Nitrogen use efficiency and farmer engagement

International Nitrogen Initiative Conference: Concurrent session 5A ‘national and community nitrogen footprints’

8 December 2016
Overview

• The challenges

• Our solution

• Why we did what we did

• Case study: producers & advisors

• How the process can influence decision making
The challenges at hand – cropping

- Reliance on recipes for N fertiliser application
- Lack of soil testing for available N
- Lack of nutrient budgeting based on removal rates
- Application of too much or too little N fertiliser
Our solution needed to be:

- Engaging producers & advisors
- Simple, using data on hand
- Relatable
- Relevant & practical
- Manageable
- Conducive to decision making
- Useful to compare paddocks, crops & farms
Partial nitrogen balance

\[
\text{NUE \%} = \frac{\text{NCR}}{\text{NFI}} \times 100
\]

N crop removal (NCR) (\textit{= all parts of the crop that are harvested and removed e.g. grain and straw}), \textit{divided by} mineral N fertiliser input (NFI), both in kilograms per hectare (kg/ha). The result is expressed in \% NUE.
NUE% - what the science tells us

Ratio of fertiliser nitrogen to nitrogen removed via biomass removal (e.g. harvest, grazing)

\[ \text{NUE} = \frac{\text{N removal}}{\text{N application}} \times 100 \]

Broadbalk long-term trial with winter wheat in Rothamsted, UK
### Nitrogen Fertiliser Inputs and Use Efficiency (NUE%)

<table>
<thead>
<tr>
<th>Farm Name</th>
<th>Total Area (ha)</th>
<th>Date</th>
<th>2014</th>
</tr>
</thead>
</table>

#### Results

<table>
<thead>
<tr>
<th>Crop Type</th>
<th>Total Area of crop on farm [ha]</th>
<th>Total fertiliser N input to crops [kg/ha]</th>
<th>N content in removed plant parts [kg/ha]</th>
<th>N removed [kg/total crop area]</th>
<th>N removed [%]</th>
<th>N effiency (NUE) [%]</th>
<th>Crop yield per unit fertiliser N used [kg/ha]</th>
<th>Fertiliser N not used [kg/ha]</th>
<th>Total amount of fertiliser N not used [tonnes]</th>
<th>Potential value of unused fertiliser over entire crop $</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crop 1</td>
<td>Poppy</td>
<td>60</td>
<td>9.84</td>
<td>23.00</td>
<td>7.13</td>
<td>427.00</td>
<td>46%</td>
<td>26.53</td>
<td>85.10</td>
<td>5.11</td>
</tr>
<tr>
<td>Crop 2</td>
<td>Barley</td>
<td>40</td>
<td>8.84</td>
<td>5.70</td>
<td>325.77</td>
<td>575.77</td>
<td>116%</td>
<td>221.79</td>
<td>-60.37</td>
<td>-138.96</td>
</tr>
<tr>
<td>Crop 3</td>
<td>Yewberry</td>
<td>25</td>
<td>3.00</td>
<td>25.70</td>
<td>125.22</td>
<td>402.52</td>
<td>116%</td>
<td>45.38</td>
<td>-24.42</td>
<td>-925.02</td>
</tr>
</tbody>
</table>

#### Crop 4

<table>
<thead>
<tr>
<th>Crop Type</th>
<th>Total Area of crop on farm [ha]</th>
<th>Total fertiliser N input to crops [kg/ha]</th>
<th>N content in removed plant parts [kg/ha]</th>
<th>N removed [kg/total crop area]</th>
<th>N removed [%]</th>
<th>N effiency (NUE) [%]</th>
<th>Crop yield per unit fertiliser N used [kg/ha]</th>
<th>Fertiliser N not used [kg/ha]</th>
<th>Total amount of fertiliser N not used [tonnes]</th>
<th>Potential value of unused fertiliser over entire crop $</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crop 5</td>
<td>Grass seeds</td>
<td>0</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

#### Crop 6

<table>
<thead>
<tr>
<th>Crop Type</th>
<th>Total Area of crop on farm [ha]</th>
<th>Total fertiliser N input to crops [kg/ha]</th>
<th>N content in removed plant parts [kg/ha]</th>
<th>N removed [kg/total crop area]</th>
<th>N removed [%]</th>
<th>N effiency (NUE) [%]</th>
<th>Crop yield per unit fertiliser N used [kg/ha]</th>
<th>Fertiliser N not used [kg/ha]</th>
<th>Total amount of fertiliser N not used [tonnes]</th>
<th>Potential value of unused fertiliser over entire crop $</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Wheat</td>
<td>0</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>
Potato crop NUE% - what the farmer’s data tells us

