Soil nutrient mapping and nutrient budgets for pasture management in Tasmania

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Farm nutrient mapping

- Delivered by TIA in conjunction with Dairy Tas, Fertiliser Co’s, Cradle Coast & KI NRM Groups

- TIA mapping started in 2005 – total of 4085 paddocks

- Concentrated in north west

- 81 dairy farms + 7 beef farms (King Island)

- Others are adopting the same approach
Farm locations
Main activities:

• Collect 30 soil cores from all paddocks on each farm to make one paddock sample for analysis

• Analyse for pH (water), Olsen Phosphorus (P), Colwell Potassium (K) and KCL Sulfur (S) [also Colwell P, pH (CaCl₂) and conductivity]

• Farm nutrient maps produced in GIS

• Nutrient budgets completed

• Look at best management for nutrients at a farm level
Project Outputs

Farmer Package

• Soil sample results

• Nutrient maps
  ▪ Phosphorous (Olsen)
  ▪ Potassium
  ▪ Sulphur
  ▪ pH

• Paddock summary

• Nutrient budget (whole farm)

• Availability
  Farmers have a report containing all their information which they can share at their discretion.

• Making Better Fertiliser Decisions for Grazed Pastures in Australia
Farm Nutrient Distribution Maps

- Colour coded into ranges
- Help identify nutrient hot spots and deficiencies
- Lead to better targeted application of fertiliser
- Minimise risk of nutrient losses to waterways
Farm maps can be aggregated into a catchment map.
District average Olsen P + min & max

Soil Olsen P (mg/kg)

King Island
Flowerdale Catchment
Ringarooma Catchment
Derwent Region
Cradle Coast
Duck catchment
Montagu catchment
Montagu resampled
Paddock Olsen P

64% of paddocks had Olsen P > 30 mg/kg

Soil Olsen P (mg/kg) vs Paddock number

- Togari
- Ringarooma
- Flowerdale
- Derwent
- Duck
- Duck 2
- Cradle Coast 6 farms

64% of paddocks had Olsen P > 30 mg/kg
Farm average Olsen P + min & max

King Island farms 2011

Olsen Phosphorus (mg/kg)
Farm Potassium distribution map
Example – King Island
District average Colwell Potassium + paddock min & max

Soil Colwell Potassium (mg/kg)

- King Island
- Flowerdale Catchment
- Ringarooma Catchment
- Derwent Region
- Cradle Coast
- Duck catchment
- Montagu catchment
- Montagu resampled
28 % of paddocks had Colwell K > 300 mg/kg
17 paddocks had Colwell K > 1000 mg/kg
Average Farm Colwell Potassium + paddock min & max

Cradle Coast project farms

Potassium (Colwell mg/kg)

Farm 1  Farm 2  Farm 3  Farm 4  Farm 5  Farm 6
Farm Sulfur distribution map
Example
Average District Sulfur (KCl) + paddock min & max

Soil Sulfur (mg/kg)

- King Island
- Flowerdale Catchment
- Ringarooma Catchment
- Derwent Region
- Cradle Coast
- Duck catchment
- Montagu catchment
- Montagu resampled
61% of paddocks had Sulfate S > 16 mg/kg.
Average Farm Sulfur
+ paddock min & max
Farm pH Distribution Map
Example
Paddock pH in water

12% of paddocks had pH < 5.5
Average Farm pH

Optimum = 5.5 - 7.0
Whole farm nutrient budgets

• Produce farm specific nutrient budgets

• Gain improved information on nutrient management and farm inputs
**Farm Specific Nutrient Budget**

<table>
<thead>
<tr>
<th>Farm information (milking area):</th>
<th>Exports -</th>
<th>P (kg/ha)</th>
<th>K (kg/ha)</th>
<th>S (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk (litres per year)</td>
<td>Milk</td>
<td>14.1</td>
<td>19.7</td>
<td>4.2</td>
</tr>
<tr>
<td></td>
<td>Soil req’t</td>
<td>25.0</td>
<td>15.0</td>
<td>12.0</td>
</tr>
<tr>
<td></td>
<td>Yards/lanes</td>
<td>2.3</td>
<td>18.6</td>
<td>2.3</td>
</tr>
<tr>
<td></td>
<td><strong>Sub Total</strong></td>
<td>41.4</td>
<td>53.4</td>
<td>18.5</td>
</tr>
<tr>
<td>Concentrates fed (T per year as fed)</td>
<td>Concentrates</td>
<td>10.6</td>
<td>14.1</td>
<td>8.8</td>
</tr>
<tr>
<td></td>
<td>Fodder</td>
<td>2.4</td>
<td>13.4</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td>Effluent</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td><strong>Sub Total</strong></td>
<td>12.9</td>
<td>27.5</td>
<td>10.8</td>
</tr>
<tr>
<td></td>
<td>Change (Exports - Import)</td>
<td>28.4</td>
<td>25.9</td>
<td>7.7</td>
</tr>
<tr>
<td></td>
<td><strong>Total (kg) fert</strong></td>
<td>42.0</td>
<td>56.0</td>
<td>26.0</td>
</tr>
<tr>
<td></td>
<td>Fertiliser applied (kg/ha)</td>
<td>13.6</td>
<td>30.1</td>
<td>18.3</td>
</tr>
<tr>
<td></td>
<td><strong>Potential fertiliser saving</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Average Soil analyses</td>
<td>57</td>
<td>172</td>
<td>17.8</td>
</tr>
</tbody>
</table>

