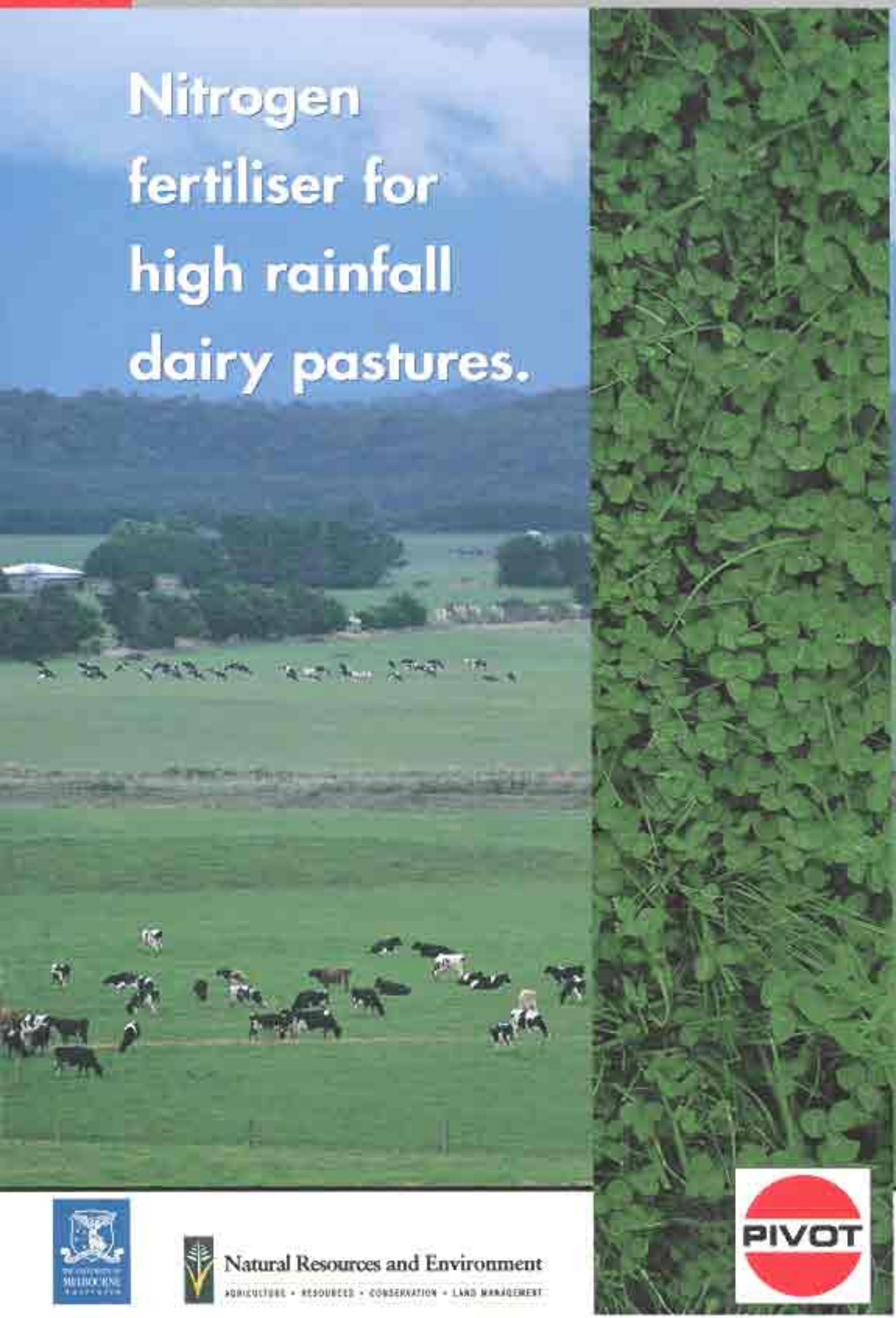
Nitrogen fertiliser for high rainfall dairy pastures.



Natural Resources and Environment

AGRICULTURE • RESOURCES • CONSERVATION • LAND MANAGEMENT

PIVOT

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INTRODUCTION

Nitrogen (N) fertiliser is a management tool for manipulating pasture yield and quality. Nitrogen fertiliser use on Victorian dairy pasture has increased significantly over the past 15 years (see Figure 1).

