Challenges and new developments in nutrient use efficiency: land and manure management

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Drivers for improved nutrient use efficiency
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GLOBAL POPULATION IS SET TO RISE TO OVER 9.5 BILLION BY 2050

Increasing demand on land to support a growing population

United Nations 2015
Land Commodities Research 2010
Drivers for improved nutrient use efficiency

Inputs of N and P supported improvements in agricultural productivity
Drivers for improved nutrient use efficiency: Environmental

Assessing and Managing Agricultural Nitrogen Losses to the Environment
S. J. Smith, J. S. Schepers, L. K. Porter
doi:10.2134/jeq1998.00472425002700020004

The Role of Phosphorus in the Eutrophication of Receiving Waters: A Review

David L. Correll

Global environmental impacts of agricultural expansion: The need for sustainable and efficient practices

David Tilman

Managing Agricultural Phosphorus for Protection of Surface Waters: Issues and Options
Andrew N. Sharpley*, S. C. Chapro, R. Wedepohl, J. T. Sims, T. C. Daniel and K. R. Reddy

Challenge: Increasing awareness of agricultural impacts on the environment alongside concerns over long term security of global fertiliser supply

Cordell et al. 2009
Drivers to improve nutrient use efficiency:
Land management

*Challenge:* No longer managing land solely for agricultural production

Schulte et al. 2015
Drivers to improve nutrient use efficiency: Legislative

From 1990 increasing number of measures across Europe aimed at improving water quality:

- Drinking Water Directive 1998
- Nitrates Action Programme 2005+
- COGAP and QA incentives

**Challenge:** Increasing regulatory mechanisms aimed at improving nutrient use efficiency
Drivers to improve nutrient use efficiency: Social

**Challenge:** Greater public demand for environmentally conscious food production
Drivers to improve nutrient use efficiency: Economic

Fertiliser price index trends
2010 = 100 base

Challenge: Increasing volatility in fertiliser prices placing pressure on farm profitability

AHDB Dairy 2016
Trends in nutrient management on grassland farms in GB

57% of grassland soils below pH 6.0

Only 9% of soils at target for P and K

Challenge: Messages on good nutrient management haven’t changed but there remains a lack of uptake on farm

PAAG Report, 2014
Trends in nutrient management on grassland farms in GB

**Challenge:** Messages on good nutrient management haven’t changed but there remains a lack of uptake on farm

Newell-Price et al. 2014
Challenges

• Greater fluxes of N and P in agriculture – negative effects on environment

• Increased legislative and societal pressure to improve nutrient use efficiency

• Increasing volatility in input prices and concerns over long term fertiliser reserves
Opportunities

Using the latest R&D and technology

Knowledge exchange opportunities
1. Soil
2. Nutrient
Opportunities

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Knowledge exchange opportunities
1. Soil
2. Nutrient
Breeding programmes – nutrient efficient forages

- Breeding programme to improve NUE and PUE in grass-clover swards

- Clovers from low P environments can improve yields of grass + clover under 0 P fertilisation

**Opportunity:** Further integration of nutrient efficiency traits into breeding programmes
Technology development – grassland productivity

Within field variation in grass dry matter (DM) in a grassland silage field

<table>
<thead>
<tr>
<th></th>
<th>DM yield t/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>First cut silage</td>
<td>3.7</td>
</tr>
<tr>
<td>Second cut silage</td>
<td>4.1</td>
</tr>
<tr>
<td>Third cut silage</td>
<td>2.4</td>
</tr>
<tr>
<td>Total yield</td>
<td>10.2</td>
</tr>
</tbody>
</table>

Opportunity: Development of technology for measurement of grass biomass and nutrient offtake

AHDB Dairy Precision Farming Project (SRUC, 2013)
Technology development – nutrient distribution across grassland

Opportunity: Development of variable rate application technology for grassland

Bailey et al. 2015
Technology development - nitrogen sensors

- Development of sensor capacity for better measure of:
  - Growth patterns
  - Nutrient uptake

- Need to address:
  - Spatial variability across fields
  - Robustness of sensors
  - Cost-benefit

**Opportunity:** Development of sensors and decision support tools to optimise timing and uptake of nutrients

Shaw et al. 2015
Technology uptake – manure application

Reduced P loss

Runoff P concentration (mg/l)

Splashplate  Trailing shoe

P<0.001

Improved N recovery

Apparent N recovery (kg/kg applied)

Splashplate  Trailing shoe

P=0.001

Opportunity: Low emission slurry spreading techniques reduce nutrient loss and improve nutrient use efficiencies

McConnell et al. 2011, Lahlor et al. 2011
Opportunities

Using the latest R&D and technology

Knowledge exchange opportunities
1. Soil
2. Nutrient
Knowledge exchange - Soil

• 70% of grassland soils exhibiting signs of compaction in England and Wales

• Yield losses of 20 – 30% caused by compaction from animal treading and machinery traffic

• Also impacts on nutrient use efficiency
Improving soil structure reduces gaseous N losses and increases N recovery.
Knowledge exchange - Soil

Healthy Grassland Soils
Pocketbook

AHDB Healthy Grassland Soils
www.healthygrasslandsoils.org.uk
Knowledge exchange – Improving forage efficiency

Wide range in concentrate input and milk from forage across farms in N.I.

Dale et al. 2015
## Knowledge exchange – improving forage efficiency

<table>
<thead>
<tr>
<th>Yield (litres per cow per annum)</th>
<th>Calculated P balance on benchmarked dairy farms (kg P per ha)</th>
<th>Most efficient</th>
<th>Least efficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>6000 – 7000</td>
<td></td>
<td>3.6</td>
<td>12.6</td>
</tr>
<tr>
<td>7000 – 8000</td>
<td></td>
<td>6.4</td>
<td>16.5</td>
</tr>
<tr>
<td>8000 – 9000</td>
<td></td>
<td>9.0</td>
<td>17.9</td>
</tr>
<tr>
<td>9000 - 10000</td>
<td></td>
<td>12.7</td>
<td>19.8</td>
</tr>
</tbody>
</table>

**Opportunity:** Better utilisation of forage improves P use efficiency, regardless of system

Ferris et al. 2015
Knowledge exchange – Nutrient management

Norway: Land management DST to determine risk of P loss

Netherlands: Phosphorus efficiency benchmarking tools

<table>
<thead>
<tr>
<th></th>
<th>P efficiency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>My farm:</td>
<td></td>
</tr>
<tr>
<td>Current</td>
<td>26.5</td>
</tr>
<tr>
<td>Increased grazing</td>
<td>33.7</td>
</tr>
<tr>
<td>Other farms:</td>
<td></td>
</tr>
<tr>
<td>In my region</td>
<td>29</td>
</tr>
<tr>
<td>Similar system</td>
<td>32</td>
</tr>
<tr>
<td>2013 target</td>
<td>31</td>
</tr>
</tbody>
</table>

Opportunity: Sharing of decision support tools and expertise across European countries
Summary

• Considerable societal and policy pressure to improve nutrient efficiency in livestock production systems.

• Need to use breadth of tools in armoury to improve NUE on farms – simple nutrient management messages (back to basics) to cutting edge technology.

• Greater sharing of research findings and knowledge transfer expertise across European countries is key.