The Signpost Series
'Pointing the way to a low emissions agriculture'

Protecting Nitrogen & Phosphorus inputs on farms

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Overview

- How do we measure the efficiency of nutrient used?

- Factors affecting the recovery of nutrient applied to soils

- Managing nutrient inputs on farms to achieve agronomic & environmental targets

- Take home messages

How can we minimise loss on nutrients?
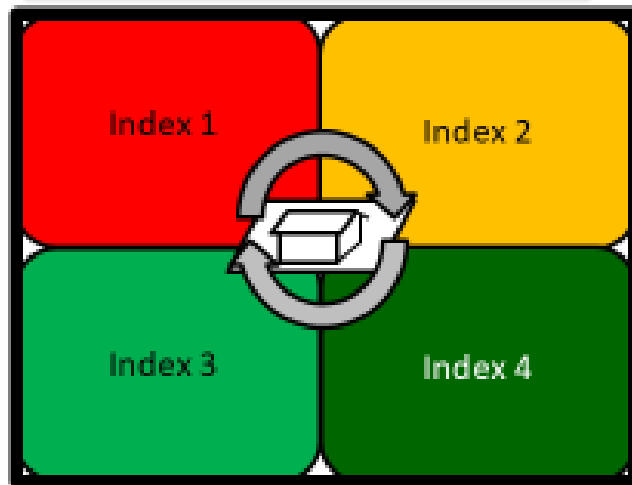
Nutrient in-flows   *vs.*   Nutrient out-flows

Inputs   >>   Outputs?

Soil nutrient storage building Soil fertility?

INPUTS
Fertiliser
Feed
Animals
Org. Manure
imports

Nitrogen
600 kg

Index 1

Index 2

Index 3

Index 4
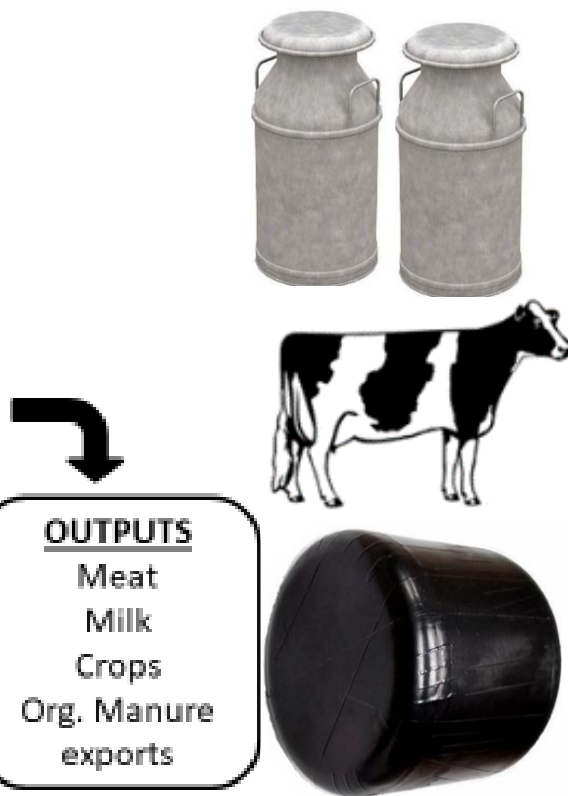
OUTPUTS
Meat
Milk
Crops
Org. Manure
exports

Nutrient loss?

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What is the nutrient use efficiency at farm level?

