Knowledge and tools for improved nutrient management in pasture systems

- Australian grazing industries contribute 45% of agricultural export earnings - worth $26 b in 2003/4
- Agricultural productivity has grown at 2% pa for the past 40 years
- Nutrients continue to be an important input for almost all grazing systems
• Australian grazing industries contribute 45% of agricultural export earnings - worth $26 b in 2003/4

• Agricultural productivity has grown at 2% pa for the past 40 years

• Nutrients continue to be an important input for almost all grazing systems

• At a national level, patchy and imprecise information on nutrient requirements for both productivity and environmental outcomes
DEPARTMENT OF PRIMARY INDUSTRIES

Better Fertiliser Decisions project

- Collate all existing experimental data relating to soil test - fertiliser responses in pasture production in Australia
- Develop new national & regionally specific soil test calibration relationships
- Develop tools for identifying the risk of nutrient loss to the environment
- Identify knowledge gaps for future research
- Work with national fertiliser industry to improve current fertiliser recommendations
DEPARTMENT OF PRIMARY INDUSTRIES

Better Fertiliser Decisions

Production Module
- Review
- Collate
- Organise
- Analyse
- Interpret

Environment Module
- Review
- Technical workshops
- Develop
- Validate
- Road-test

Communication Module
- Determine end and next user needs
- Develop products
- Road-test
- Disseminate information

1 Tas South
2 Tas Midlands and East Coast
3 Tas North East
4 Tas North
5 Tas North West
6 Tas Far North West
7 Vic East Gippsland
8 Vic North East
9 Vic West Gippsland
10 Vic North Central
11 Vic Wimmera
12 Vic South West
13 SA South East
14 SA Kangaroo Island
15 SA Lower Murray
16 SA Adelaide Hills
17 NSW South Coastal
18 NSW Central and Southern Tablelands
19 NSW Southern Highlands and Plains
20 NSW North Coast
21 NSW Northern Tablelands
22 NSW Northern Highlands and Plains
23 Qld Darling Downs and Burnett
24 Qld Central South East
25 Qld Dry Sub-tropics
26 Qld Wet Tropical Coast
27 WA South Coast
28 WA Great Southern
29 WA South West
30 WA West Midlands
What was so special about BFD?

Catalyst for bringing together grazing industry support, state agencies, regulators, and the fertiliser industry, nationally

- over 50 National Network members actively engaged
- over 90 nutrient management experts in regional workshops
- all states & major fertiliser companies represented

National Network team contributed to:

- collation of pasture and animal production fertiliser response data
- the interpretation of data
- delivery of products and information
Soil test calibration relationships

Relative Response (RR) equals the response (a) as a proportion of the potential yield (b)

\[
\text{Relative Response} = \frac{100 \times [\text{max}(\text{yield}) - \text{min}(\text{yield})]}{\text{max}(\text{yield})}
\]
Where did the data come from?

Total sites = 3001  
Total site years = 4333

Research Questions

Soil tests:
- Colwell P, Olsen P, Bray P, Acid Extractable
- Colwell K, Skene K, Exchangeable K
- CPC S, KCL40 S

Comparisons between:
- National, State, regional, experiments, sites
- Soil texture: S, SL, SCL, CL, C, volcanic clays
- Irrigated vs non-irrigated ???
- Soil pH ???
- P buffering ???
- Measurement method ???
Phosphorus
Categorisation of soils based on Buffering Capacity

Australian Phosphorus Buffering Index (PBI)
Burkitt, Moody, Gourley and Hannah (2001)

Soil Test Phosphorus – Colwell P National Data by PBI range
Colwell P critical soil test value = 19.64 + 1.11 × PBI value \(^{0.552}\)

<table>
<thead>
<tr>
<th>PBI category</th>
<th>Critical value(^1) for mid point of PBI category (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;15</td>
<td>Extremely low 23 (20 – 25)</td>
</tr>
<tr>
<td>15-35</td>
<td>Very very low 26 (25 – 28)</td>
</tr>
<tr>
<td>36-70</td>
<td>Very low 30 (28 – 31)</td>
</tr>
<tr>
<td>71-140</td>
<td>Low 34 (31 – 37)</td>
</tr>
<tr>
<td>141-280</td>
<td>Moderate 41 (37 – 44)</td>
</tr>
<tr>
<td>281-840</td>
<td>High 56 (45 – 65)</td>
</tr>
<tr>
<td>&gt;840</td>
<td>Very high n/a</td>
</tr>
</tbody>
</table>

Potassium
Soil Test Potassium – Colwell K National Data by Texture

<table>
<thead>
<tr>
<th>Soil texture</th>
<th>Critical value (mg/kg)</th>
<th>Confidence interval</th>
<th>Number of experiments</th>
<th>Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand</td>
<td>126</td>
<td>111-142</td>
<td>194</td>
<td>$100 \times \left( 1 - e^{-0.022 \times \text{Colwell K}} \right)$</td>
</tr>
<tr>
<td>Sandy loam</td>
<td>139</td>
<td>125-157</td>
<td>50</td>
<td>$100 \times \left( 1 - e^{-0.022 \times \text{Colwell K}} \right)$</td>
</tr>
<tr>
<td>Sandy clay loam</td>
<td>143</td>
<td>137-172</td>
<td>75</td>
<td>$100 \times \left( 1 - e^{-0.022 \times \text{Colwell K}} \right)$</td>
</tr>
<tr>
<td>Clay loam</td>
<td>161</td>
<td>150-181</td>
<td>122</td>
<td>$100 \times \left( 1 - e^{-0.022 \times \text{Colwell K}} \right)$</td>
</tr>
</tbody>
</table>

