Improving dairy farm NUE using advanced technologies
More Profit from Nitrogen: Improving dairy farm nitrogen efficiency using advanced technologies

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Research questions / objectives

• How can fertiliser N use efficiency be improved in high rainfall zone dairy systems of SE Australia?

• Investigate approaches to improve NUE;
  • Determine seasonal N fertiliser responses
  • Consider N supply from mineralisation in budget
  • Understand the fate of applied N
  • Understand the source of N for pasture nutrition
  • Assess the role of enhanced efficiency fertilisers
  • Use new technologies to determine N requirements
Major Research activities / methodologies

- >2.5 years of field trial in SW Victoria (Allansford)
- N response (0-80 kg N/ha), enhanced efficiency fertiliser
- Dryland and irrigated sites, plus additional short-term site
- Pasture biomass, N uptake, Agronomic NUE, Fate of applied N (15N)
- Multispectral imagery of pasture
Major Research activities / methodologies

- Prediction of mineralised N supply (models)
- $\text{N}_2\text{O}:\text{N}_2$ laboratory experiments
Findings: Seasonality of N response and NUE

\[ \text{NU}_{\text{AE}} = \frac{(\text{kg DM in fert trt} - \text{kg DM in control})}{\text{kg N applied}} \]

Regional practice

Graphs showing the relationship between N application and DM production, as well as N use efficiency across different seasons.
Findings: Variability of seasonal N response at autumn break
Management of water leading into autumn appears key for N response
➢ Mineralisation, N utilisation, Pasture growth potential
Over summer under dryland systems some moisture is required for mineralisation but high water input leads to lower mineral N at the break because of pasture growth.

**Findings: Mineralisation**

- 180-200 kg N ha\(^{-1}\) yr\(^{-1}\)
- \(~1\%\) of organic N pool
- Eg. 20 kg N ha\(^{-1}\) available at autumn break

**Drivers of soil N for Autumn growth**

- N rate
- Future temperature
- Soil OC

**Autumn mineralisation**

- Past temperature
- Past rainfall
Findings: Source of N for plants

<table>
<thead>
<tr>
<th>N rate kg ha⁻¹</th>
<th>N derived from fertiliser (%)</th>
<th>N derived from soil (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Autumn</td>
<td>Spring</td>
</tr>
<tr>
<td>20</td>
<td>18±2.5</td>
<td>21±2.1</td>
</tr>
<tr>
<td>40</td>
<td>35±1.1</td>
<td>36±6.0</td>
</tr>
<tr>
<td></td>
<td>Autumn</td>
<td>Spring</td>
</tr>
<tr>
<td></td>
<td>82±2.4</td>
<td>79±2.3</td>
</tr>
<tr>
<td></td>
<td>65±1.3</td>
<td>64±1.5</td>
</tr>
</tbody>
</table>

After 12 months (Autumn) and 8 months (Spring)

Majority of N comes from the soil
## Findings: Fate of applied N

Percentage recovery of fertiliser N in pasture from a single fertiliser event

<table>
<thead>
<tr>
<th>N rate (kg N ha(^{-1}))</th>
<th>Growth cycle</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AUTUMN</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>24.3</td>
<td>5.4</td>
</tr>
<tr>
<td>40</td>
<td>26.2</td>
<td>7.4</td>
</tr>
<tr>
<td></td>
<td>SPRING</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>22.5</td>
<td>16.1</td>
</tr>
<tr>
<td>40</td>
<td>22.2</td>
<td>13.0</td>
</tr>
</tbody>
</table>

Highest N recovery occurs in 1\(^{st}\) growth cycle, N continues to be taken up
Findings: Fate of fertiliser N

AUTUMN (12 months)

SPRING (8 months)

15N recovery (%)

Unaccounted
Total
Soil
Shoots
Roots

Applied N continues to cycle through soil-plant system – consider loss risk at application time
**Findings: Recovery of N in soils from SW Vic region**

Recovery (%) of N applied to soils of different properties, applying 40 kg N ha\(^{-1}\)

<table>
<thead>
<tr>
<th>Site</th>
<th>Texture</th>
<th>OC (%)*</th>
<th>Plant</th>
<th>Soil+roots</th>
<th>Total</th>
<th>Plant</th>
<th>Soil+roots</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coorimungle</td>
<td>Medium clay</td>
<td>5.5</td>
<td>36</td>
<td>36</td>
<td>72</td>
<td>26</td>
<td>36</td>
<td>62</td>
</tr>
<tr>
<td>Coorimungle</td>
<td>Sandy clay loam</td>
<td>7.4</td>
<td>32</td>
<td>30</td>
<td>62</td>
<td>49</td>
<td>27</td>
<td>76</td>
</tr>
<tr>
<td>Naringal</td>
<td>Sandy clay</td>
<td>11</td>
<td>30</td>
<td>30</td>
<td>60</td>
<td>33</td>
<td>25</td>
<td>55</td>
</tr>
<tr>
<td>Naringal</td>
<td>Sand</td>
<td>3.5</td>
<td>29</td>
<td>36</td>
<td>65</td>
<td>46</td>
<td>35</td>
<td>81</td>
</tr>
<tr>
<td>Panmure</td>
<td>Clay loam</td>
<td>4.0</td>
<td>31</td>
<td>36</td>
<td>67</td>
<td>39</td>
<td>29</td>
<td>68</td>
</tr>
<tr>
<td>Allansford</td>
<td>Loam</td>
<td>3.2</td>
<td>29</td>
<td>42</td>
<td>71</td>
<td>36</td>
<td>28</td>
<td>64</td>
</tr>
</tbody>
</table>

* 0-10 cm

55-81% recovery of N in the soil-plant system
Findings: N\textsubscript{2} loss and N\textsubscript{2}O:N\textsubscript{2} ratio

High losses of N\textsubscript{2} under wet conditions
Findings: Usefulness of new technologies

Normalised Difference Red Edge

Photochemical reflectance index

Intermediate growth stage gives best results
Key messages

• Pasture N largely from soil
• Applied fertiliser N cycles through plant-soil system over long-term
• Build soil N stocks through regular fertilisation
• Mineralisation supply is seasonal and can be predicted for budget
• Avoid high N use during times of low use / high loss risk
• Consider water management to maximise productivity – particularly at growing season margins
• Use of remote sensing technology shows promise for predicting N needs
Outputs for industry

• Update of BMPs
  o Autumn break N
  o Use of enhanced efficiency fertilisers
  o Seasonal mineralisation

• Mineralisation tool

• Remote sensing tools (proof of concept)

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

is a collaborative project of the cotton, dairy, sugar & horticulture industries of Australia.