Nutrient Use Efficiency – Profits & Policy

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Better Crops, Better Environment ... through Science

Background -

• Millennium Development Goals
  – 8 goals set in 2002 with a target of 2015

• Sustainable Development Solutions Network
  – opened dialogue for the post-2015 strategy
  – Feb 2014 preliminary draft, May 2014 working draft
  – Setting Sustainable Development Goals
    • 10 goals – harmonized with MDG’s
    • Each goal has a set of targets, indicators & evidence
  – Performance against these goals reported
    • nationally & annually
## Relevant targets & indicators

<table>
<thead>
<tr>
<th>Goal &amp; Target</th>
<th>Issue</th>
<th>#</th>
<th>Potential Indicator</th>
<th>Potential Lead</th>
</tr>
</thead>
<tbody>
<tr>
<td>2b Countries report on their contribution to planetary boundaries</td>
<td>Nitrogen and phosphorus fluxes</td>
<td>10</td>
<td>Excessive loss of reactive N and P to the environment (kg/ha) – indicator to be developed</td>
<td>UNEP or other agency</td>
</tr>
<tr>
<td>6a Sustainable food production</td>
<td>Staple crop yields</td>
<td>50</td>
<td>Crop yield gap (actual as % attainable)</td>
<td>FAO with IFA</td>
</tr>
<tr>
<td></td>
<td>Sustainability of agriculture</td>
<td>51</td>
<td><strong>Crop nitrogen use efficiency</strong></td>
<td>FAO with IFA</td>
</tr>
<tr>
<td></td>
<td>Water productivity</td>
<td>52</td>
<td>Crop water productivity</td>
<td>FAO</td>
</tr>
<tr>
<td>8b Reduce non-energy related GHG emission</td>
<td>GHG emissions from landuse change</td>
<td>78</td>
<td>Net GHG emissions in agriculture, forest &amp; other land use sectors</td>
<td>UNFCCC</td>
</tr>
</tbody>
</table>

[http://unsdsn.org/resources/goals-and-targets/](http://unsdsn.org/resources/goals-and-targets/)
Planetary boundaries concept

- Identifies 9 pre-conditions for human development
- 3 have been overstepped.
- Endorsed by UN, 2012
- Withdrawn from Rio-2012 UN conference on SD
  - concerns about impact on poverty reduction

Debate over both the preconditions and the boundary position eg for N – Authors suggested 25% of current N use ie 35 Mt y\(^{-1}\)
- first guess only and requires much more research and synthesis.
Nutrient Use Efficiency or Nutrient Performance Indicators

- INI - Our Nutrient World - Released 2013
- Full chain **N use efficiency** by 20% by 2020
  - 20-25 Mt less N used
  - improved human health, climate and biodiversity
  - value of $170 billion per year
- This target was not endorsed at 2013 INI meeting.

So – how to measure efficiency or performance?

**EFFICIENCY ≠ EFFECTIVENESS**
IPNI interfaces with the issue

- **UN GPNM – T. Roberts, Chair**
  - Likely will follow IPNI lead
  - Accepts removal to use as a Performance Indicator (i.e. PNB)
  - Wants global and regional baselines by June

- **IFA Nutrient Stewardship Task Force – T. Bruulsema, member**
  - Wants PNB connected to productivity index
  - Wants Performance Indicators completed in 2014
  - Released position statement on NPI’s in June 2014.

- **International Nitrogen Initiative**

- **UN Sustainable Development Solutions Network**
  - IPNI response

- **IPNI position statement developed**
  - Importance of regional & farm scale assessments linked to soil fertility, productivity, environmental impact & grower nutrient BMP’s.
Nutrient Performance Indicators

• Need to be:
  – Systematic in their estimation
  – Scalable
    • regional, national, global
    • relevant to farm and field scales also
  – Involve repeated measures over time
    • every 3 to 5 years: national, regional global
    • every year: for farms/fields
    • enable backward and forward looking
• Transparent and Traceable
Removal to Use Ratio  
(or Partial Nutrient Balance)

- Cited in SDSN, IFA, and INI publications
- *May become reportable under UNEP*

**PNB = Nutrient Removal / Fertilizer Nutrient Supplied**

\[
\text{PNB} = \frac{\text{Nutrient Removal}}{\text{Fertilizer Nutrient Supplied}}
\]

\[
\text{NR} = \text{Nutrient concentration} \times \text{Product Removal}
\]

\[
\text{NS} = \text{Fertilizer applied}
\]

- **GRDC has indicated in its most recent investment plan that Partial nutrient balances and Partial factor productivities are to be the guage of success.**
All cereals: N partial nutrient balances

<table>
<thead>
<tr>
<th>Region</th>
<th>Cereal PNB kg N / kg N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>0.82</td>
</tr>
<tr>
<td>North America</td>
<td>0.68</td>
</tr>
<tr>
<td>SS Africa</td>
<td>1.89</td>
</tr>
<tr>
<td>East Asia</td>
<td>0.46</td>
</tr>
<tr>
<td>World</td>
<td>0.66</td>
</tr>
</tbody>
</table>

> 1 – more nutrient removed than added – depletion & drawdown of soil reserves

< 1 – more nutrient added than removed – build up of soil reserves or contributions to the environment

What does it mean? – what is good, what is bad
NuGIS (Nutrient Use GIS)

- Assess nutrient balance and nutrient use efficiency in crop production
- Identify weaknesses in the assessment process
N balances – National values – all agriculture = 1.76; cereals = 0.82

<table>
<thead>
<tr>
<th></th>
<th>New South Wales</th>
<th>Victoria</th>
<th>Queensland</th>
<th>Western Australia</th>
<th>South Australia</th>
<th>Tasmania</th>
<th>NT</th>
<th>Australia</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.05</td>
<td>2.49</td>
<td>1.08</td>
<td>1.48</td>
<td>2.28</td>
<td>1.25</td>
<td>4.20</td>
<td>1.76</td>
</tr>
</tbody>
</table>
Regional/National Nutrient Audits

- To present the IPNI data
- Use of the nutrient balances
- Spatial patterns
- Link to production

Bar chart showing imbalance intensity (kg N/ha) for different agricultural sectors in 2007/8 and 2009/10.
Challenge 1 – Ensure we have the best data possible to reflect what is happening.

• Should look to have regional values – purpose of the data is to benchmark changes.
• Already have good quality data on production.
• Regional & crop specific fertilizer application rates.
• Regional & crop specific product nutrient concentrations.
  – Canola
  • UEP 36 kg N/t
  • MNSA 49 kg N/t
Challenge 2 – Demonstrate NUE improvement

Since 1975:
- 12% increase in N fertilizer use
- 51% increase in N efficiency

Data sources: USDA Ag Chem Use Survey & Annual Crop Production.
Will any one indicator be useful

- Need to link nutrient performance to
  - Productivity (eg yield gaps)
  - Potential losses to the environment
  - Change in soil nutrient status

- It is naive to think that one number can convey that complexity.

- Involve farmers in these metrics
  - Farm scale assessments.
  - Nutrient issues are regional.
  - Interventions will be by farmers.
Challenge 3 - Translate into farmer practice, *ie $ and yields*

Australian growers know about Water Use Efficiency - target 20 kg/ha/mm

What is the nitrogen use efficiency?
  - Partial Factor Productivity (kg grain / kg N)
  - Partial Nutrient Balance

• Regionally & farm specific – grower benchmarks
• 4R practices linked to these indicators.
Challenge 4 – There is a limit.

International Plant Nutrition Institute

- http://www.ipni.net
- http://anz.ipni.net