The ‘Dairy Nitrogen Fertiliser Advisor’
An on-line tool to improve the profitability of nitrogen fertiliser use on dairy pastures

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Profit-maximising principles

With their advisors dairy farmers will be able to test their intuition about how much N to apply to a particular paddock, for the particular time of the year, so that the last kilogram adds to profit.
Dairy N Fertiliser Advisor Interface

Select your season and region for the current rotation
Select your most likely pre and post-grazing dry mass for the prevailing conditions and your typical N application
Estimate your “as spread” cost of lease and the equivalent market value of extra pasture consumed

N applied = 58kg N/ha
Profit maximising DM consumed 1003kg DM/ha
Pasture consumed from last kg of N applied = 5.34kg DM/kg N
Marginal return on last $ invested in N = $18

State
NSW SA Tas Vic WA

Season
Spring Summer Autumn Winter

Most likely post-grazing dry mass: 1500 kg DM/ha
Most likely pre-grazing dry mass: 2500 kg DM/ha
Market price for pasture consumed: $210 DM

Urea cost “as spread”: $830
Nitrogen cost “as spread”: $1370
What's in the text box?

<table>
<thead>
<tr>
<th>N applied (kg N/ha)</th>
<th>Pasture consumption (kg DM/ha)</th>
<th>Additional consumption compared with no N (kg DM/ha)</th>
<th>Average pasture consumption per kg N applied (kg DM/kg N)</th>
<th>Pasture consumption from last kg of N applied (kg DM/kg N)</th>
<th>Value of pasture consumed from last kg of N applied ($/kg N)</th>
<th>Cost of last kg of N applied ($/kg N)</th>
<th>Return from last kg of N applied ($/kgN)</th>
<th>Rate of return on last $ invested in N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>546</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>10</td>
<td>689</td>
<td>143</td>
<td>12.5</td>
<td>3.07</td>
<td>1.40</td>
<td>1.67</td>
<td>119%</td>
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</tr>
<tr>
<td>20</td>
<td>799</td>
<td>253</td>
<td>9.6</td>
<td>2.36</td>
<td>1.40</td>
<td>0.96</td>
<td>69%</td>
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<tr>
<td>30</td>
<td>884</td>
<td>338</td>
<td>7.4</td>
<td>1.82</td>
<td>1.40</td>
<td>0.42</td>
<td>30%</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>950</td>
<td>403</td>
<td>10.1</td>
<td>5.7</td>
<td>1.40</td>
<td>1.40</td>
<td>0.00</td>
<td>0%</td>
</tr>
<tr>
<td>50</td>
<td>1,000</td>
<td>454</td>
<td>9.1</td>
<td>4.4</td>
<td>1.08</td>
<td>1.40</td>
<td>-0.32</td>
<td>-23%</td>
</tr>
<tr>
<td>60</td>
<td>1,039</td>
<td>492</td>
<td>8.2</td>
<td>3.4</td>
<td>0.83</td>
<td>1.40</td>
<td>-0.57</td>
<td>-41%</td>
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<tr>
<td>70</td>
<td>1,069</td>
<td>522</td>
<td>7.5</td>
<td>2.6</td>
<td>0.64</td>
<td>1.40</td>
<td>-0.76</td>
<td>-54%</td>
</tr>
<tr>
<td>80</td>
<td>1,092</td>
<td>545</td>
<td>6.8</td>
<td>2.0</td>
<td>0.49</td>
<td>1.40</td>
<td>-0.90</td>
<td>-65%</td>
</tr>
<tr>
<td>90</td>
<td>1,109</td>
<td>563</td>
<td>6.3</td>
<td>1.6</td>
<td>0.38</td>
<td>1.40</td>
<td>-1.02</td>
<td>-73%</td>
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<tr>
<td>100</td>
<td>1,123</td>
<td>577</td>
<td>5.8</td>
<td>1.2</td>
<td>0.29</td>
<td>1.40</td>
<td>-1.11</td>
<td>-79%</td>
</tr>
</tbody>
</table>
Model of N fertiliser responses

\[ Y = \alpha (1 - \exp(-\beta - \lambda N)) \]

3 parameters....

- Maximum attainable yield when N applied is large and has had sufficient time to express itself (\( \alpha = 1 \))
- Implicit measure of existing soil nitrogen (\( \beta \), varies with season and State)
- Measure of curvature (\( \lambda \), constant)
Profit maximising N rate ($N^*$)

$N^*$ was obtained by equating the slope of the production function to the ratio of the cost of the input ($P_n$) to the value of the output ($P_{dm}$).

\[
\alpha \lambda \exp(-\beta - \lambda N) = \frac{P_n}{P_{dm}}
\]

\[
=> N^* = \frac{1}{\lambda} \left( \ln \left( \frac{P_n}{P_{dm}} \right) \right) + \beta
\]
Pre-and post grazing dry-mass:

Picture showing post-grazing residual of 4-6 cm, equivalent to 1,500-1,600 kg dry matter (DM) per ha. Source: http://www.dairyaustralia.com.au/~/media/Documents/Animal%20management/Feed%20and%20nutrition/thirtythirty/3030-%20PRG%20Max%20growth%20and%20nutritive%20value%201.pdf
Major N-type fertilisers used in the dairy industry

- Urea: 79%
- Ammonium sulphate: 11%
- Other specialised blends: 1%
- Ammonium nitrate: 2%
- Potassium nitrate: 6%
- Ammonium Phosphate: 1%
N cost ‘as spread’ (real)

![Graph showing cost of nitrogen as spread over years from 1983/84 to 2013/14.](image)
Market value of pasture forage
Equivalent market value of pasture ‘delivered’ (real)

<table>
<thead>
<tr>
<th>Year</th>
<th>Pasture market value</th>
<th>+1 SD</th>
<th>-1 SD</th>
<th>mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1983/84</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1988/89</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1993/94</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>1998/99</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>2003/04</td>
<td></td>
<td></td>
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<tr>
<td>2008/09</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2013/14</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
Ratio of N cost to pasture value

\[ \frac{P_n}{P_{dm}} \]

Year

Conclusions

The N-advisor provides production and profitability information that has the rigour and relevance to add value to farmer decision-making about their application of N.

- 40 years of experimental data on N fertiliser responses.
- Profit maximising principles
- What-if analysis on risky variables