N fertiliser input vs. NUE% (Simplot, Australia)
Potato crop NUE% - what the farmer’s data tells us

N fertiliser applied vs. yield (Simplot, Australia)

N applied and yield

Yield [t/ha]

Fertiliser N [kgN/ha]

Seed
Processing
NUE% - what the farmer’s data tells us

2015 data from a dairy/cropping farmer

<table>
<thead>
<tr>
<th>Crop</th>
<th>Fertiliser N input (kg/ha)</th>
<th>N removed (kg/ha)</th>
<th>NUE%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potatoes (overall)</td>
<td>465</td>
<td>334</td>
<td>72</td>
</tr>
<tr>
<td>Potatoes (lowest yielding)</td>
<td>465</td>
<td>284</td>
<td>61</td>
</tr>
<tr>
<td>Potatoes (highest yielding)</td>
<td>465</td>
<td>395</td>
<td>85</td>
</tr>
<tr>
<td>Poppies</td>
<td>166</td>
<td>57</td>
<td>34</td>
</tr>
</tbody>
</table>
Soil testing

Potato crops - soil available N (kg/ha) for soils tested in October

Data: AgVita Analytical
## What we found

<table>
<thead>
<tr>
<th>Crop</th>
<th>Average NUE</th>
<th>Range</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poppies</td>
<td>50%</td>
<td>35 – 85%</td>
<td>8</td>
</tr>
<tr>
<td>Potatoes</td>
<td>109%</td>
<td>57 – 233%</td>
<td>57</td>
</tr>
<tr>
<td>Wheat</td>
<td>160%</td>
<td>93 – 271%</td>
<td>6</td>
</tr>
</tbody>
</table>
How it impacts decision making on farm

<table>
<thead>
<tr>
<th>N application rate (kg N/ha)</th>
<th>N removal (kg N/ha)</th>
<th>NUE (%)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>26</td>
<td>-</td>
<td>Soil mining ¹</td>
</tr>
<tr>
<td>48</td>
<td>56</td>
<td>116</td>
<td>Risk of soil mining ²</td>
</tr>
<tr>
<td>96</td>
<td>92</td>
<td>96</td>
<td>Balanced in- and outputs ³</td>
</tr>
<tr>
<td>144</td>
<td>126</td>
<td>88</td>
<td>Risk of high N losses ⁴</td>
</tr>
<tr>
<td>192</td>
<td>151</td>
<td>79</td>
<td></td>
</tr>
<tr>
<td>240</td>
<td>166</td>
<td>69</td>
<td></td>
</tr>
</tbody>
</table>

(1) **Soil mining** = N removal exceeds N input -> declining soil fertility and yield = unsustainable
(2) **Risk of soil mining** = additional N requirement for roots and straw is not met by N input
(3) **Balanced in- and outputs** = N fertilizer input meets total crop demand (grain, straw, roots)
(4) **Risk of high N losses** = N fertilizer input exceeds total crop demand -> increased risk of leaching

Data from the long-term “Broadbalk Experiment”, Rothamsted/UK, winter wheat, avg. yield of 1996-2000
Monitoring

1. **Determine Crop N Requirement**
   - Consider removal rates (e.g., 5 kg N/t of potatoes and yield expected)

2. **Calculate N Fertiliser Requirements**
   - Measure soil available N via soil tests (e.g., N-check)
   - Consider mineralisation from soil organic matter and previous crop residues

3. **Plan N Rates, Fertiliser Types and Timing**
   - Aim to match timing with crop needs using split applications.
   - When applying N, follow the 4 Rs:
     1. Right type
     2. Right amount
     3. Right time
     4. Right placement

4. **Manage and Monitor the Crop**
   - Monitor available soil N
   - Adjust N management and plan as required
   - Use plant sap tests

5. **Review NUE% at the End of the Season**
   - Calculate the NUE% for the crop; if the figure is low, identify why

6. **Monitor NUE%**
   - Monitor paddock and rotation NUE% over time, adjusting approach as required

Ensure the soil is in good condition, all nutrients are in balance, irrigation is managed well and the crop is healthy.
Key points

• The NUE% data is useful for monitoring efficiency over time

• Starting with complex information is less effective in supporting the decision making process with farmers and advisors
Any questions?

Acknowledgements

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