This brochure aims to provide some practical management guidelines for the use of nitrogen fertilisers on intensive dairy pastures. The guidelines presented here have been developed from research conducted in south-west Victoria, Gippsland and Tasmania.

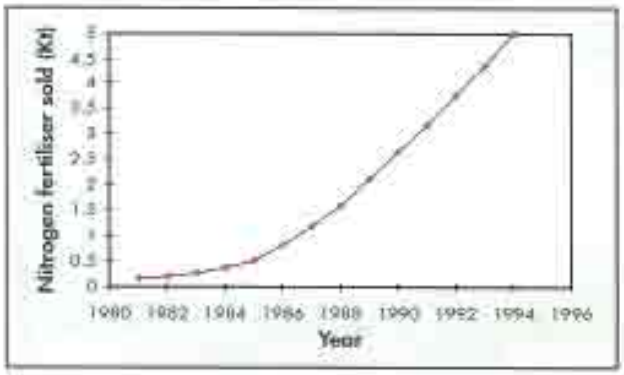

Figure 1. Trends in nitrogen fertiliser sales to pastoral farmers in Victoria over the past 15 years.

1. Nitrogen Strategies

There are 3 main nitrogen strategies that we see on farms:

- **No Fertiliser Nitrogen.**

The pasture relies purely on clover to provide all the nitrogen. This system is well suited to low stocking rates.

- **High Nitrogen.**

Nitrogen fertiliser is applied after every grazing while the pasture is growing. This system is suited to very high stocking rates.

- **Strategic Nitrogen.**

Nitrogen fertiliser is applied tactically, as and when additional feed is required. Here nitrogen fertiliser could be considered **a feed supplement and not a fertiliser.** Figure 2 shows the main periods in the season when clover cannot supply sufficient nitrogen, due to colder temperatures, but grass can still grow and respond to nitrogen fertiliser.

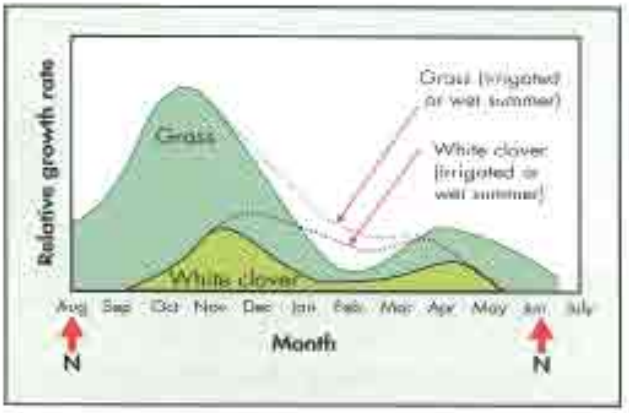

Figure 2. Relative growth patterns of perennial ryegrass and white clover. Arrows point to periods of the year when low temperatures limit clover growth, justifying nitrogen (N) fertiliser use.

2. Before Applying Nitrogen Fertiliser

When planning an application of nitrogen fertiliser, the following principles may help you target paddocks that will give the best return:

- **Soil temperature.**

Ryegrass can respond to nitrogen as long as soil temperatures are above 3-4°C, while white clover effectively stops growing, and fixing nitrogen, below 10°C soil temperature (see Figures 2 and 3).

- **Soil moisture.**

If the pasture is even slightly moisture-stressed, the response to nitrogen fertiliser will be restricted. Likewise, prolonged waterlogging can reduce pasture response in winter.

- **Soil fertility.**

If other soil nutrients are limiting pasture growth, then the response to nitrogen will be limited (see Figure 4).

- **Pasture species.**

Annual, short rotation and perennial ryegrasses respond most efficiently to nitrogen fertiliser in that order, with most other species being less efficient (see Figure 4). It would therefore make sense to target pastures high in these species.

Regular application of 60 kgN/ha post grazing (right) during winter significantly increases pasture production compared with no nitrogen fertiliser (left).

3. Nitrogen Rates

Although pastures respond to single nitrogen application rates over 120 kg nitrogen per hectare, overall efficiency of nitrogen use is best at rates between **25 and 60 kg nitrogen per hectare.** Below these rates, responses to nitrogen are less predictable. Above these rates, both nitrogen losses increase and nitrogen efficiency decreases significantly.

