



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

Dr Debbie McConnell

Debbie.mcconnell@ahdb.org.uk

Drivers for improved nutrient use efficiency



.....
GLOBAL POPULATION
IS SET TO RISE TO OVER

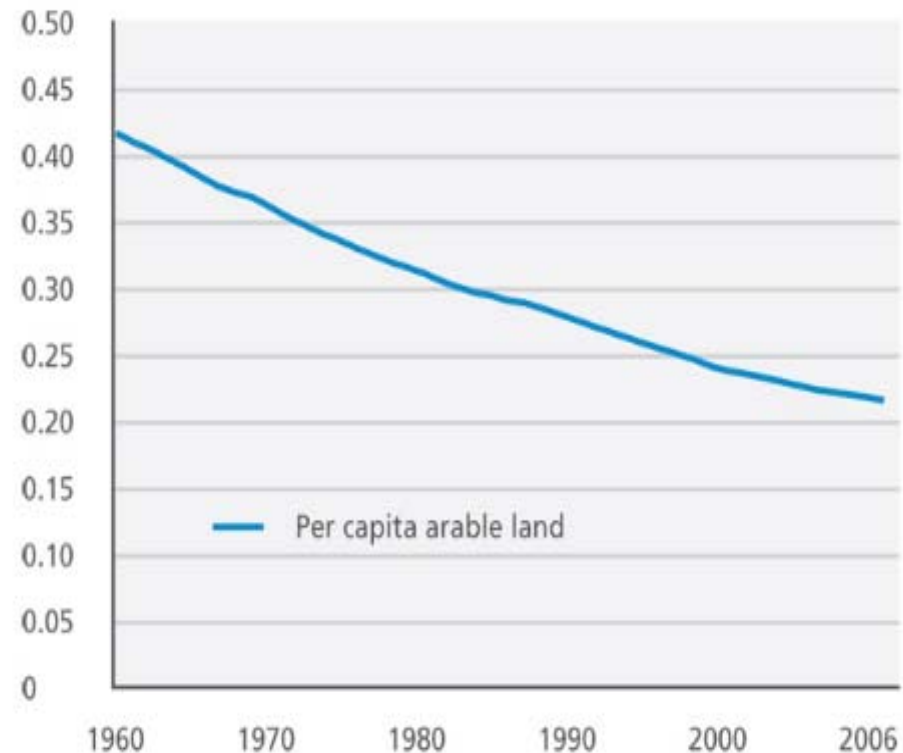
.....
9.5 BILLION

.....
BY 2050¹
.....

Drivers for improved nutrient use efficiency

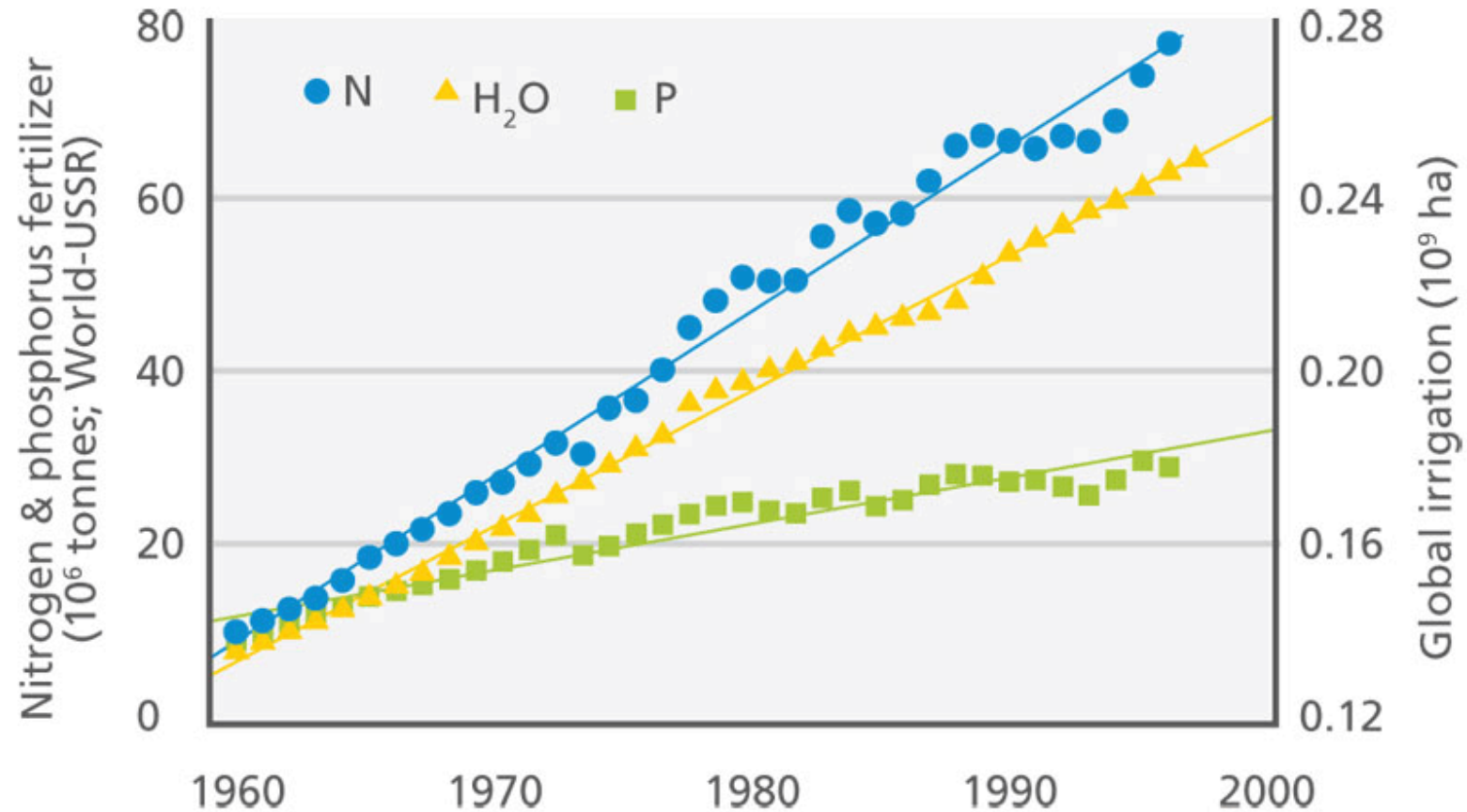


GLOBAL POPULATION
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9.5 BILLION
BY 2050¹