Teagasc NFS, Sustainability Report 2018

Nutrient Use Efficiency (%) at farm level

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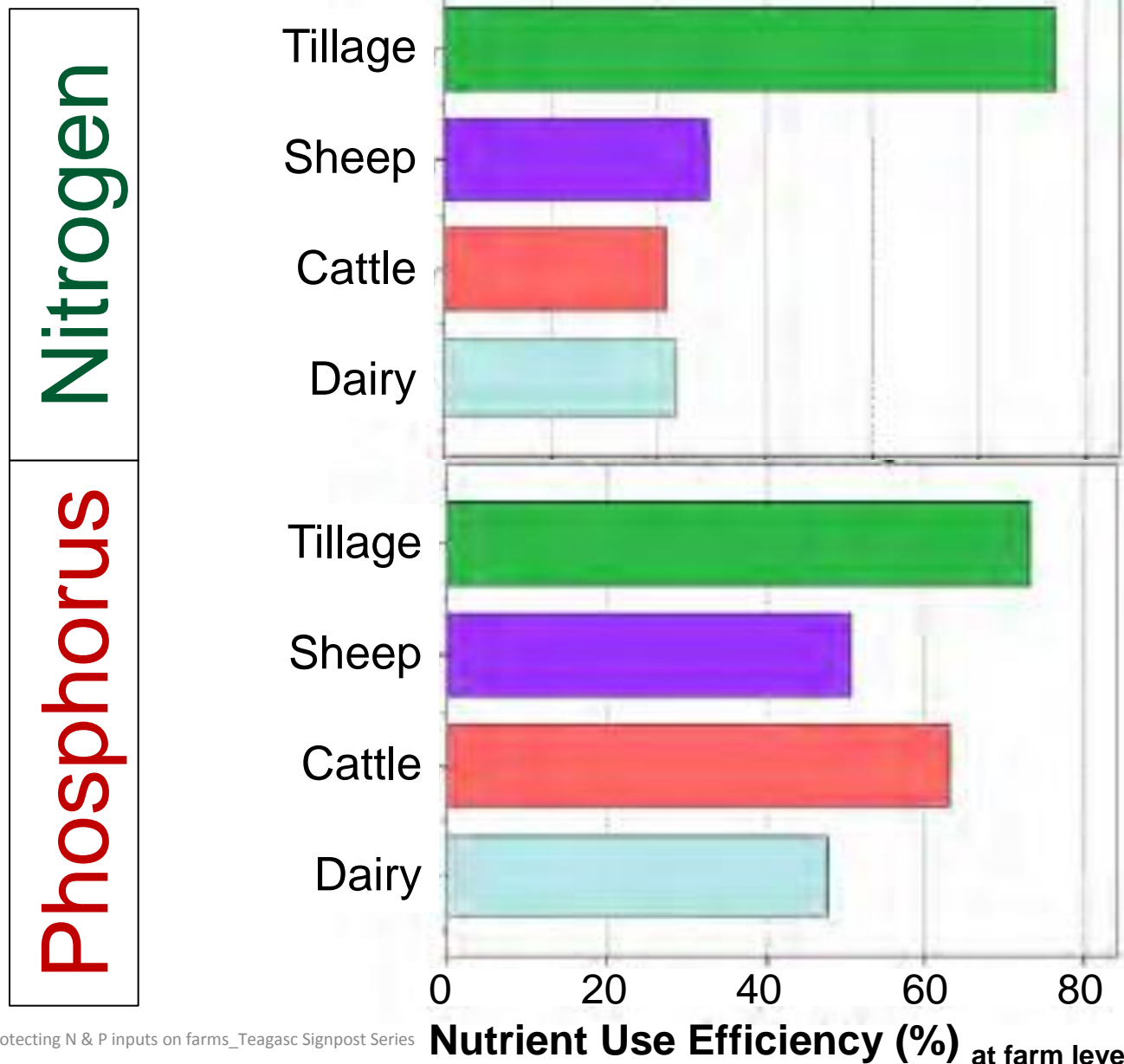
How can we categorize soils for management?

