Nitrogen fertiliser (7-10)

There are three main sources of nitrogen (N) in New Zealand clover-based pastures. There is the N that is fixed by clover plants, there is fertiliser N (see below) and there is the N which is brought onto farms as imported supplementary feeds. All contribute to the N cycle, pasture production and N leaching. Nitrate N leaches into the waterways, this is an environmental hazard. Therefore managing the N cycle, through fertiliser N use, supplementary feed use and clover growth is very important for two reasons:

- To optimise the farm profitability and,
- To minimise avoidable N leaching to waterways.

The nitrogen cycle in a clover-based pasture producing about 900 kg MS/ha

Optimising clover growth

The optimal amount of fertiliser N and clover N to maximise profitability is dependent on both milk price and N fertiliser cost. Where management can optimise clover growth there are benefits in clover providing N and the clovers increasing the feed quality of the sward (clover is more digestible, has a higher energy value, ME than ryegrasses). The target clover content is between 30-40%. If this is achieved the clover will be adding 170 to 220 kg N/ha/yr.

The key principles for maximising clover growth are:

- Clover has a higher requirement for all nutrients (except fertiliser N) and therefore the fertiliser policy needs to maximise clover growth. This means operating at, but not above the optimal nutrient levels (see Farmfacts 7-1, 7-2, 7-3, 7-4 and 7-5).
- Achieving recommended pre and post grazing targets will help to prevent canopy closure and optimise the amount of sunlight getting to the clover plant. Refer to Farmfact 1-2 Principles of grazing management for more information.
Applying N when feed is not required leads to shading.

Applying high amounts of N reduces N fixation. The rule of thumb is clover N fixation declines by 3 kg N/ha for every 10 kg fertiliser N applied.

**Optimising fertiliser N use**

Nitrogen is not a supplement; it is a fertiliser as are the other 15 nutrients that plants require for growth. However, as N is often the last nutrient limiting growth it is treated as a supplement and the economic returns are based on the extra kg DM grown per kg N applied. Therefore to use N fertiliser profitably and to minimise the impact on the environment, clover growth and N fixation consider the following:

- Only apply N when other factors are not limiting growth and there will be an economic response (cost of extra kg DM grown from N related to milk price). Fertiliser N does no create growth if a factor other than N is limiting growth. N simply multiplies the growth that is occurring.
- Avoid using fertiliser N if it is going to add to the spring pasture surplus and result in a loss of feed quality
- Use fertiliser N to stimulate out-of-season ryegrass growth (i.e. early spring and late autumn and winter).
- Apply N at rates of between 25-30 kg N/ha/year (except in extreme feed deficits when a higher rate is required, up to 50 kg N/ha). These rates optimise the kg DM produced per kg N applied (see below).

**What influences the response rate to nitrogen?**

The amount of pasture grown in kg DM/ha per kg N/ha applied is the “response rate”. For example where 30 kg N/ha is applied and an additional 300 kg DM/ha of pasture is grown the response rate is 10 kg DM/kg N fertiliser applied. The response rate is dependent on:

1. Amount of available N in the soil – the greater the deficit, the higher the response
2. Soil temperature – the warmer the soil, the greater and more immediate the response
3. Plant growth – the faster the growth, the greater and more immediate the response
4. Moisture – too much or too little water will lower the response
5. Rate of N applied per application – there is a diminishing response at high application rates

Table 1 below shows that the best response to N fertiliser occurs on fast growing pasture, when other factors such as moisture and soil temperature are not limiting growth.

<table>
<thead>
<tr>
<th>Pasture growth rate</th>
<th>Pasture growth (kg DM/ha/day)</th>
<th>Response (kg DM/kg N)</th>
<th>Time for full response (weeks)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slow</td>
<td>10</td>
<td>5</td>
<td>10 - 14</td>
</tr>
<tr>
<td>Moderate</td>
<td>20 – 40</td>
<td>10</td>
<td>6 – 8</td>
</tr>
<tr>
<td>Fast</td>
<td>50 -70</td>
<td>15</td>
<td>5 - 6</td>
</tr>
<tr>
<td>Rapid</td>
<td>80</td>
<td>20</td>
<td>3 – 4</td>
</tr>
</tbody>
</table>
The likelihood (% probability) of getting a 10:1 response to fertiliser N is:

- Spring/early summer (80-100%)
- Late winter/early spring (60-80%)
- Autumn - high rainfall (50-70%)
- Autumn - low rainfall (20-40%) (See below).

**How N efficient is your farm?**

There are some simple tests to determine whether your farm operation is working efficiently with respect to the N cycle and fertiliser use:

- Inspect your pastures. If they contain less than 30% clover, check that your fertiliser policy or grazing management is not contributing to the lack of clover. Check for clover root weevil. See Farmfact 1-25 Managing dairy farms profitably with clover root weevil, for more information.
- Run a nutrient budget (see Farmfact 7-20) to calculate your N-use efficiency (i.e. the proportion of the total N (in clover, fertiliser and feed) going into the farm relative to the amount being captured in the products leaving the farm). For most farms there is a lot of room to improve N-use-efficiency.

**Types of fertiliser N**

All the common fertilisers (urea, ammonium sulphate and DAP) produce the same amount of DM per kg N applied i.e. a kg N is a kg N regardless of the product. Therefore choose the cheapest form based on the cost per unit N, after taking into account the value of the other nutrients (see below).

<table>
<thead>
<tr>
<th>Type</th>
<th>Cost ($/tonne)</th>
<th>Value of companion nutrient ($/tonne)</th>
<th>Cost of N ($)</th>
<th>Amount of N (kg)</th>
<th>Cost of N ($/kg N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urea</td>
<td>795</td>
<td>Nil</td>
<td>795</td>
<td>460</td>
<td>1.73</td>
</tr>
<tr>
<td>Coated urea</td>
<td>758</td>
<td>Nil</td>
<td>750</td>
<td>380</td>
<td>1.97</td>
</tr>
<tr>
<td>Ammonium sulphate</td>
<td>645</td>
<td>$102 (230 Kg of S at 0.45 cents/Kg)</td>
<td>560</td>
<td>205</td>
<td>2.73</td>
</tr>
<tr>
<td>DAP</td>
<td>1082</td>
<td>$680 (200 kg of P at $3.40/kg)</td>
<td>402</td>
<td>180</td>
<td>2.23</td>
</tr>
</tbody>
</table>

Note ¹ all costs are ex works April 2012
**Acidification due to N fertiliser**

Some N fertilisers produce acids when they dissolve and hence lower the soil pH over time. The effects however are very small. If you applied urea at 150 kg urea/ha (i.e. 75 kg N/ha) annually for about 20 years you would need about 1 tonne of limestone/ha to ‘mop’ up the acidity from the urea. Thus, the effects of fertiliser N on soil acidification are minor in comparison with the effects of all the other acid-producing reactions in the soil (see Farmfact 7-15).

<table>
<thead>
<tr>
<th>Type</th>
<th>Annual application rate (Kg N/ha/yr.)</th>
<th>Time (yrs.) for annual application to decrease the soil pH by 0.1 pH unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urea</td>
<td>75</td>
<td>18-27</td>
</tr>
<tr>
<td>Ammonium sulphate</td>
<td>75</td>
<td>4-6</td>
</tr>
<tr>
<td>DAP</td>
<td>50</td>
<td>33-50</td>
</tr>
</tbody>
</table>

Refer to Farmfact 7-11 Seasonal nitrogen use for more about N use throughout the year, and Farmfact 7-23 Minimising N Loss on farm for more information about N leaching and practical on farm methods for mitigation.

**Further reading**