Increasing demand on land to support a growing population

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/jeq1998.00472425002700020004x

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

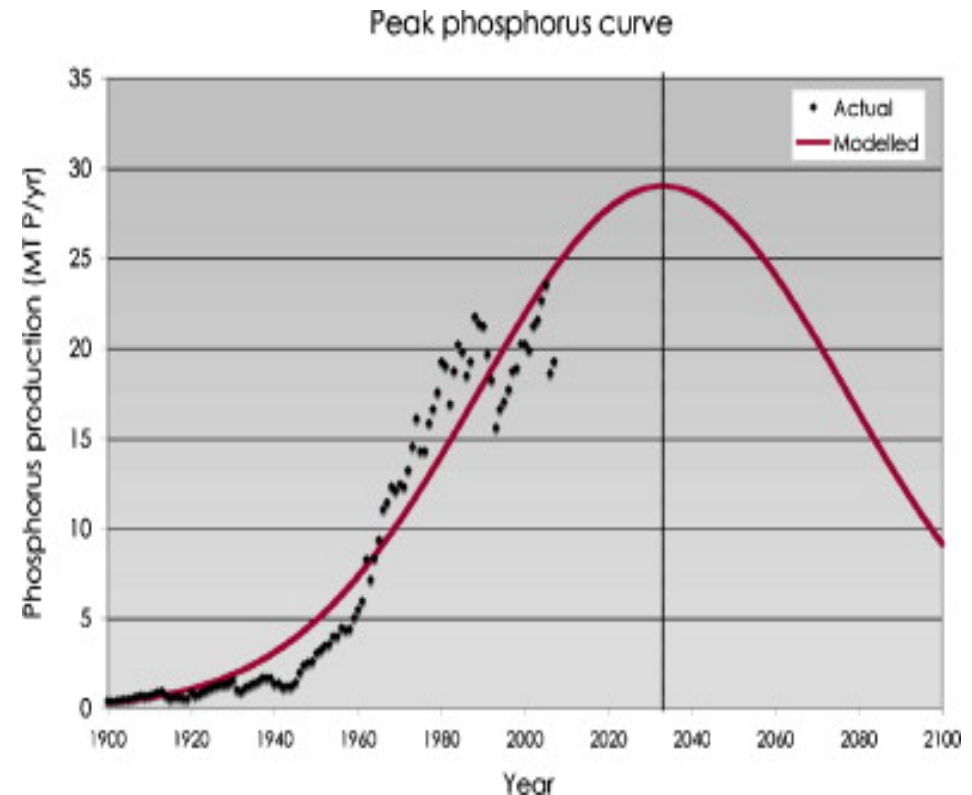
David L. Correll*

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

DAVID TILMAN

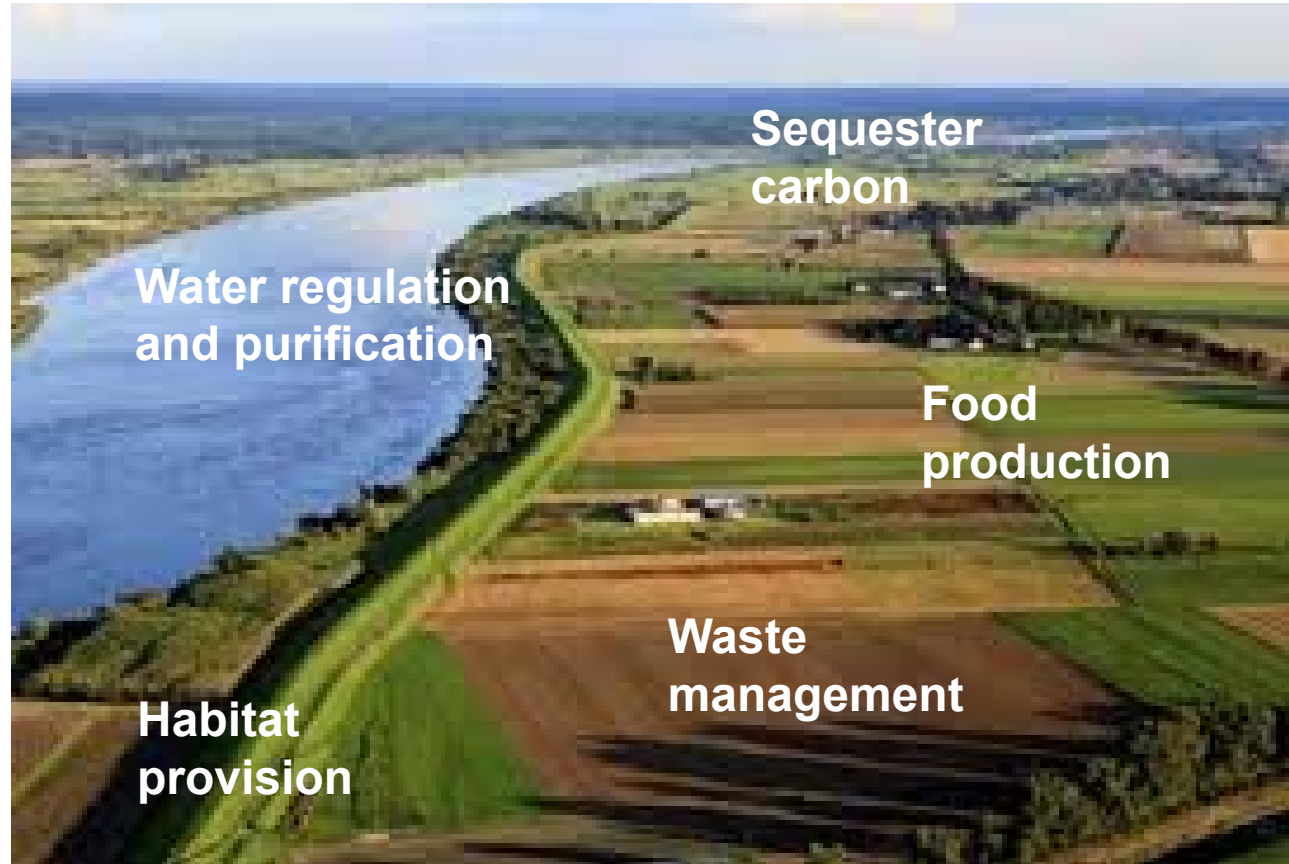
Managing Agricultural Phosphorus for Protection of Surface Waters: Issues and Options

