More Profit from Nitrogen:
Increasing nitrogen use efficiency in the sub-tropical and NSW dairy regions

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Increasing nitrogen use efficiency in the sub-tropical and NSW dairy regions

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More Profit from Nitrogen

The 4 R’s of fertiliser management

1. Optimising NUE in irrigated systems

2. Accounting for N mineralisation

3. Enhanced Efficiency Fertilizers

From nutrientstewardship.org
### Subtropical/NSW fertiliser use

<table>
<thead>
<tr>
<th>Region</th>
<th>Average annual Urea Use (kg/N/ha)</th>
<th>Median Urea Use (kg/N/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy NSW</td>
<td>43</td>
<td>18</td>
</tr>
<tr>
<td>Sub-tropical Dairy</td>
<td>86</td>
<td>37</td>
</tr>
<tr>
<td>Gipps Dairy</td>
<td>93</td>
<td>46</td>
</tr>
</tbody>
</table>

DA survey (2012) via IPNI

- 88% cite climatic conditions which prevent them applying urea.
  - paddocks are too wet to drive on (60%),
  - soil moisture is limiting and conditions are too dry (59%)
  - weather is too hot and/or windy (50%).
Generalised exponential rise to a maximum response of DM yield to increasing fertiliser N (fN) inputs (Godard et al., 2008) (b) Relationship between fN inputs and N losses (adapted from Shcherbak et al., 2014)
The N cycle in subtropical dairy pastures

Fertiliser N inputs 300-500 kg N ha/yr

Volatilisation NH3 losses from fertiliser – minimal under normal application conditions

Mineralisation: N released from soil organic matter

Soil Organic Matter pool
2%—5% Carbon
~9 tonne/N ha in top 30 cm

Gaseous denitrification losses:
N2O: 5—10 kg N ha\(^{-1}\) yr\(^{-1}\)
N\(_2\): 45–160 kg N ha\(^{-1}\) yr\(^{-1}\)
>20 kg N ha following heavy rainfall

Urine deposition:
Equivalent to >700 kg N ha, >30 kg N lost via denitrification

Legume fixation – minor in fertilised pastures

Volatilisation NH3 losses from fertiliser – minimal under normal application conditions

Ammonium Fertilisers
Urea

Soil Organic Matter pool
2%—5% Carbon
~9 tonne/N ha in top 30 cm

Mineralisation: N released from soil organic matter

#sandy/duplex soils
#heavier clay soils

N\(_2\) and N\(_2\)O
**Right rate – Accounting for mineralisation**

![Diagram showing N from mineralisation and zero N](image)

- Camden, NSW: Duplex soil, 2% C*. Mineralised 100 kg N ha\(^{-1}\) yr\(^{-1}\).
- Gympie, QLD: Laterite clay loam, 4.7% C*. Mineralised 170 kg N ha\(^{-1}\) yr\(^{-1}\).
- Casino, NSW: Heavy black vertosol, 3.1% C. Mineralised 190 kg N ha\(^{-1}\) yr\(^{-1}\).

~2% of total soil N annually
**Right rate** – Accounting for mineralisation, fertiliser interaction and soil type

\[^{15}\text{N} \text{ fertiliser recovery}\]

- \( ^{15}\text{N} \) Urea applied
- \( ^{15}\text{N} \) recovery 1
- \( ^{15}\text{N} \) recovery 2
- \( ^{15}\text{N} \) recovery 3
- 60 days
Casino

15N Urea applied 15N recovery 1 15N recovery 2 15N recovery 3

15N fertiliser recovered

Camden

15N Urea applied 15N recovery 1 15N recovery 2 15N recovery 3

15N fertiliser recovered
Variability in summer kikuyu pasture production metrics across different grazing cycles

*assuming a fodder value of $0.25 kg DM and $1.30 kg N urea fertiliser
**Nitrification inhibitors**

*assuming a fodder value of $0.25 kg DM and $1.30 kg N urea fertiliser*
Right product – Total denitrification (N₂ + N₂O) losses following large rain event

DMPP = 3.9 fold reduction in N₂
26-73% increase in immobilisation to SOM

DMPP at the lower rate increased annual yields by 31% compared to the equivalent urea treatment with no difference to the high N rates. 40% of the N added was lost.
Right time - Balancing soil N supply with plant N demand

Fertiliser N demand

Rye sowing – low N demand

Autumn N deficit

High summer mineralisation

Max Rye growth – high N demand
Mineralisation during summer can supply most of N requirements but higher N requirements in spring Rye season.

Autumn and late summer fertilizer requirements most variable/highest risk → tied to losses from large rain events.

EEF’s variable

Urease limited potential under “normal conditions”

Nitrification inhibitors can increase yields in spring Rye – long-term effect of higher soil N
  • DMPP reduces N losses if soil NO$_3^-$ aren’t too high prior applications

Limited potential to see a direct yield benefit in summer (swamped by high mineralisation)

EEF’s need to be applied at reduced rate (~15-20%) to be profitable.

If irrigation = ET denitrification losses will remain low (i.e. avoid over irrigation)

• Exponential increase of denitrification losses in response to WFPS
• Major losses of N$_2$+N$_2$O triggered by
  • repeated rainfall
  • waterlogging for >2 days,
  • after intense rainfall events following dry periods
  • Autumn Ryegrass establishment

• Mineralisation during summer can supply most of N requirements but higher N requirements in spring Rye season
  • Autumn and late summer fertilizer requirements most variable/highest risk → tied to losses from large rain events

• EEF’s variable
  • Urease limited potential under “normal conditions”
  • Nitrification inhibitors can increase yields in spring Rye – long-term effect of higher soil N
    • DMPP reduces N losses if soil NO$_3^-$ aren’t too high prior applications
  • Limited potential to see a direct yield benefit in summer (swamped by high mineralisation)
  • EEF’s need to be applied at reduced rate (~15-20%) to be profitable
Journal Papers published


• Friedl, J., Scheer, C., Rowlings, D.W., Deltedesco, E., Gorfer, M., De Rosa, D., Grace, P.R., Müller C., and Keiblinger, K.M., (2020). Effect of the nitrification inhibitor 3,4-dimethylpyrazole phosphate (DMPP) on N-turnover, the N2O reductase-gene nosZ and N2O:N2 partitioning from agricultural soils., Scientific Reports.


Journal Papers in review

• Friedl, J., De Rosa, D., Rowlings, D.W., Grace, P.R., Müller, C., Scheer, C. Sources of nitrous oxide from intensively managed pasture soils. Submitted to Soil Biology and Biochemistry (Jun 2020).

• Johannes Friedl, Clemens Scheer, Katharina M. Keiblinger, Evi Deltedesco, Markus Gorfer, Daniele De Rosa, Peter R. Grace, and David W. Rowlings. The legacy effect of different irrigation frequencies on N2 and N2O emissions triggered by an intense rainfall event. Submitted to Biogeosciences (March 2020).


• Friedl, J., Laura M. Cardenas, Timothy Clough, Michael Dannenmann, Chunsheng Hu and Clemens Scheer. Measuring denitrification and the N2:N2O emission ratio from agricultural systems. Invited review for Current opinions in environmental sciences. (March 2020).
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Visit

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The More Profit from Nitrogen Program:
*enhancing the nutrient use efficiency of intensive cropping and pasture systems*

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