at LUDF in the 'high input' and 'lower input' years

	High input years	Low input years	Difference
Metabolisable energy (MJ/kg DM)	12.2	12.0	- 0.2 (- 2%)
Crude protein (% DM)	23.4	20.8	- 2.6 (- 11%)

It is important to mention that clover has returned to the pastures as it was before the clover root weevil outbreak. We expect this would also have 'buffered' the effects of halving N fertiliser inputs, but no information was available on pasture composition to check this.

5. Summary of key points:

a) N fertiliser inputs were reduced by an average of 158 kg N/ha per year between the high input and low input years
b) As a result, pasture growth rates were lower in most months and by ~ 1.5 t DM/ha per year annual total
c) Lower growth rates meant it took longer to reach the pre-graze covers required to meet feed requirements, automatically resulting in longer rounds (average 4 days) and higher pre-graze targets. Farmers should anticipate this sequence of events if making large reductions in n fertilsier use.
d) On average there was 1.7 fewer grazings per year during the lower input years, which helped reduce total N inputs (1.7 fewer N applications)
e) Longer rounds/fewer grazings meant led to higher leaf stage at grazing in the lower input years (2.3 versus 1.9) and an estimated 1.1 t more pasture DM grown compared with staying on the same round length/leaf stage that applied during the high N fertiliser input years
f) This 'buffered' the expected large negative effect on pasture production of halving N fertiliser inputs.
g) Higher pre-graze covers under the lower N inputs reduced average ME of pasture by about 2% on average across the whole lactation. This did not appear to restrict milk production.
h) At the same time, crude protein in pastures was 11% lower which, in combination with only a small decrease in ME, should have resulted in less urinary N being excreted by cows in the lower input years.