Andrew N. Sharpley*, S. C. Chapra, 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

Drivers to improve nutrient use efficiency: Land management



Challenge: No longer managing land solely for agricultural production

Drivers to improve nutrient use efficiency: Legislative

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

- Nitrates Directive 1991
- Drinking Water Directive 1998
- Water Framework Directive 2000
- Nitrates Action Programme 2005+
- COGAP and QA incentives

Challenge: Increasing regulatory mechanisms aimed at improving nutrient use efficiency



The Telegraph

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Bavarian farmer puts nappies on his cows in EU protest
Bavarian farmer puts nappies on his cows in anger at EU nitrates directive that bans fertiliser on any mountain slope with a gradient of more than 15 per cent

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Farmer Johann Huber presents his cows Ami (left) and Doris, in a diaper, in Gmund am Tegenersee, Germany Photo: ...

HDB

DAIRY

Drivers to improve nutrient use efficiency: Social

The screenshot shows the BBC News website interface. At the top, there are navigation links for News, Sport, Weather, iPlayer, and TV. Below this is a red banner with the word "NEWS" in white. Underneath the banner are more navigation links: Home, UK, World, Business, Politics, Tech, Science, Health, and Education. The main content area features a headline: "Beef environment cost 10 times that of other livestock". Below the headline is a sub-headline: "Pollution from Giant Livestock Farms Threatens Public Health". A short paragraph follows: "Waste lagoons and manure sprayfields -- two widespread and environmentally hazardous technologies -- are poorly regulated." At the bottom of the screenshot, the Guardian logo is visible, along with a navigation bar for various sections like ball, opinion, culture, economy, lifestyle, fashion, environment, tech, money, travel, and a "browse all sections" button.

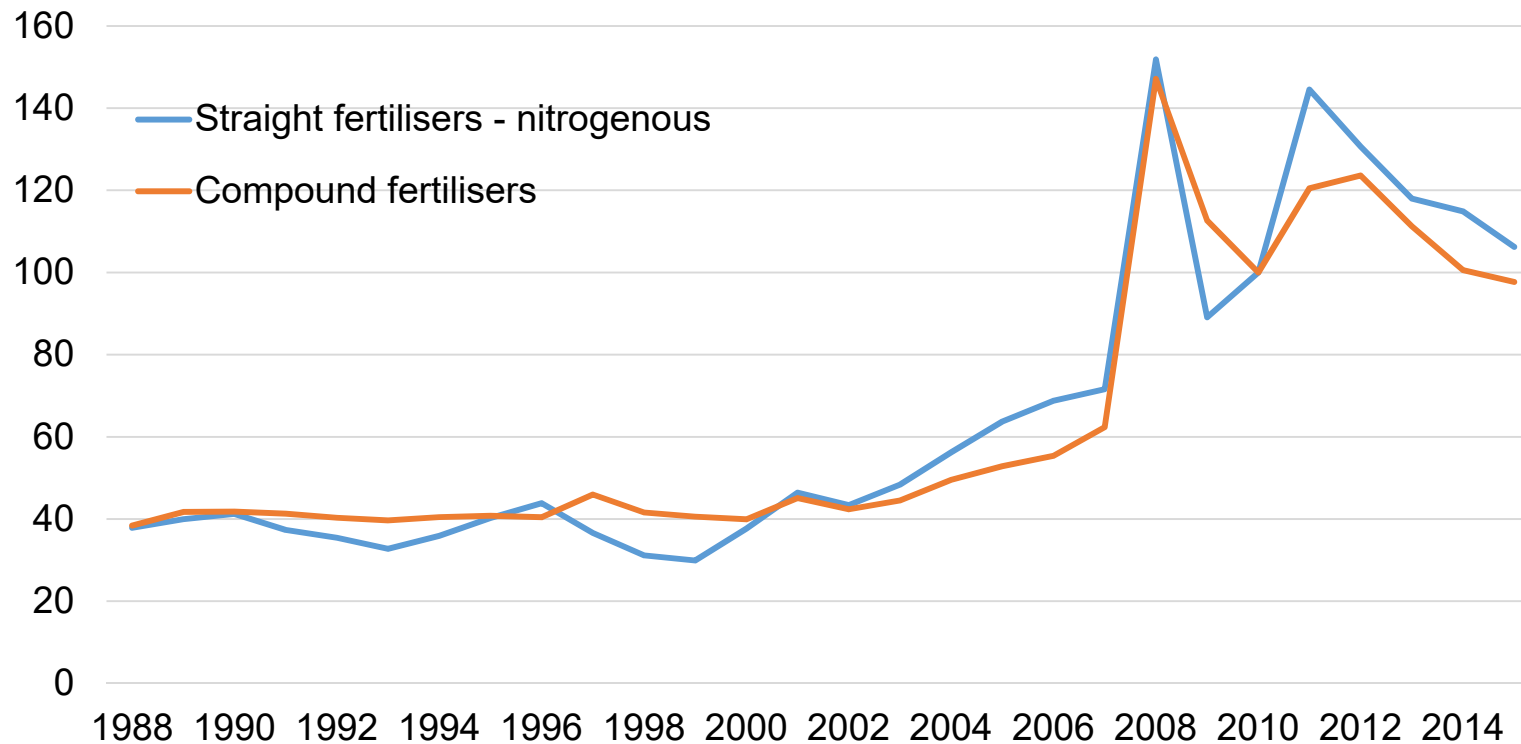
UN urges global move to meat and dairy-free diet