- **Total exports per ha**
- **Total imports in fertiliser form per ha**
- **Total surplus per ha**
- Can use this information to calculate total potential savings per ha
Nutrient surplus/deficit in Duck catchment from 12 month nutrient budgets
Relationship between phosphorus fertiliser applied in last 12 months to recent soil test value on farms in the Duck River catchment

![Graph showing the relationship between fertiliser applied and Farm Olsen phosphorus](image)

- **Hill country farms**: 
- **Flat country farms**: 

Hill country $R^2 = 0.3832$
Relationship between potassium fertiliser applied in last 12 months to recent soil test value on farms in the Duck River catchment

![Graph showing the relationship between potassium fertiliser applied (kg/ha) and Farm Colwell potassium (mg/kg) for flat and hill country farms. The correlation coefficients are R² = 0.2342 for flat country farms and R² = 0.5166 for hill country farms.](image-url)
Farmer prior assessment of soil phosphorus levels compared to actual soil test results on farms in the Duck River catchment.
Farmer prior assessment of soil potassium levels compared to actual soil test results on farms in the Duck River catchment.

- **Farmer Prediction**
  - Actually low
  - Actually optimal
  - Actually high
  - Actually very high

<table>
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<tr>
<th>Prediction</th>
<th>Number of Farmers</th>
</tr>
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<tr>
<td>Very high</td>
<td>2</td>
</tr>
<tr>
<td>High</td>
<td>3</td>
</tr>
<tr>
<td>Opt</td>
<td>15</td>
</tr>
<tr>
<td>Low</td>
<td>24</td>
</tr>
<tr>
<td>Very low</td>
<td>1</td>
</tr>
<tr>
<td>Unsure</td>
<td>1</td>
</tr>
</tbody>
</table>
Togari & Brittons swamp re-sampling 2011

- 540 paddocks
- 9 farms (10 previous) of 29 sampled in 2005/2006
Olsen P (mean + min & max)
2011: 65% of paddocks > 30

Soil phosphorus Olsen (mg/kg)

Farm

2005  2011 significantly different
Colwell K (mean + min & max)
2011: 22% of paddocks > 300
Sulfur (mean + min & max)
2011: 29% of paddocks > 16

Soil sulfur (mg/kg)

Farm

2005

2011 significantly different

0 10 20 30 40 50 60 70 80

1 2 3 4 5 6 7 8 9
pH (mean + min & max)

2011: 62 paddocks (12%) < 5.5
## Nutrient change over 6 years summary

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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Phosphorus Olsen (mg/kg)</td>
<td>48.6</td>
<td>34.7</td>
<td></td>
<td>50.5</td>
<td>36.7</td>
<td>**</td>
</tr>
<tr>
<td>Phosphorus Colwell (mg/kg)</td>
<td>119</td>
<td>110</td>
<td></td>
<td>127</td>
<td>123</td>
<td>*</td>
</tr>
<tr>
<td>Potassium Colwell (mg/kg)</td>
<td>188</td>
<td>200</td>
<td></td>
<td>218</td>
<td>242</td>
<td>*</td>
</tr>
<tr>
<td>Sulfate Sulfur (mg/kg)</td>
<td>24.0</td>
<td>13.0</td>
<td></td>
<td>26.2</td>
<td>16.5</td>
<td>**</td>
</tr>
<tr>
<td>pH water</td>
<td>5.9</td>
<td>6.0</td>
<td></td>
<td>6.0</td>
<td>6.0</td>
<td></td>
</tr>
</tbody>
</table>

* P < 0.05; ** P < 0.0001 in Students t test (paired) of significant difference between mean results from 2005 and 2011
Nutrient summary

Farm soil nutrient mapping of 4085 paddocks has highlighted:

- High within farm nutrient variability
- Some districts and catchments have higher average values than others

- 64% of paddocks had Olsen P > 30 mg/kg
- 28% of paddocks had Colwell K > 300 mg/kg
  - 17 paddocks had Colwell K > 1000 mg/kg
- 61% of paddocks had Sulfate S > 16 mg/kg
- 12% of paddocks had pH < 5.5
Summary

- Whole farm nutrient budgets indicate that many farmers are applying a surplus to requirements of P, K & S

- Most farmers underestimate their soil nutrient status

- Farmers in the Montagu catchment have significantly reduced their soil P & S levels over the past 6 years (+ reduced range)
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