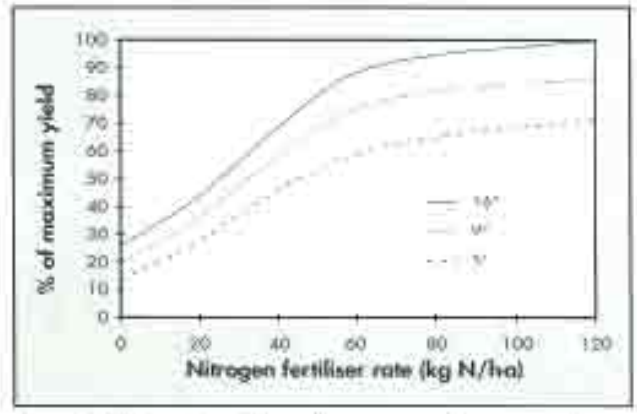

Figure 3. A typical pattern of response of a perennial ryegrass/clover pasture to N fertiliser, as affected by soil temperature.

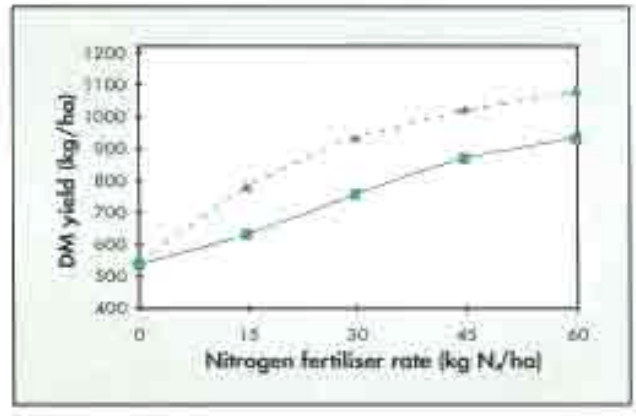

Figure 4. The combined effect of soil fertility and pasture species on the yield response to increasing rates of nitrogen. The top line represents a pasture with 37 ppm Olsen P and 65% ryegrass, and the lower line 17 ppm Olsen P and 25% ryegrass (Frank McKenzie, Western Victoria).

4. Timing of Nitrogen

When your herd's feed demand exceeds normal pasture production levels, as in winter, nitrogen fertiliser is a potentially profitable means of supplying additional forage. Advance planning is required to effectively fill this feed gap, as the pasture must be given time to respond to the applied nitrogen. The data in Table 1 may be used as a guide to the potential response from nitrogen fertiliser.

Nitrogen is most efficiently applied soon after grazing, as long as the pasture has some green leaf (i.e. 1400-1500 kg DM per hectare)

Table 1. The pasture response time and potential nitrogen efficiency of a ryegrass and clover pasture, assuming ideal fertility, pasture species and soil moisture. Ranges should be used to adjust to local conditions.

Season	Response time (days)	Nitrogen efficiency (kg DM/kg N)
Autumn		
• Early	28 - 36	9 - 14
• Late	28 - 42	6 - 12
Winter		
• Early	42 - 91	6 - 12
• Late	20 - 30	12 - 16
Spring	14 - 28	14 - 20
Summer		
• Wet	21 - 28	11 - 16
• Dry	45 - 60	7 - 12

5. Nitrogen Products

There are many sources of nitrogen on the market today, as well as many blends of nitrogen with other fertilisers.

As there are differences in the composition and nitrogen content of these products (see Figure 5), it is important that you apply the recommended elemental rate of nitrogen.

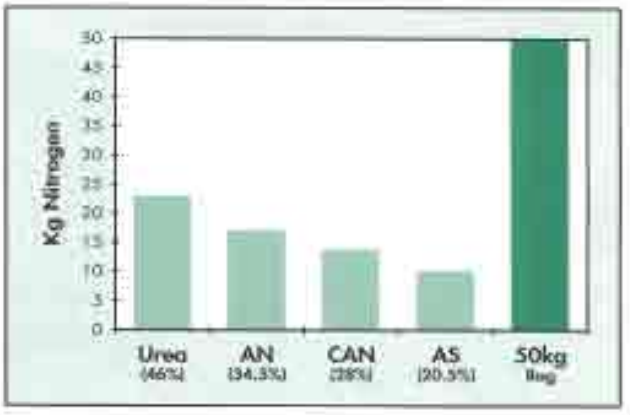

Figure 5. An illustration of the amount of nitrogen in a 50 kg fertiliser bag (right), either as urea, ammonium nitrate (AN), calcium ammonium nitrate (CAN), or ammonium sulphate (AS). The actual nitrogen content of each source is in brackets, i.e. 100 kg urea has 46 kg nitrogen.