Challenge: Greater public demand for environmentally conscious food production



Drivers to improve nutrient use efficiency: Economic

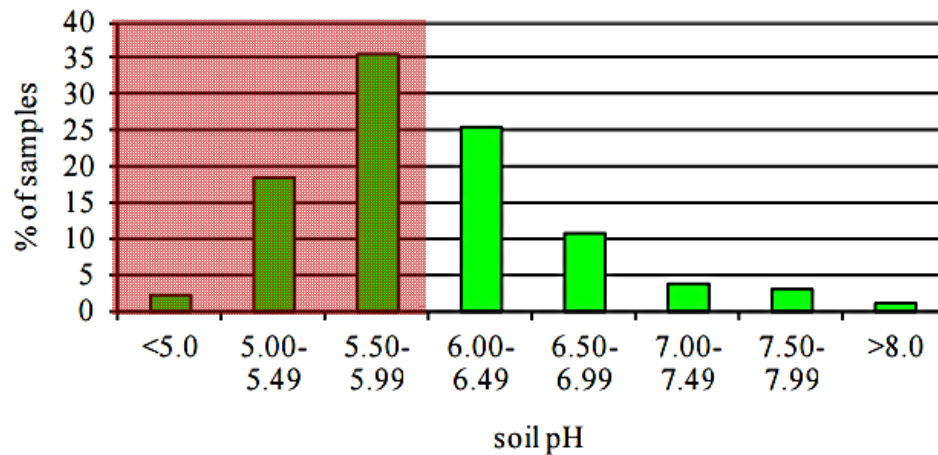
Fertiliser price index trends
2010 = 100 base



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

Trends in nutrient management on grassland farms in GB

Distribution of soil pH values
(Grass samples)



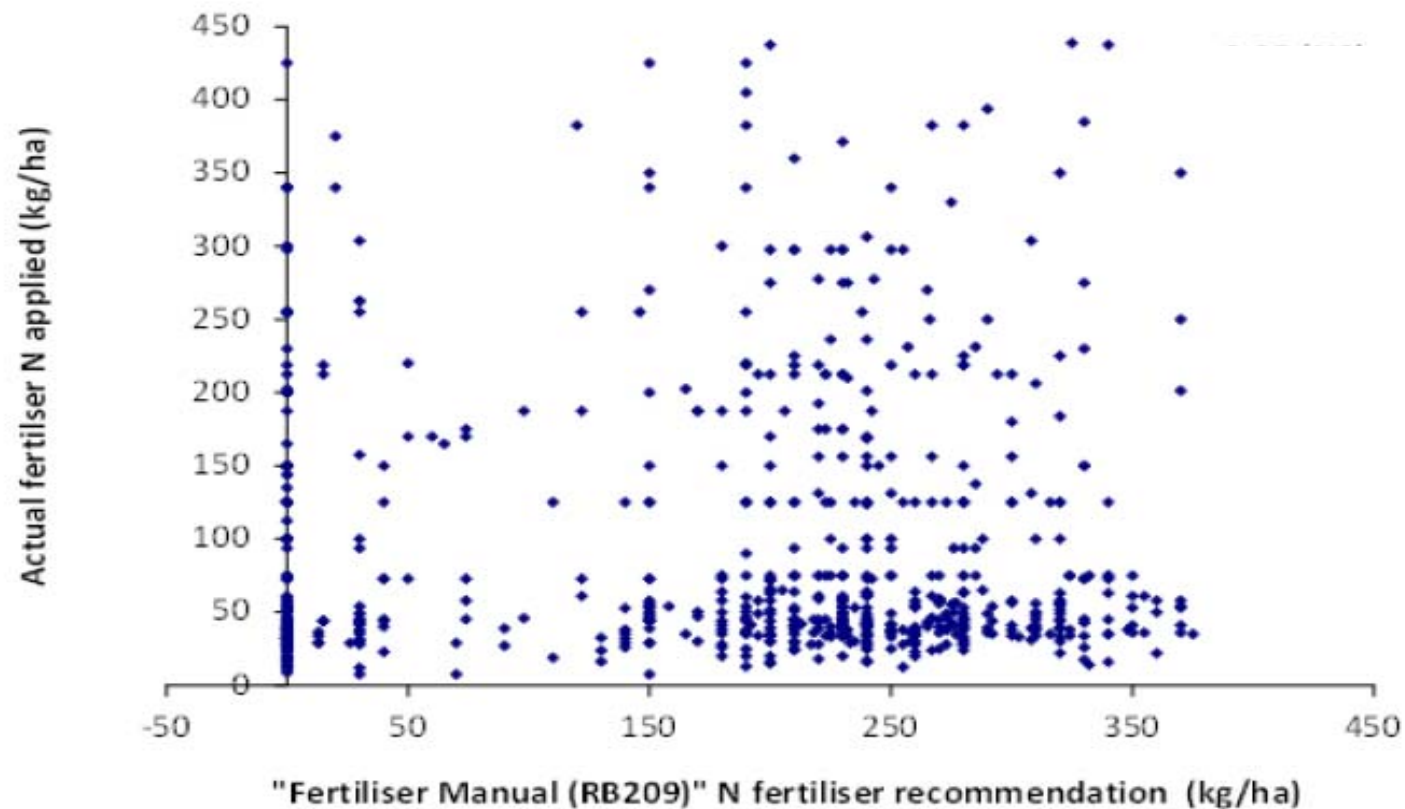
57% of grassland soils below pH 6.0

Only 9% of soils at target for P and K

K Index	P Index		
	<target	target	>target
<target	19	13	9
target	10	9	9
>target	7	10	15

