

# Tactical use of nitrogen fertiliser

Find out how nitrogen fertiliser use can be carefully targeted and managed to assist pasture growth, without compromising the environment or your profits.



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## Nitrogen fertiliser use in New Zealand

With the limelight on high-input farming systems and nitrogen (N) contributing to water quality degradation and greenhouse gas (GHG) emissions, it's timely to re-visit how best to use a lesser amount of N fertiliser on grazed pastures.

In the last 25 years, the annual application of N via fertiliser has increased more than six-fold in New Zealand, from 59,000 tonnes in 1990 to 429,000 tonnes in 2015. The dairy sector is the largest user: 63 percent of all N fertiliser used in New Zealand<sup>1</sup>.

This increase has been partly due to an increase in land area used for dairy farming<sup>2</sup>, but annual rates of N used on dairy farms have also increased in general. For example, an average use of 40kg N/ha in the late 1990s has increased to an average use of 45kg N/ha for System 1 farms, and up to 156kg N/ha for System 5 farms (overall average 126kg N/ha) in 2015/16<sup>3</sup>.

## Seasonal considerations

N fertiliser trials in the 1970s and 1980s showed that well-managed ryegrass/white clover pastures in New Zealand were N deficient, responding well to N fertiliser.

In late autumn to early spring, low temperatures usually restrict clover growth, N fixation and mineralisation, resulting in less N available for the grass<sup>4</sup>. So N deficiency is more pronounced in spring, when soil temperature and moisture don't limit grass growth, and rapid production responses to fertiliser N can be expected<sup>5</sup>.

Consequently, the tactical use of N fertiliser in autumn and early spring was promoted to maintain the N fixation and feed quality benefits of clover in late spring through to early autumn.

Care needs to be taken to avoid long-lasting shading of clover stolons (runners) in spring by prolonged canopy closure (e.g. with

## KEY MESSAGES

- New Zealand grass/clover pastures are inherently nitrogen (N) deficient and will respond to N fertiliser when growth conditions are right.
- Many farmers have moved from a tactical use of N fertiliser to fill feed deficits, to production systems that rely on N fertiliser all year round.
- Higher N application and pasture yields increase animal N intake per hectare and urinary N excretion, which increases the risk of N loss to the environment.
- Overseer is responsive to reductions in N fertiliser rates, so when N leaching limits apply, N fertiliser use should be evaluated.
- Farm N surplus and kg milksolids produced per kg N fertiliser indicate if N fertiliser rates are compromising profit and environment.
- Restricted annual N fertiliser rates increase the need for tactical use of N fertiliser.

heavy silage cuts). Shading of clover stolons reduces branching. This reduces clover production and, hence, N fixation later in the year, risking lower summer pasture yields.

Response to autumn applications could be too slow to fill autumn feed gaps but could help to achieve desired pasture covers going into winter.

## What's the approach since then?

From the 1990s on, the increased rates of N fertiliser illustrate a move away from relying on clover N fixation and shifting to frequent N applications (e.g. routinely after every grazing or silage cut). It can be easier to manage N-fertilised pasture than clover-based pasture because of greater predictability of pasture production and less year-to-year variation<sup>6</sup>. Also, when N fertiliser is applied during good pasture growth conditions and additional pasture is utilised to produce milk, N fertiliser use is nearly always economical.

## How high is too high?

High rates of N fertiliser achieve pasture production greater than can be achieved with N fixation in grass/clover pastures, when growth conditions are favourable (i.e. no lack of other soil nutrients and water, optimal temperatures, no weeds, no pests and no diseases).

However, if higher pasture production is utilised by grazing animals, total N intake/ha is greater, and more N is excreted in urine. This reduces the efficiency of N use, increases the farm's N surplus and increases the risk of N loss to the environment (for an example, see *Figure 1*). Results from DairyBase data presented in an earlier DairyNZ *Technical Series* article illustrate this<sup>3</sup>.

## Response indicators

There are several indicators available to assess if N fertiliser can be expected to provide sufficient pasture and milk production responses, or if the amount of N in the system poses a risk to the environment.

### 1. Soil organic matter or soil total N

Soils with a high organic matter or total N content have relatively high soil mineral N and mineralisable N available for plant growth. This reduces the need for N fertiliser<sup>7</sup>. Soil tests and associated recommendations are available commercially.