Sulphur
Soil Test Sulfur – CPC S National Data by Texture

Soil Test Sulfur – KCl 40 S National Data by Texture
## Soil Test Sulfur - National Data

<table>
<thead>
<tr>
<th>Sulfur test</th>
<th>Critical value (mg/kg)</th>
<th>Confidence interval</th>
<th>Number of experiments</th>
<th>State</th>
<th>Predominant soil types</th>
<th>Equation for % maximum yield =</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPC</td>
<td>3</td>
<td>2-4</td>
<td>94</td>
<td>Vic, NSW, Qld</td>
<td>Clay loam, Sandy loam</td>
<td>$100 \times (1 - e^{-1.014 \times CPC S})$</td>
</tr>
<tr>
<td>KCl\textsubscript{40}</td>
<td>8</td>
<td>6-10</td>
<td>37</td>
<td>NSW, SA</td>
<td>Clay loam, Sandy loam</td>
<td>$100 \times (1 - e^{-0.338 \times KCl\textsubscript{40} S})$</td>
</tr>
</tbody>
</table>

### Whole farm nutrient planning

Nutrient loss pathways
Objective

Develop a tool to identify the risk of nutrient loss from farms to the environment

Nutrient loss impacts

- Surface water quality degradation
- Groundwater quality degradation
- Greenhouse gas emissions

caused by

processes of P & N loss from pasture systems
Scope

Nitrogen
Phosphorus

Factors

Transport and flow delivery factors
- Soil type
- Waterlogging
- Proximity to waterways
- Rainfall
- Groundcover
- Landscape features

Nutrient source and management factors
- Phosphorus
- Nitrogen
- Effluent
- Stocking rate
- Hotspots

Vector Factors
Vector
Source
Risk of loss
Source Factors
Where is the greatest risk of N or P loss?

- Low risk of either N or P loss
- High risk of N loss
- High risk of P loss

High risk loss areas are often small compared with the size of the whole farm

From Farm to Catchment

- A Catchment Context
Nutrient budgets

Whole farm nutrient planning

- 30-50% diet from off farm source
- 1800 kg grain/cow (0-3.5 t/ha)
- 1000 kg hay/cow (0-1.8 t/ha)

- Dairy farms in net positive nutrient balance
### Farm gate budget

**Nutrient Budget for 200 cows on 100 ha**

<table>
<thead>
<tr>
<th>Inputs</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertiliser</td>
<td>200</td>
</tr>
<tr>
<td>Clover</td>
<td>80</td>
</tr>
<tr>
<td>Hay purcha</td>
<td>4</td>
</tr>
<tr>
<td>Barley</td>
<td>20</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>304</td>
</tr>
</tbody>
</table>

**Export in Animal Products**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Milk</td>
<td>80</td>
</tr>
<tr>
<td>Meat</td>
<td>9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>89</td>
</tr>
<tr>
<td><strong>Surplus</strong></td>
<td>215</td>
</tr>
</tbody>
</table>

### Nutrient distribution

*Whole farm nutrient planning*
Need for improvements in nutrient management

- Economic – inefficient nutrient use = wasted $ and missed opportunity
- Environmental - inefficient nutrient use increases risk of environmental impact
- Demonstrate to community including regulators that we are managing nutrients wisely and therefore….
- Avoid regulation of nutrient management as is the case in Northern hemisphere

Where are these nutrients accumulating?

- Highly spatially variable across farm
- Distribution related to farm practices and management
Why have an Australian nutrient accounting framework?

- Nutrients generally in surplus in dairy industry
- Spatial variability of nutrient re-distribution means lost economic opportunity and environmental risk
- Nutrient accounting improves understanding of nutrient flows on farms and identifies opportunities to improve their management
- Existing international models/frameworks lack the complexity/rigour required
  - provide a level of ownership by Australian industry
Project Objective

To develop a national nutrient accounting framework for Australian dairy farms.

The project will:
- Use the expertise of industry and scientific leaders in the field
- Draw on the experiences of international efforts on nutrient accounting
- Measure nutrient dynamics on ~50 farms drawn from across Australia’s dairying zones representing the full spectrum of production systems
- Develop an accounting framework for N, P, K, S, Ca and Mg for both farm and paddock scales
- Deliver information and tools to next users including fertiliser companies, milk factories, consultants and Dept advisory staff

Working with next and end users

Australian fertiliser industry
- Fertcare training program
- Integration into DS programs of major fertiliser companies
  - Fertiliser Response Relational Database’
  - Improved ‘response relationships’ for soil textural classes, regional, state, and national scales
  - Farm Nutrient Loss Index

Other key stakeholders:
- State Departments of Agriculture
- CMA’s, State EPAs
- Farmers and consultants
- Scientists
Take home messages

• National approaches need:
  – Realistic time frames
  – Investment in time and actual cash funding
  – Constant nurturing throughout the life of the project

• There is tremendous benefit in involving the next users
  – Right from the start of the project
  – Road testing of information and products

Our collaborators