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

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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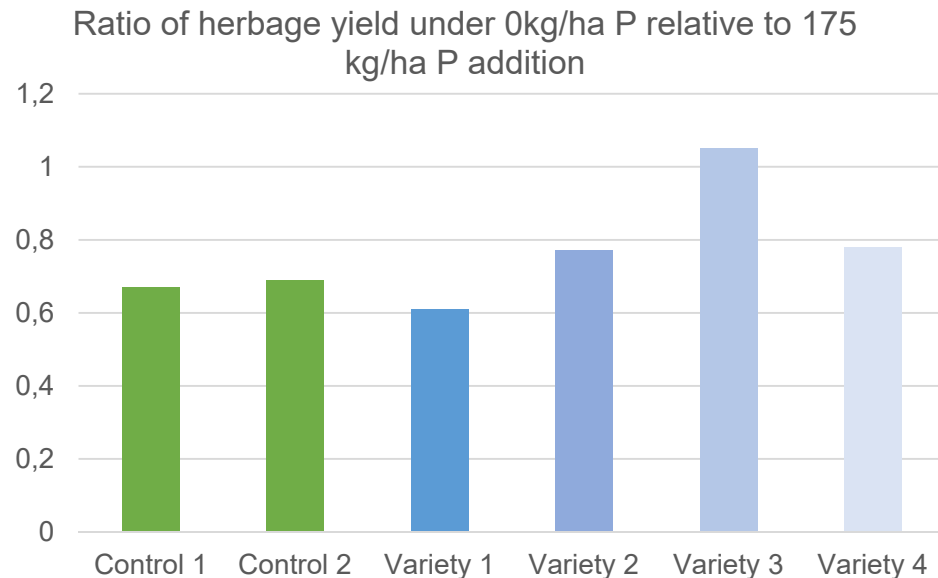
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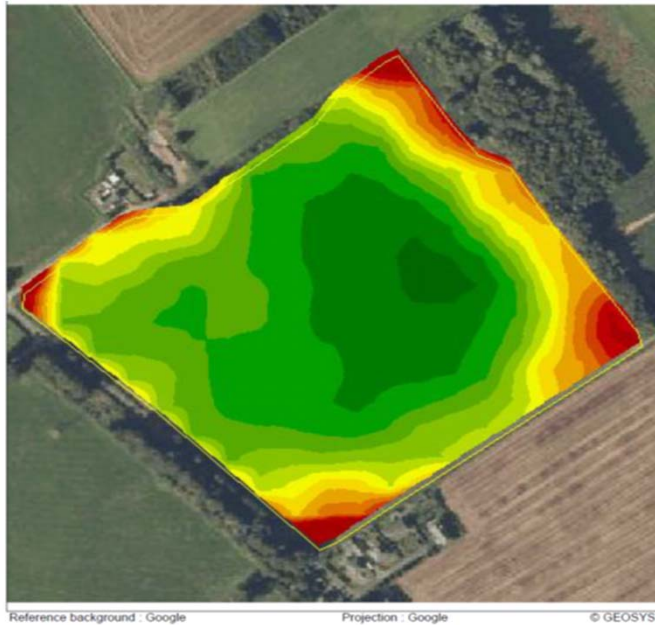
Breeding programmes – nutrient efficient forages

