Management guidelines for reducing nitrogen fertiliser use: an approach to reduce nitrate leaching from dairy systems.

This document summarises three trials that decreased Nitrogen (N) fertiliser inputs.

With nutrient loss limits being progressively implemented by regional councils at farm and catchment level, reducing N leaching from the milking platform needs addressing.

There is no single solution to reducing N leaching and staying profitable so a range of changes (big and small) may need to be applied to a farm system.

The Pastoral 21 research trial on three farmlets (Waikato, Canterbury and Southland) tested reducing the amount of N (supplements and N fertiliser) entering the farm system and then using the remaining N as effectively as possible to sustain production and reduce the amount leaching. This document describes the results compared with a control farmlet that maintained N inputs at a higher level.

Key findings

1. Limiting N fertiliser applications to a dairy system can be a cost-effective method to maintain production and profit, and reduce N leaching.
2. Reducing N fertiliser and supplements may result in decreased stocking rate in response to reduced feed supply (less pasture grown and supplement).
3. As a result, a high level of pasture management is required to maintain quality and identify surpluses and deficits early.
4. It is important to use fertiliser applications at times and at rates that maximise dry matter production per unit of N applied.
5. Regional and on-farm climate, soil types and infrastructure differ – meaning individual solutions will need to be designed.

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Research trial descriptions

The Waikato trial started with the aim of applying 50kg N/ha/year. As this was a limited amount the trial developed a strategic approach (rather than tactical), planning to apply 25kg N/ha early season and 25kg N/ha late season (March), to match early season feed demand and extend lactation later in the season. The control was a standard grass based Waikato farm, applying 138kg N/ha.

In the Canterbury trial, the 'lower input efficient' farm system was set up with a strategic target of using no more than 150kg N per year on pastures, applied throughout the year as needed. This is lower than typical N rates used on well-irrigated farms in Canterbury. The control was a high input grass based system applying on average 317kg N/ha.

The Telford trial in South Otago was set up with a strategic target of using no more than 30kg N/ha per year on pastures. The majority of the available N fertiliser was targeted at Italian ryegrass pastures in spring to boost their high growth rates at this time. The control was a standard grass based farm applying on average 107kg N/ha.

How much grass will I grow?

Due to the reduction in N fertiliser and stocking rate, it is to be expected that there will be a reduction in how much grass is grown, with climate variation also causing seasonal differences.

Waikato's low N input system reduced N fertiliser by 86kg N/ha/year and grew 1.5 t/DM/ha less than the control. The stocking rate was reduced by 0.6 cows/ha.

Canterbury's low input system reduced N fertiliser by 154kg N/ha/year and grew 1.8 t/DM/ha less than the control. The stocking rate was reduced by 0.4 cows/ha.

Telford's low input system reduced N fertiliser by 67kg N/ha/year and grew 0.9 t/DM/ha less than the control. The stocking rate was reduced by 0.1 cows less/ha.

How much milk will be produced?

Waikato trial: the low input system produced 68kg MS more per cow and 50kg MS less per ha.

Canterbury trial: the low input system produced 43kg MS more per cow and 573kg MS less per ha.

Telford optimal system: produced 4kg MS per cow and 33 kg MS less per ha, than the control.

Did the trials make a profit?

All three trials ran a 'control' to compare a low input system against a regional standard herd, due to differences in cost structures profits differed between regional sites. At comparable milk price operating profits/ha were:

The Waikato trial low input system was $227/ha less profitable ($7.30/kg MS).

The Canterbury trial was $190/ha less profitable ($6.30/kg MS).

The Telford trial was $131/ha more profitable ($6.45/kg MS).

It should be noted the impact of milk price on profitability. The Canterbury trial analysed profitability based on milk payout of $5.10 and $6.97, with the lower input system being more profitable at a low payout and less at high payout when compared to the control.

How much will this reduce N leaching?

Again the amount of N leaching is dependent upon on-farm climate, soil type and access to infrastructure (i.e. ability to hold cows off when nitrogen is at high risk of leaching). Over the three years of the trial the low input sites compared to the control's decrease N leaching by:

Waikato trial by 43%*

Canterbury trial by 22%

Telford trial by 22%

*The Waikato trial also used an off paddock facility to remove cows during autumn. Modelling showed that 50% of the N leaching reduction was due to cows being taken off paddock and 50% due to low input system.

How does limiting N fertiliser application reduce N leaching and profitability?

Lowering feed and fertiliser inputs reduces the total feed supply, resulting in reduced feed eaten per ha and therefore the N eaten and excreted by the herd.

The Waikato farmlet had a 15% reduction in N eaten/ha compared with the control. This reduction in feed eaten/ha can reduce production and profitability. To minimise this reduced stocking rate the point where annual feed allowance per cow is increased. The aim being to increase production per cow to compensate for reduced stocking rate. In the Waikato farmlet cows/ha reduced by 19%, but there was a 19% increase in MS/cow.

Reducing stocking rate will reduce the number of urine patches and the potential for N leaching.

Production and profit were maintained through efficient management of reduced inputs and known grazing principles, resulting in:

- Achieving more milk production per kg of live-weight
- Reduced costs due to fewer cows and lower replacement rate
- Use of N fertiliser to fill deficits, not to boosts surpluses
- Focus on using pasture where possible (not supplements) through applying principles of pasture management and grazing

What would my farm system look like?

The three trials – due to climate, soils and infrastructure availability – set their farm systems up differently to meet the target of reducing N leaching and staying profitable. Each system was modelled first to check viability. The differences compared to the control over three lactations were:

Waikato

- N fertiliser applied only at 2 or 3 critical periods (using long-term growth rates and weather forecasts)
- N fertiliser applied reduced from 137kg N/ha to 52kg N/ha applied mostly in spring
- The low input system used higher BW cows to help generate higher production per cow at the reduced stocking rate
- Cows were put on a stand-off between 8 and 16 hours from March to June to reduce urine deposited on pasture
- The stand-off combined with less feed eaten/ha resulted in 19% less urine N deposited per ha.

Canterbury

- N fertiliser applied based on the weekly feed wedge and saving enough N for later summer applications
- N fertiliser applied was reduced from 309kg N/ha to 159kg N/ha, with N only applied when the feed wedge shows deficit or paddocks display signs of deficiency (i.e. clear urine patches, yellowing, or poor performance), rather than blanket application to all paddocks
- Stocking rate dropped by 1.5 cows/ha
- 4t DM/ha/yr less supplement offered.

Telford

- Applied N fertiliser reduced from 109kg N/ha to 42kg N/ha. The lesser amount was mostly applied to annuals (Italians) to boost spring growth and the rest of farm when deficit shown, rather than following the cows
- Italian ryegrass pastures established for late winter/ spring feed
- Whole crop silage made on 10% farm for low N autumn feed
- Stocking rate dropped by 0.1 cows/ha.

Calving date became later to better match pasture supply to demand.

The lessons learnt when making changes to the existing farm systems are:

- Determine how much nitrogen fertiliser regional regulations will allow
- Match the bulk of the available fertiliser with the periods of highest pasture growth response, so as to maximise pasture growth
- Adjusting the stocking rate to the new level of annual pasture growth so that the feed offered annually per cow is increased
- Carry any surplus pasture generated with efficient fertiliser N use forward to keep cows in milk for longer when autumn pastures slow down.

A high level of pasture management and monitoring is needed to continue to provide high-quality pasture.

Regional differences and the ability to use irrigation will have an impact on the use of Nitrogen.