Nutrient Management Planning

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Best practices in improving the sustainability of agriculture
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Presentation Outline

1. Nutrient cycling in European agriculture
2. Introduction to best practice
3. Best practice techniques overview
4. Soil fertility and field nutrient budgeting
5. Legume incorporation
6. Livestock nutrient budgeting
7. Manure management
8. Conclusions

1. Nutrient cycling in European agriculture

Climate change

Resource depletion
Also phosphate: a finite resource!

Acidification
Eutrophication


Also phosphate: a finite resource!

EUR 70 to 320 billion per year cost to Europe!

2. Best practice introduction

- Nutrient leakage drives environmental burdens and can be reduced by better management practices
- NMP is critical to the concept of "sustainable intensification"
- NMP is a cross cutting topic within the EMAS report for agriculture
- EMAS “BEMPs” and “Benchmarks of Excellence” provide guidance on efficient practice: what’s possible and how to achieve it

“Benchmarking is undertaken by people humble enough to know that other people might do what they do more efficiently, and clever enough to learn from those other people…”

3. Best practice techniques overview

<table>
<thead>
<tr>
<th>BEMP</th>
<th>Title</th>
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<tbody>
<tr>
<td>4.1</td>
<td>Assess soil fertility</td>
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<td>5.1</td>
<td>Field nutrient budgeting</td>
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<td>5.2</td>
<td>Crop rotation</td>
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<td>5.3</td>
<td>Precision application</td>
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<td>5.4</td>
<td>Lower impact fertilisers</td>
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<td>7.3</td>
<td>Pasture renewal and legume incorporation</td>
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<td>8.2</td>
<td>Livestock farm nutrient budgeting</td>
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<td>8.3</td>
<td>Dietary reduction of N excretion</td>
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<td>9.3</td>
<td>Slurry and digestate separation</td>
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<td>9.6</td>
<td>Injection slurry application and manure incorporation</td>
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<td>9.7</td>
<td>Banded, trailing shoe and injection application to grassland</td>
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</tbody>
</table>

4. Field nutrient budgeting

- Agronomic advice to target economic optimum
- Account for soil nutrient supply
- Soil testing essential
- Account for organic nutrient inputs
- Organic nutrient testing helpful


- Liebig’s barrel
- Plant growth constrained by most deficient nutrient
- Apply the right nutrients
- Applying other nutrients may not increase yields (= wasted nutrients)
- Soil testing essential!
- pH and soil structure also important (whc, OM)

4. Nutrient budgeting benefits

Savings per hectare
- 27 kg N
- 16 kg P
- 80 kg K
- 410 kg CO$_2$e
- 5.16 kg PO$_4$e
- 3.73 kg SO$_2$e
- 2608 MJe

NB: Available N following Spring application with splash-plate (DEFRA, 2010). Available K from manure in excess of crop demand can be carried over to the next crop (negative fertiliser application rate in year of application).

Source: DEFRA (2010)

5. Legume incorporation

Reduced fertiliser-N application: 7-21% lower burdens per L milk

Source: ATP lecture material

4. Precision technologies

Source: http://www.brettbrothers.ie/precision-farming.html

• Sensor and GPS technologies for mapping field nutrient status and/or yield
• Can be linked with precision application technologies

4. Nutrient budgeting economics

Fertiliser costs:
- EUR 1.06 per kg N
- EUR 0.94 per kg P$_2$O$_5$
- EUR 0.71 per kg K$_2$O

- NMP can save EUR 1000s per farm per year
- E.g. Rhual farm in Wales: EUR 14,000/yr
- Soil testing and advice: c. EUR 1000/yr

6. Livestock nutrient budgets

Best practice is to: (i) measure; (ii) control nutrient balance

<table>
<thead>
<tr>
<th>Imports onto farm</th>
<th>Exports from farm</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Mineral fertilisers</td>
<td>• Livestock</td>
</tr>
<tr>
<td>• Livestock feeds (concentrates, fodder</td>
<td>• Livestock products (milk, eggs, meat</td>
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<tr>
<td>and waste products)</td>
<td>and wool)</td>
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<tr>
<td>• Young livestock</td>
<td>• Crop products (including straw and</td>
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<tr>
<td>• Bedding (straw, wood shavings etc.)</td>
<td>fodder)</td>
</tr>
<tr>
<td>• Inorganic fertilisers</td>
<td>• Organic manures</td>
</tr>
<tr>
<td>• Biologically fixed nitrogen (clover,</td>
<td></td>
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<tr>
<td>lucerne, peas, beans etc.)</td>
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</tbody>
</table>

Source: DEFRA (2005)

6. Nutrient losses

Inputs
- Concentrate feeds
- Grazing and silage
- Slurry storage (manure management)

Losses to air and water
- Direct $N$ inputs
- Direct $N_2O$ emissions
- Indirect $N_2O$ ($NH_3$ and $NO_3$)
- Slurry storage (manure management)

6. Indicators & benchmarks

- NUE = nutrients out in products/nutrient inputs (%)
- Nutrient surplus = nutrient inputs minus nutrient outputs in products, kg/ha/yr

Source: Sutton et al. (2013). The European Nitrogen Assessment.

7. Manure management

Manure management “continuum” (Chadwick et al., 2011):

- Housing ($NH_3$): Best practice is ventilated (cooler) sheds, slatted floors, regular scraping
- Storage ($NH_3$ and $N_2O$): Best practice is separation, covered tank storage and anaerobic digestion.
- Application ($NH_3$, $N_2O$, $NO_3$, $PO_4$): Best practice is shallow injection/trailing shoe/incorporation, at right time (spring, moist soils, no rain) in right place (where soils deficient in nutrients).
- Various benchmarks!
7. Method of application

Trailing shoe and shallow injection:
• Increased N uptake
• Reduced N losses to air
• Improved NUE

BM: 100% of slurries applied to land are applied via injection, or trailing shoe where injection not possible, and 100% of manures applied to arable land are incorporated into the soil within four hours.

8. Production efficiency: milk env. footprint

NMP is about conserving nutrients in the crop-livestock system:
• avoids loss impacts
• avoids synthetic fertiliser impacts
• saves resources and money
• requires basic calculations (DSTs available)

8. Conclusions

• Nutrient leakage and use inefficiency are key environmental and resource challenges for agriculture
• NMP central to resource efficient farming and sustainable intensification
  • Maximise outputs per unit input
• Fertiliser application can be significantly reduced through “basic” nutrient budgeting
• Fertilisers can be substituted through more efficient management of organic nutrients and legume inputs
• Huge scope for economic and environmental win-wins
• Nutrient losses “invisible”: Challenge is to engage farmers with calculations and decision support tools

Thank you!

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Websites:
http://ec.europa.eu/environment/emas/index_en.htm