- 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

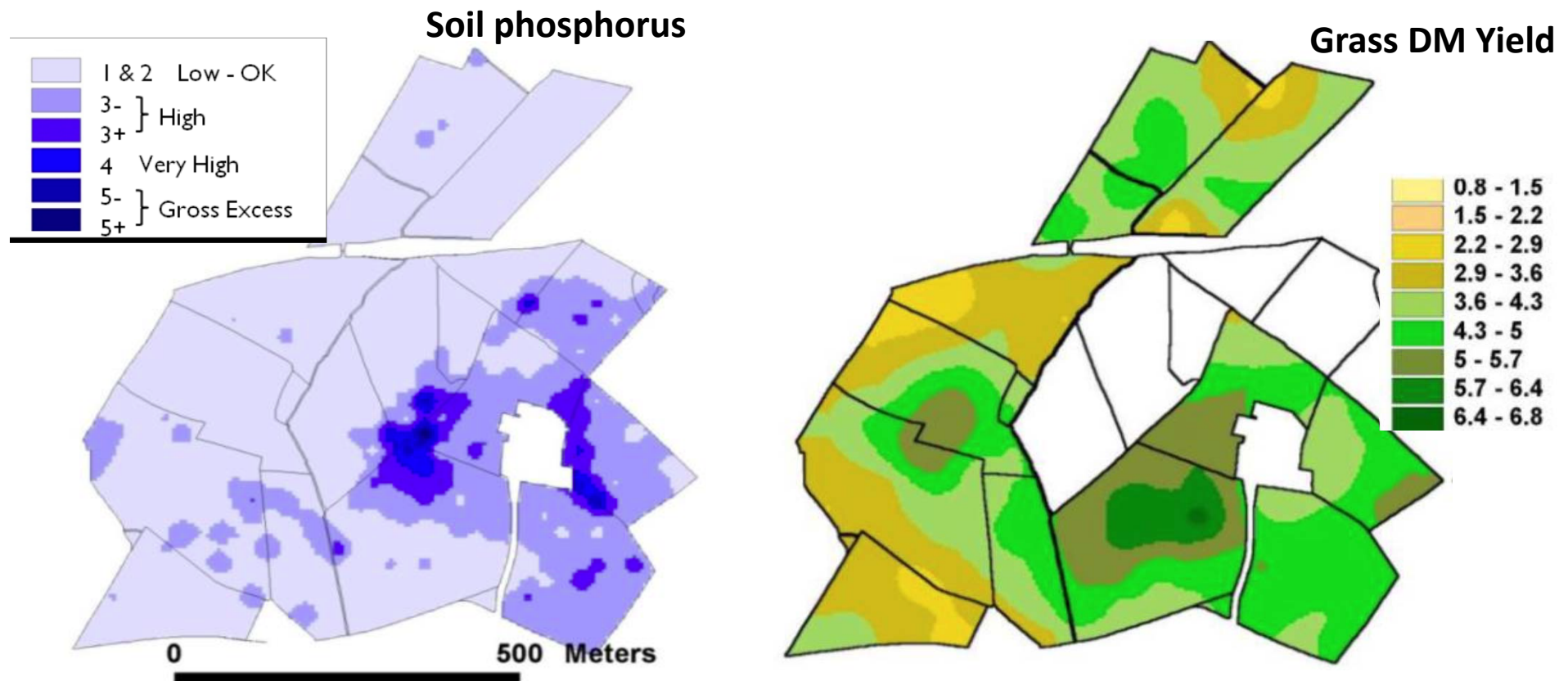


Within field variation in grass dry matter (DM) in a grassland silage field

	DM yield t/ha	
	Mean	Range
First cut silage	3.7	1.1 – 6.3
Second cut silage	4.1	2.3 – 5.4
Third cut silage	2.4	1.1 – 4.0
Total yield	10.2	6.8 – 13.2

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

Technology development – nutrient distribution across grassland



Opportunity: Development of variable rate application technology for grassland

Bailey et al. 2015

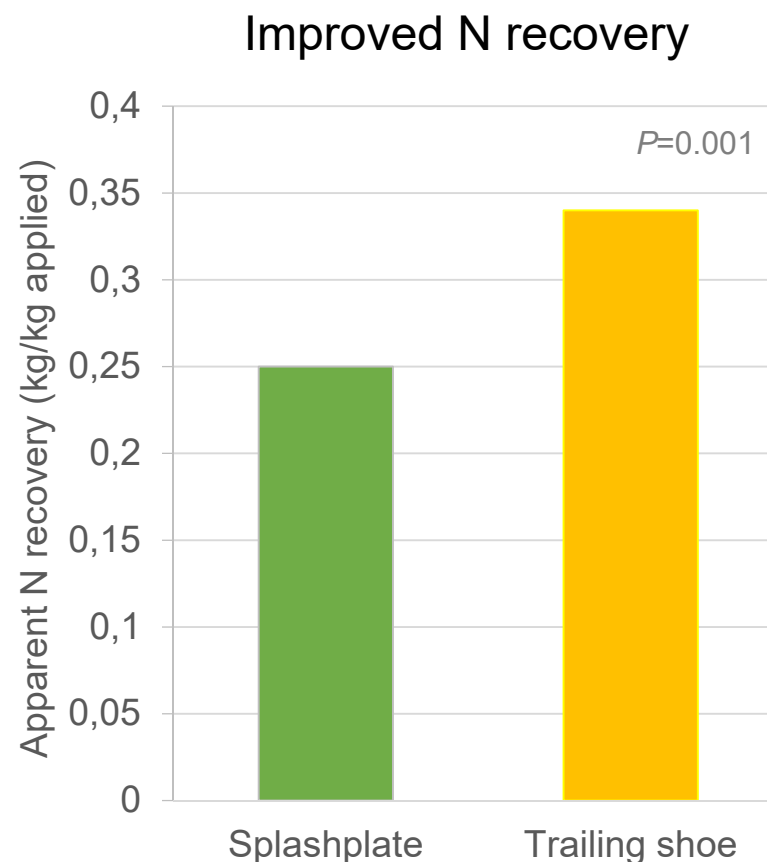
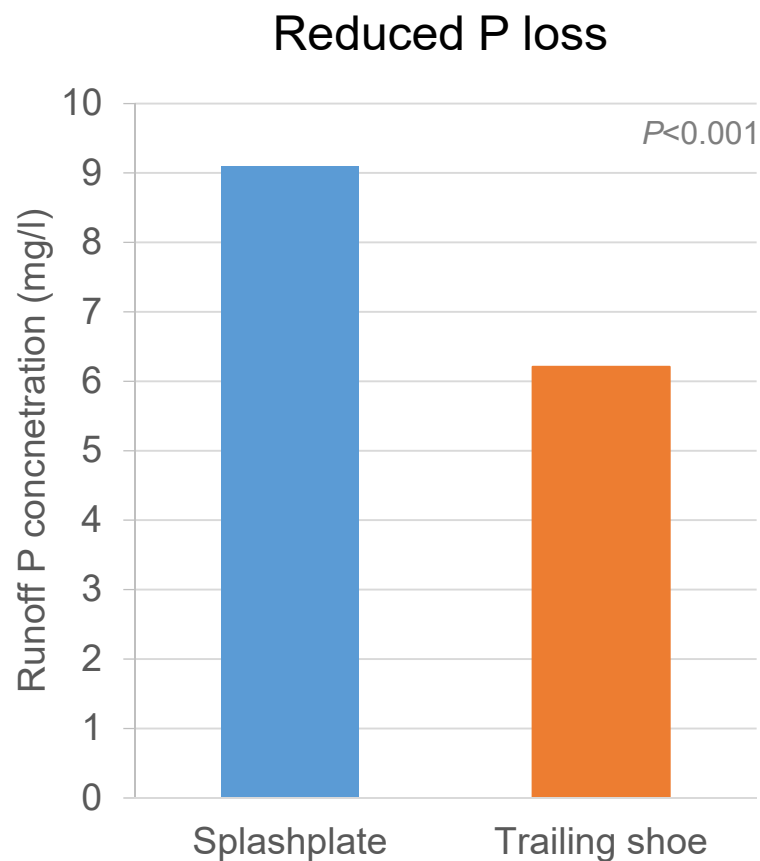
Technology development - nitrogen sensors

