Richard Eckard

Nitrogen Management
All plants need nitrogen (N) for growth

“Nitrogen (N) fertiliser can be a useful management tool for manipulating seasonal pasture growth rate, as and when additional forage is needed”

But,

too much nitrogen will increasingly be lost to the environment.
It takes about 600 kg N to grow 12 t DM/ha!

*Regardless of where the N comes from*

- **Dung and Urine**: 200 - 500 kg N/ha
- **Legumes**: 0 - 250 kg N/ha
- **Soil**: 100 - 250 kg N/ha

* New nitrogen

Eckard 2004
Gas

Ammonia

Nitrogen

Nitrous oxide

Milk, meat, wool
Hay, silage

15-50% of ‘new’ N

Runoff

Drainage

nitrate

organic

Only 30 to 40% of total N is fully recycled!

Eckard 2004
Stocking rate is however, the single largest determinant of N required and N loss.
• A source of ‘new’ nitrogen
• 0 and 250 kg N/ha per year
• Needs >25 - 30% clover in mix
• Average clover content
  – in Gippsland = 12%?
  – Western Victoria = 8-15 %?
• Temperature
  – $N_2$ fixation restricted at low soil temp (<10°C)
  – Only available during warmer months

• Most likely only 30 – 100 kg N/ha per year

Eckard 1998
Soil Organic Nitrogen

• ‘re-cycled’ N
• Sources:
  – Decaying grass and legume roots
  – Dung and urine
• N content:
  – Most pasture soils contain 6 – 8 t N/ha in the top 15 cm
  – BUT
  – Only around 1 - 3% available per year
    • Mineralisation is restricted at low soil temp (<10° C)
    • Only available during the warmer months
  – 50 – 250 kg N/ha per year from the soil

Eckard 2004
Nitrogen from Dung and Urine

- ‘re-cycled’ N
- 60 - 90% of the N in urine is liquid urea
- However, 40 - 60% of this N can be lost
- A single urine patch
  - Dairy cow = 1000 - 1300 kg N/ha
  - Beef cow = 300 – 500 kg N/ha
- BUT
  - Covers entire paddock every 3 - 6 years

Eckard 2004
What does N do?

• Essential for protein
• Growth rate
  – 30 – 150% increase
  – Leaf length and width
  – Plant vigour
  – Cold and stress tolerance
• Root volume
  – Water use efficiency
  – Nutrient uptake
Clover dynamics
N fertiliser
The concept of strategic N inputs
Perennial ryegrass/white clover

Relative growth rate

Month

Perennial Ryegrass

White Clover

Soil N
Clover N

Irrigated or wet summer

Eckard 2004
BMP for Nitrogen fertiliser

- Rate
- Source
- Timing
- Placement

4 Rs
- Right Rate
- Right Source
- Right Time
- Right Place
- Match rate & timing to plant demand

Eckard, Johnson, Chapman (2006)
Nitrogen Efficiency – what is it?

N Efficiency = the slope of the response curve
OR = kg ‘extra’ DM produced/kg N applied

Using an N efficiency of 10:1 as an example:
• If you are short 5 t DM
• 50 kg N/ha @ 10:1 = 500 kg DM/ha
• Apply 50 kg N to 10 ha
**Average N response – Gippsland (kgDM/kgN)**

<table>
<thead>
<tr>
<th>Pasture potential</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
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<tr>
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<td>3</td>
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<tr>
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<td>18</td>
<td>22</td>
<td>18</td>
<td>16</td>
<td>12</td>
</tr>
</tbody>
</table>
Nitrogen Rate

• Depends on additional growth required:
  – e.g.
  – 25 kg N => 8 – 20 kg DM/ha.day more
  – 50 kg N => 16 – 40 kg DM/ha.day more
• So it follows that (at 10:1):
  – 25 kg N/ha on 100 ha = 50 kg N/ha on 50 ha
  BUT
  – 40 kg/ha on 100 ha > 80 kg/ha on 50 ha
• ALSO
  – N over the whole farm is 7 – 10% less efficient than following the cows
Nitrogen Timing

Average Pasture growth rate vs. Days post grazing

Phase 1
Slow/negative growth post grazing due to:
1. Limited leaf area
2. Decay

Phase 2
Rapid Growth - Adequate leaf area for photosynthesis

Phase 3
Slower growth due to:
1. Shading
2. Decay
No difference between sources in yield
  - As long as the same N rate is applied
  - N losses do differ

- Urea (46% N)
  - Cheapest ‘pure’ N source
  - Ammonia Losses <10% (May-Nov)
  - Summer losses may be 14 - 20 %

- DAP (18%)
  - Cheapest ‘mixed’ N source
  - Top up with Urea
Nitrogen Source - losses

- Control
- Ammonium nitrate
- Urea

Eckard et al. 2002

Nitrous Oxide loss (kg N/ha)
Enhance Efficiency Fertilisers

• Nitrification inhibitors
  – DMPP
    • Entec (3,4-dimethyl pyrazole phosphate)
  – Nitrapyrin
    • eNTrench (liquid)
  – DCD (?)
    • Eco-N (Dicyanciamide)

• Urease inhibitor
  – Agrotain
    • Green urea (NBPT)

• Polymer Coated Urea (PCU)

• Not cost-effective in grazing systems?
Nitrogen losses
Ammonia Losses from Urea

- Comes back down in rain
  - 5 to 8 kg N/ha from deposition
  - But can form N$_2$O
- Autumn break to Nov
  - 3 to 6% of Urea-N lost
    - No specific management needed
- Summer months
  - 6 to 14% of urea N lost
  - 25% max recorded in Gippsland
  - Urea still cheapest N source
  - DAP & AN – minimal loss

Eckard et al. 2003
- Apply N 3 days before grazing
- Only during warmer months
50 kg **Urea-N** applied in Feb:
- No Rain: 0 – 13% loss
- Rainfall within 24hrs of N:
  - 5 mm: 7 – 10% loss
  - 20 mm: 0 – 1% loss
- Rainfall 24 hrs before N:
  - 20 mm: 7 – 21% loss

**Eckard et al. 2008**
• Free draining soils lose more nitrate
• Impacts accumulate over years
  – <10 kg N/ha through to >40 kg N/ha
• Warm and waterlogged soils

• Actual losses are low
  – 1 to 5% of N applied

• BUT

• Nitrous oxide is a powerful greenhouse gas
  – 310 times to GWP of carbon dioxide

Eckard et al. 2003
- Ammonium nitrate denitrifies more than urea
- Denitrification is higher in water logged soils than dry soils
- Higher denitrification with higher N and stocking rate

Eckard et al. 2003
Animal Health Effects
• Nitrate Toxicity
  – Annual ryegrass
  – Capeweed
  – Brassicas

NOT
  – Perennial ryegrass
  – Clover

• Ammonia toxicity/bloat
  – sad-cow syndrome
  – 'belly-ache'
  – Urine scalds/ammonia smell

Eckard 1994; 1999
In Summary

• N fertiliser can be a useful management tool
• Only apply N when pasture is actively growing
  – No closer than 28 days apart
• Apply Urea or DAP between 25 and 50 kg N/ha
  – The N rate depends on the extra growth rate required
• Avoid high rates of N on wet soils
• Stocking rate is the biggest influence on
  – N input demand
  – N loss to the environment