This means that the choice of nitrogen products depends on 3 factors:

- If other nutrients are adequate, then use the lowest cost per kg nitrogen.
- If nitrogen and phosphorus are required together, then DAP could be the most cost effective product for both elements.
- If additional nutrients are required, a blend of fertilisers may be used.

6. Environmental Impact

Nitrogen may be lost from a dairy pasture system in many ways. The most important of these would be:

- **Dung and urine.**

Both dung and urine are very high in nitrogen. More than 60% of the nitrogen deposited in a urine patch will be lost, either through leaching (in soil water) or volatilisation (as ammonia gas). High losses of nitrogen may also result from cows standing in laneways.

- **Ammonia volatilisation.**

Ammonia volatilisation results from urea applied either as fertiliser or as urine. During the cooler and wetter months these losses are seldom above 10% of the nitrogen applied. However, in the summer losses may be as high as 25%. In hot weather, 10 mm of rain within 24 hours of urea application should halve volatilisation loss, while 20 mm rain should eliminate urea loss altogether.

- **Nitrate leaching.**

Leaching is the process of loss that is of greatest environmental concern, as water entering the streams and ground waters may be polluted with nitrate from dairy pastures. To minimise nitrate leaching from pastures:

- Nitrogen fertiliser rates should not exceed 60 kg nitrogen per hectare in any single application (see Figure 6).
- Apply nitrogen only when the pasture is actively growing and can utilise the fertiliser, especially during periods of high rainfall.
- Avoid applying nitrogen fertiliser to well drained soils if heavy rains are predicted.
- Avoid excessive pugging of pasture in winter.

Sampling nitrogen losses through ammonia volatilisation (top) and nitrate leaching at the Dairy Research Institute, Ellinbank.

- **Denitrification**

Denitrification occurs when nitrate in warm, waterlogged soils is converted to nitrous oxide, a powerful greenhouse gas. Fortunately, in south eastern Australia, soils are usually either waterlogged and cold in winter, or warm and dry in summer. The periods of greatest loss would be around the autumn break and in late spring, on waterlogged soils when soil temperatures are above 10°C.

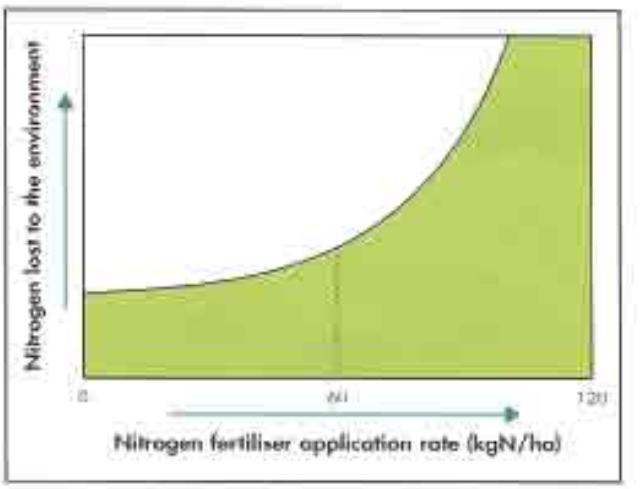

Figure 6. An illustration of the increasing trend of total nitrogen loss to the environment as nitrogen fertiliser rate is increased (data from Curran & Clough, New Zealand).

7. Animal Health

There are 2 main health problems that are associated with the excessive use of nitrogen fertiliser:

- **Nitrate toxicity.**

This is not common in dairy pasture systems in south eastern Australia and is almost always associated with a forage crop or capeweed. Nitrate toxicity is usually seen in unadapted, hungry and/or dry cows (no stockfeed), where there is a sudden change of diet (i.e. moving from a good pasture to one in which a volunteer forage crop or weed has invaded). Although perennial ryegrass is not known to accumulate toxic levels of nitrate, annual ryegrass and short rotation ryegrass may accumulate nitrate (see Figure 7).