- 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



Technology uptake – manure application



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

Opportunities

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Knowledge exchange
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1. Soil
2. Nutrient

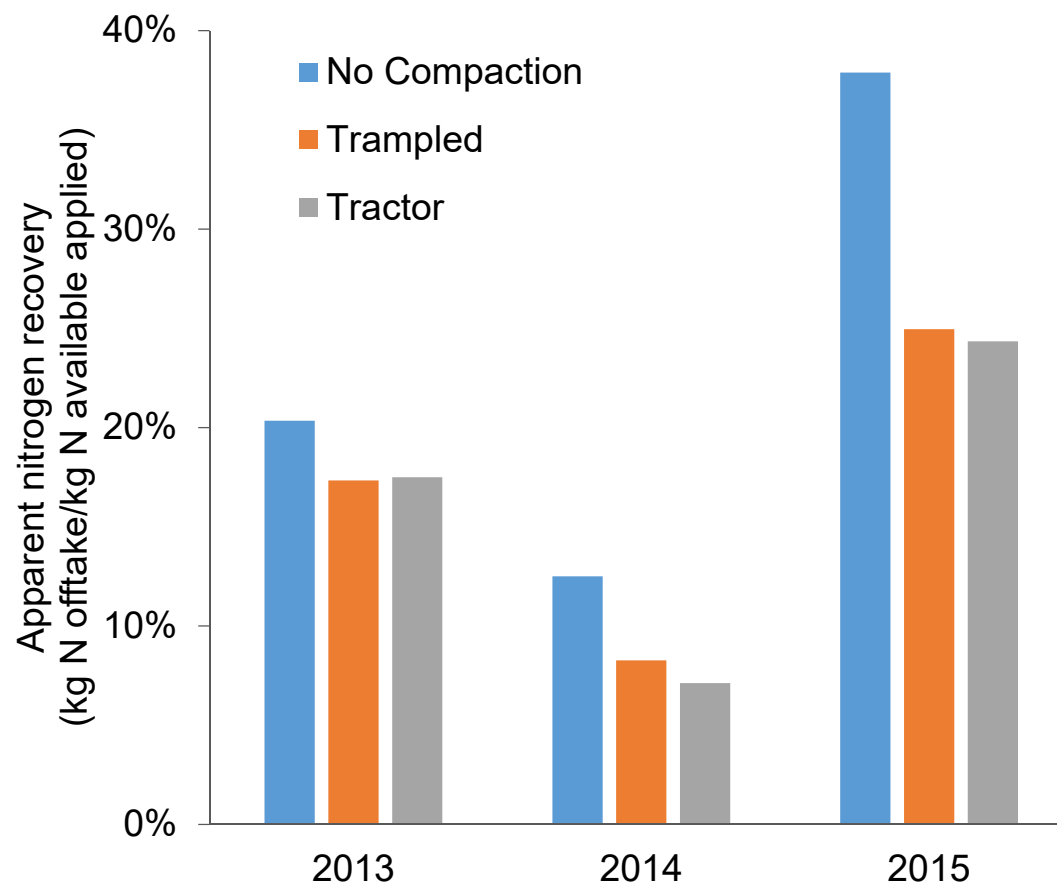
Knowledge exchange - Soil

- 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



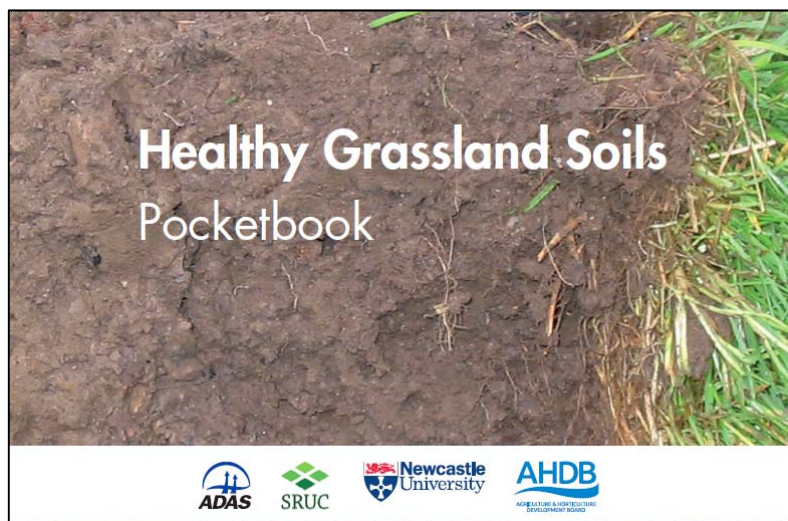
Knowledge exchange - Soil

	Nitrous oxide flux (g/ha)
No compaction	89.3
Tractor	122.1
Animal	96.7



Improving soil structure reduces gaseous N losses and increases N recovery

Knowledge exchange - Soil



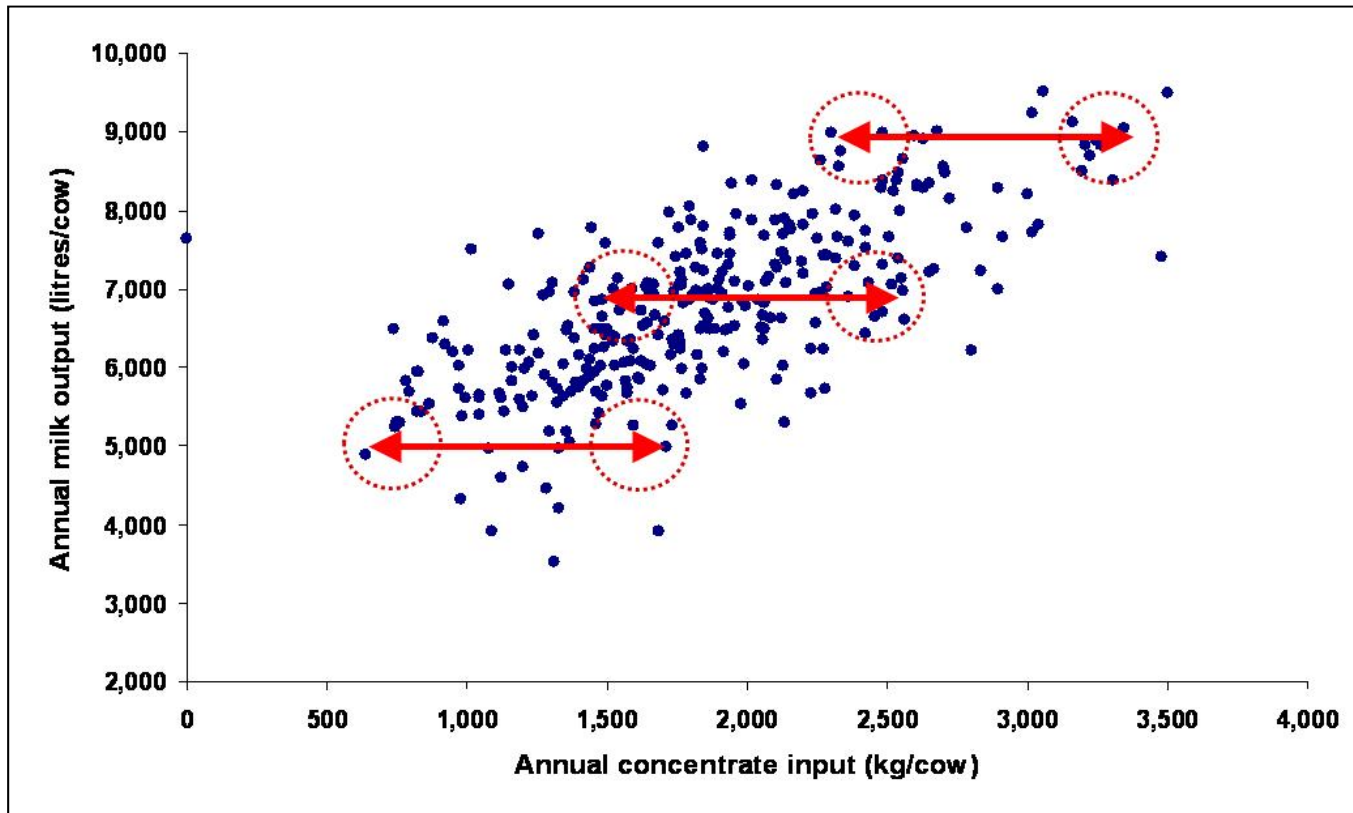
Place the top of the probe level with the surface and assess the soil below

Structure quality	Identification of structural problem eg limiting layer	Soil structure features	Description
Score 1 Friable Aggregates readily crumble with fingers			<ul style="list-style-type: none"> Good soil structure Highly porous Many roots Sweet earthy smell No signs of compaction
Management Options	Re-assess after equipment crosses the ground or grazing in wet conditions or every two years.		
Score 2 Intact Aggregates easily break apart			<ul style="list-style-type: none"> Good soil structure Porous Good root distribution Earthy smell Some indication of larger aggregates
Management Options	Re-assess after equipment crosses the ground or grazing in wet conditions or yearly in spring.		
Score 3 Firm Most aggregates break down			<ul style="list-style-type: none"> Adequate soil structure Some aggregates non-porous, less visible pores Moderate root distribution No strong smell Some indication of reduced porosity Fewer worms
Management Options	Consider infrastructure changes (eg back-fencing, multiple field entrance or tracks) to minimise traffic in marginal weather conditions.		