### 2. Farm N surplus or surplus of purchased N

This is the difference between N inputs (N in fertiliser and supplements = purchased N) and N outputs in products (milk, meat, crops) and is related to the risk of loss to the environment.

Efficiency gains are possible when a farm's surplus of purchased N is relatively high, for example compared with the median surplus of purchased N of 130kg N/ha for a System 4 dairy farm, and 70kg N/ha for a System 2 farm<sup>3</sup>.

**Note:** Overseer's N surplus includes N inputs from biological fixation and irrigation water and is therefore higher than the surplus of purchased N.

### 3. Kg milksolids produced per kg N fertiliser

When production is low for the amount of N fertiliser used (<6kg MS/kg N fertiliser), N fertiliser use efficiency is low and a reduction in N fertiliser rate is likely to be profitable<sup>9</sup>.

*Figure 2* shows this is more likely to occur at annual N fertiliser rates of >200kg N/ha.

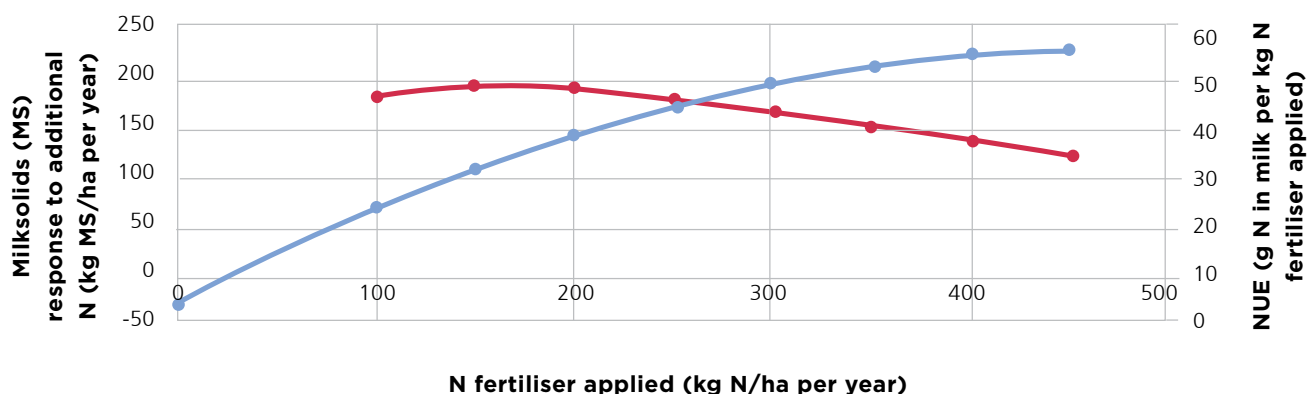
## Increasing N use efficiency

Earlier publications have summarised good management practice for N fertiliser use, e.g. other DairyNZ *Technical Series* articles<sup>10, 11</sup> and DairyNZ's *Farm Facts* on plant nutrition<sup>12</sup>. A comprehensive overview is the *Code of Practice* published by the Fertiliser Association of New Zealand<sup>13</sup>.

Here are some less well-known aspects of N fertiliser use<sup>12, 13, 14, 15</sup>.

- Pasture height needs to be above 3.5cm (~1500kg DM/ha) to respond to N fertiliser.
- Within four days after application, pasture does not respond to N fertiliser. This means it could be grazed without a response penalty in the following re-growth period.
- Thereafter, N uptake is rapid if growth conditions are good, but from four to 14 days after application, this is not yet converted to DM yield. Pasture N content is higher in these first weeks and, when grazed in this period, is associated with higher N excretion in urine and, therefore, higher risk of N loss to the environment.
- It takes 20 (spring) and up to 40 (autumn) days after application to get a significant yield response to N fertiliser.