- **Ammonia toxicity/bloat** *(also referred to as free gas bloat, sad-cow syndrome or 'belly-ache').*

This is more commonly associated with annual or short-rotation ryegrass, fertilised with a high rate of nitrogen in spring or autumn. Unadapted, hungry and/or dry cows (no stockfeed) are most susceptible. Common symptoms of a sub-clinical problem would be:

- 'Belly-ache' or 'sad-cows'. Cows refusing lush pasture, usually due to a build up of ammonia and methane gas in the rumen.
- Ammonia smell in the dairy, as cows belch rumen ammonia and methane.
- Urine scalding in the pasture, due to urine of very high nitrogen content.

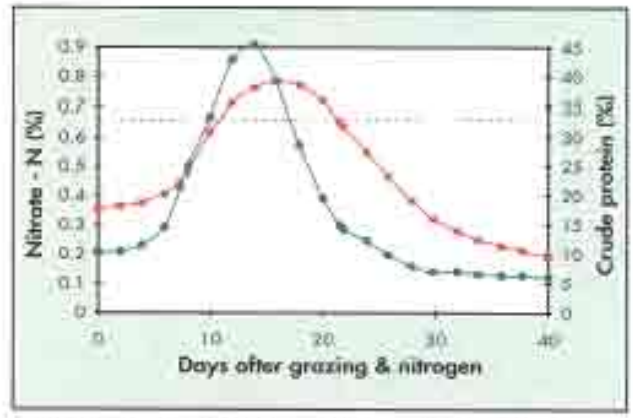

Figure 7. The change in nitrate (green line) and crude protein (red line) of an annual ryegrass pasture after grazing and nitrogen application (50kg nitrogen per hectare) in spring. The horizontal line indicates the level at which animal health may be affected.

Management recommendations to avoid both problems include:

- Do not graze pastures 7 to 14 days after nitrogen fertilisation, as nitrate levels are highest (see Figure 7).
- Do not apply more than 60 kg nitrogen per hectare in a single application. Lower rates are recommended where problems are suspected.
- Never give starved, unadapted or dry cows unrestricted access to highly nitrogen-fertilised postures.
- Cows that are suffering as a result of excess nitrogen in their diet tend to select for lower quality roughage. A bale of low quality hay in the corner of the paddock can be used as an indicator of nitrogen stress.

Nitrogen research site at the Dairy Research Institute, Ellinbank.

GLOSSARY

Nitrate Leaching:
Nitrogen in the soil is usually converted to the nitrate form, which moves (leaches) with soil water when it drains out of the soil.

Volatilisation:
The loss of nitrogen from urea (urine & fertiliser), in the form of ammonia gas.

Denitrification:
The loss of nitrogen when soil nitrate is converted to nitrous oxide, a powerful greenhouse gas.

Nitrogen Response:
The additional pasture growth resulting from the application of nitrogen fertiliser. Usually measured in terms of daily growth rate (kg DM per hectare per day), dry matter yield (kg DM per hectare), or nitrogen efficiency (kg DM per kg nitrogen applied).

Nitrogen Efficiency: *(kg DM per kg nitrogen applied)*
Measured in terms of the mass of extra pasture dry matter (kg DM) per kilogram of nitrogen fertiliser applied. This requires a comparison of yield without nitrogen.

Elemental Rate:
The percentage of nitrogen in a product, i.e. there is 46 kg of nitrogen in 100 kg of urea, so urea has an elemental rate of 46%.

Olsen P or Colwell P:
Measures of the phosphorus in the soil that is potentially available to plants. Pivotest laboratories provide both analyses.

For more information, please contact the author or your local Pivot Productivity Specialist.

Rules of Thumb

- If the grass is growing, nitrogen fertiliser can accelerate that growth.
- If pasture growth rates are low (i.e.10 kg DM per hectare per day), nitrogen fertiliser can almost double them (18 kg DM per hectare per day).
- There is no great difference in the quantity or quality of pasture produced by different sources of nitrogen fertiliser.
- A north facing slope may be as much as 2°C warmer than a south facing slope in winter, allowing a greater nitrogen response.
- Delaying the application of nitrogen fertiliser reduces the potential response by about 1% per day post grazing.
- In hot summer weather, 10 mm of rain within 24 hours of urea application will halve volatilisation loss, while 20 mm rain will eliminate urea loss altogether.