Score 4 Compact Effort needed to break down aggregates			<ul style="list-style-type: none"> Large angular aggregates (>5cm across) with low pore numbers Some red/orange mottling maybe present (sign of poor drainage) Roots clustered in large pores, worm channels and cracks between aggregates May have sulphur smell (ie bad eggs)
Management Options	Consider use of sward slitter or aerator (if poor soil structure <10cm) or top-soiler or sward lifter (if poor soil structure deeper than 10cm).		
Score 5 Very compact Aggregates compact, difficult to pull apart and play			<ul style="list-style-type: none"> Very large angular aggregates (>10cm), with very few pores Any roots seen mainly at the surface or clustered down large pores or cracks May have gray colour with red/orange mottling (sign of poor drainage) May have strong sulphur smell (ie bad eggs)
Management Options	Use sward slitter or aerator (if poor soil structure <10cm) or top-soiler or sward lifter (if poor soil structure deeper than 10cm). Assess sward and plough and reseed if required.		

Based on the VESS method of soil structure assessment (www.sruc.ac.uk/vess)
See Healthy Grassland Soil Pocketbook for more information. It is available at www.healthygrasslandsoils.com.



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

Yield (litres per cow per annum)	Calculated P balance on benchmarked dairy farms (kg P per ha)	
	Most efficient	Least efficient
6000 – 7000	3.6	12.6
7000 – 8000	6.4	16.5
8000 – 9000	9.0	17.9
9000 - 10000	12.7	19.8

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

Knowledge exchange – Nutrient management

Norway: Land management DST to determine risk of P loss

Netherlands: Phosphorus efficiency benchmarking tools

	P efficiency (%)
My farm:	
Current	26.5
Increased grazing	33.7
Other farms:	
In my region	29
Similar system	32
2013 target	31



Separation



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.



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