Nitrogen performance indicators on southern Australian grain farms

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Elaina vanderMark, Southern Farming Systems

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National N Accounts

- 2002-2010
  - N use from Fertilizer Australia
  - N removal
    - ABARE production stats
    - ANRA nutrient densities

- Variation in PNB due to swings in production with a relatively constant N fertilizer use

- Since 2010
  - N use has increased 50%
  - grain alone increased 30%

• Removal of N in farm products – ABARE farm statistics/ANRA Nutrient Density
• Addition of N as fertilizer - Fertilizer Australia
  • No consideration of biological N fixation or recycled N (manures, etc).
• Based on areas fertilized – by Natural Resource Management Zones
• Three audit periods – average

2007-08  2009-10  2011-12

(Robert Edis)
Comparison of agricultural crops and NUE

- Production and fertilizer use data from ABS Farm Survey 2012
- Nutrient densities from ANRA Nutrient Density
- No estimate of fixed N or manure or recycled residues.
- Estimate a nutrient balance intensity - kg N/ha surplus or deficit.
**Cereal N PNB - kg N grain/kg N fertilizer**

<table>
<thead>
<tr>
<th>Crop</th>
<th>PNB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>0.74</td>
</tr>
<tr>
<td>Rice</td>
<td>0.56</td>
</tr>
<tr>
<td>Corn</td>
<td>0.55</td>
</tr>
<tr>
<td>Other</td>
<td>1.23</td>
</tr>
</tbody>
</table>

*FAO Stats, IFA FUBC data*

*No manure use included*

*No fixed N included*

*No crop residue removal*

*Assumed grain N content*

*Most crops are grown in rotations – so is benchmarking by product useful?*

<table>
<thead>
<tr>
<th>Region</th>
<th>PFP - N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>52</td>
</tr>
<tr>
<td>Canada</td>
<td>45</td>
</tr>
<tr>
<td>World</td>
<td>43</td>
</tr>
</tbody>
</table>

Norton, Davidson & Roberts, 2015
Deriving performance metrics (eg PNB, PFP, NBI)

• What is the purpose of deriving the metrics
• None of these *per se* provide environmental or economic insights
  – Statements of accountability for regions/industries?
  – Market access and/or production system certification?
  – Provide information to farmers so they can improve their nutrient management?

• Can they be derived?
  – Numerator Y/F or (Y-Y0) – Denominator F or (F+S)
Deriving performance metrics (e.g., PNB, PFP, NBI)

- Have good quality data on which to estimate the metrics.
  - Regional and industry specific values – system (not crop).
  - Production data is usually of good quality.
  - Regional & crop specific fertilizer application rates – difficult to find.
  - Regional & crop specific product nutrient concentrations.
    - e.g. Canola in South Australia - UEP 36 kg N/t cf MNSA 49 kg N/t
  - Include non-fertilizer nutrient inputs & removals
    - Manures, fixed N, cover crops, crop residue management, water/air.
What did we do?

• Collected farm/paddock level nutrient input and removal from farmers and consultants
  – 3-5 years of paddock records, 2555 paddock/years
    • Crops, yields, protein, hay, stubble management

<table>
<thead>
<tr>
<th>Region</th>
<th>Growers</th>
<th>Paddocks</th>
<th>Area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HRZ</td>
<td>45</td>
<td>145</td>
<td>7,600</td>
</tr>
<tr>
<td>Mallee</td>
<td>23</td>
<td>184</td>
<td>17,800</td>
</tr>
<tr>
<td>SNSW</td>
<td>33</td>
<td>63</td>
<td>5,300</td>
</tr>
<tr>
<td>Wimmera</td>
<td>17</td>
<td>82</td>
<td>4,200</td>
</tr>
<tr>
<td>Tasmania</td>
<td>4</td>
<td>15</td>
<td>320</td>
</tr>
<tr>
<td>UEP</td>
<td>6</td>
<td>18</td>
<td>2,100</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Crop</th>
<th>%Pdk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>37%</td>
</tr>
<tr>
<td>Barley</td>
<td>21%</td>
</tr>
<tr>
<td>Canola</td>
<td>20%</td>
</tr>
<tr>
<td>Pulse</td>
<td>11%</td>
</tr>
<tr>
<td>Pasture</td>
<td>6%</td>
</tr>
<tr>
<td>Fallow</td>
<td>2%</td>
</tr>
</tbody>
</table>

• Some earlier data surveying actual wheat and canola regional nutrient densities. Large regional and annual variability.
Nutrient use by region & crop
Developing nutrient balances

• Removal of nutrients
  – Grain
  – Burned stubbles (Y/Hi* loss – N (80%), P (44%), K (40%), S (80%))
  – Grazing N (50%), P, K, S (0)

• Inputs of nutrients
  – Fertilizers
  – Fixed N – derived from grain yield
    • Shoot N%, %Ndfa,
      Shoot N:Root N and Hi
    • Used a gross value
    • Deduct removal in grain/hay
      – Net range 7-65 kg N/t grain
    • Pastures – cereal*2*40

<table>
<thead>
<tr>
<th>Region</th>
<th>% BNF</th>
</tr>
</thead>
<tbody>
<tr>
<td>HRZ</td>
<td>16</td>
</tr>
<tr>
<td>Mallee</td>
<td>29</td>
</tr>
<tr>
<td>SNSW</td>
<td>50</td>
</tr>
<tr>
<td>Wimmera</td>
<td></td>
</tr>
</tbody>
</table>

Shu-Kee Lam
PNB (efficiency) – N – all data

mean 1.14 kg N removed per kg N applied

- Removal > twice supply (15%)
- Removal once to twice supply (45%)
- Removal less than supply – ie surplus (40%)
PNB (efficiency) – N (% in N deficit)

- PNB-N Mallee: 75%
- PNB-N HRZ: 70%
- PNB-N Wimmera: 50%
- PNB-N SNSW: 60%
PNB “Correcting” for yield –

N surplus and yield

3.5 t/ha

Soil accumulation
Risk of loss

Soil depletion

N removal (kg N/ha/y) - "yield"
PFP (effectiveness) – N – all regions

mean 77 kg grain per kg N

Value of grain : Cost of urea
So what to make of this?

- Many grain producers are in N deficit
- Few growers are in N surplus
- Can develop nutrient efficiency and effectiveness regional values (need to refine both) – with ranges
- The farming system not the product is the unit, so farmers need to be engaged.
- Link to soil “health”, environmental indicators.
- Link to economic indicators.
- Communicate and explain what these numbers mean to growers & advisors.
- Multiple indicators are needed

<table>
<thead>
<tr>
<th>Regions</th>
<th>Average of PNB-N</th>
<th>Average of PFP-N</th>
</tr>
</thead>
<tbody>
<tr>
<td>HRZ</td>
<td>1.55</td>
<td>71</td>
</tr>
<tr>
<td>Mallee</td>
<td>2.09</td>
<td>105</td>
</tr>
<tr>
<td>SNSW</td>
<td>1.20</td>
<td>50</td>
</tr>
<tr>
<td>Wimmera</td>
<td>1.24</td>
<td>47</td>
</tr>
<tr>
<td>South East</td>
<td>1.66</td>
<td>77</td>
</tr>
</tbody>
</table>
Thanks for your attention...

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