**Figure 1.** Milk production response to additional N fertiliser\*



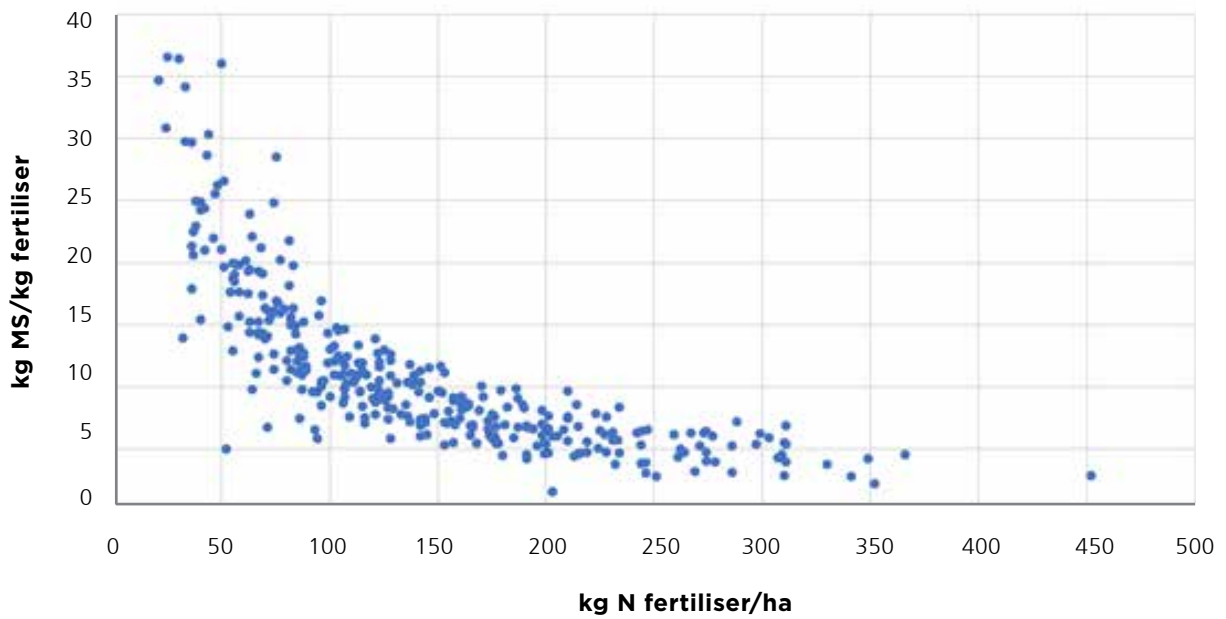
This graph indicates that milk production hardly responded to N fertiliser above 450kg N/ha.

At N fertiliser application rates of 100-200kg N/ha, the N use efficiency was greatest.

*\*(kg/ha, blue line, left hand axis) reported from seven farmlet studies conducted from 1971 to c. 1995<sup>8</sup>, and the associated N use efficiency (NUE, grams N in milk per kg N fertiliser added, red line, right hand axis).*



**Figure 2.** Milksolids production per kg N fertiliser used plotted against annual N fertiliser rates



Data from 2015/16 DairyBase<sup>3</sup>



Well-managed ryegrass/white clover pastures are N deficient and respond to N fertiliser.

- At low soil temperatures (<6°C) pasture growth is limited and a response will not occur until soil temperatures increase again.
- High soil temperatures (>16°C) inhibit grass growth, and response to N fertiliser will be limited.
- Grazing should take place at the 2.5- to three-leaf stage of perennial ryegrass to ensure pasture quality is maintained and high growth rates are utilised. However, prolonged shading of the plant base should be avoided because it will reduce clover branching and grass tillering.

### How to reduce N fertiliser use

When an assessment as indicated above indicates that a reduction in N fertiliser use might be environmentally or economically beneficial, a stepwise approach can be taken to adjust to a different N fertiliser management strategy.

The following recommendations are based on research cited above and on experiences from farmers participating in the Forages for Reduced Nitrate Leaching Programme\*.

- Use applications of maximum 25 to 40kg N/ha. N applications of 40kg N/ha are useful only when conditions for pasture growth are optimal and pasture surplus to requirements for grazing is harvested for silage, to avoid high pre-grazing covers and residuals.

- Ensure round length is not faster than the number of days needed for significant yield response (e.g. 20 days in spring, as mentioned on page 9) and that pasture is consistently grazed at the 2.5- to three-leaf stage. This may reduce the total number of grazings per year and 'automatically' reduce the number of N applications, if routinely following the cows with fertiliser.
- A longer round length reduces the N content in pasture and, therefore, urinary N excretion.
- Skip a few paddocks from your routine applications when pasture growth rates are high and silage making is not wanted/needed. A weekly farm walk and constructing a feed wedge will help with these decisions.
- Skip N applications on paddocks in summer when clover content is high.
- Reduce or don't apply N fertiliser in late autumn, when average cover is sufficient and risk of drainage is increasing.
- Ensure N fertiliser is applied to the paddocks targeted. If using contractors, check the application tracking data.

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