One soil does not fit all!
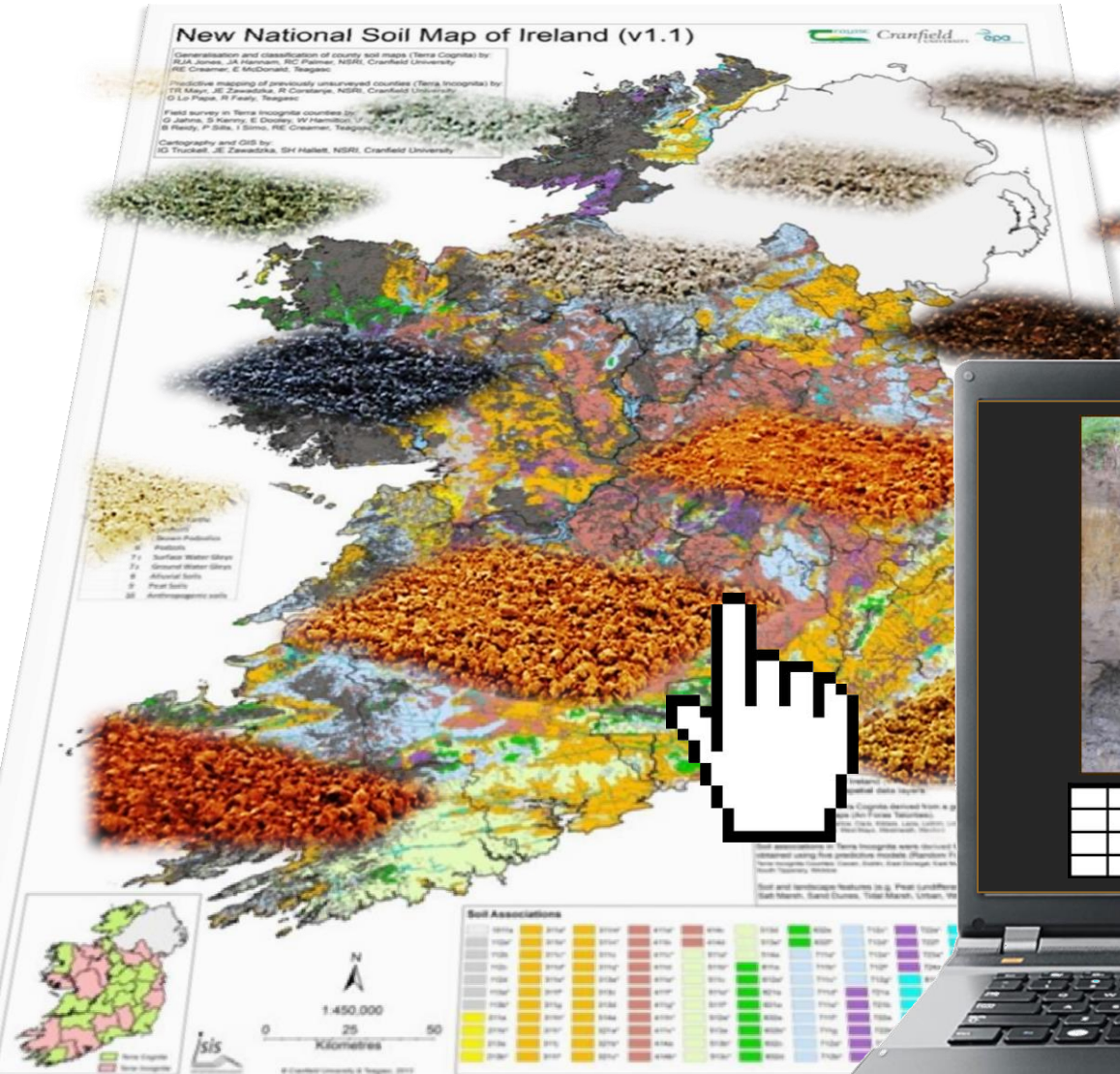
Organic Soil/Peat Soil
>20% Organic Matter

potential N loss when peat wets up as N_2O gas

potential P loss in shallow & surface runoff
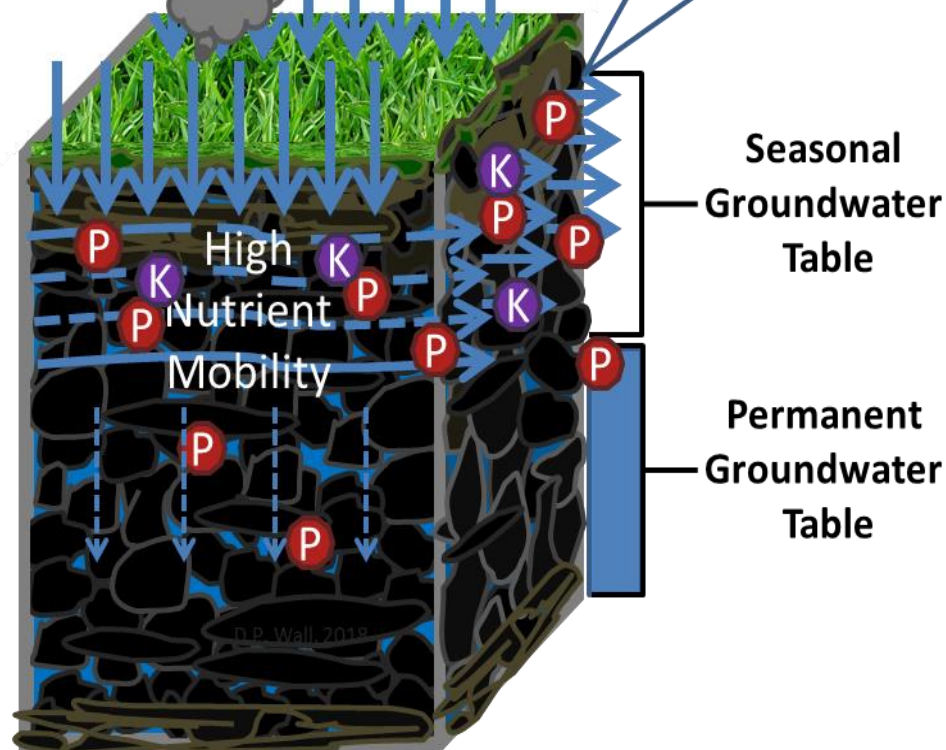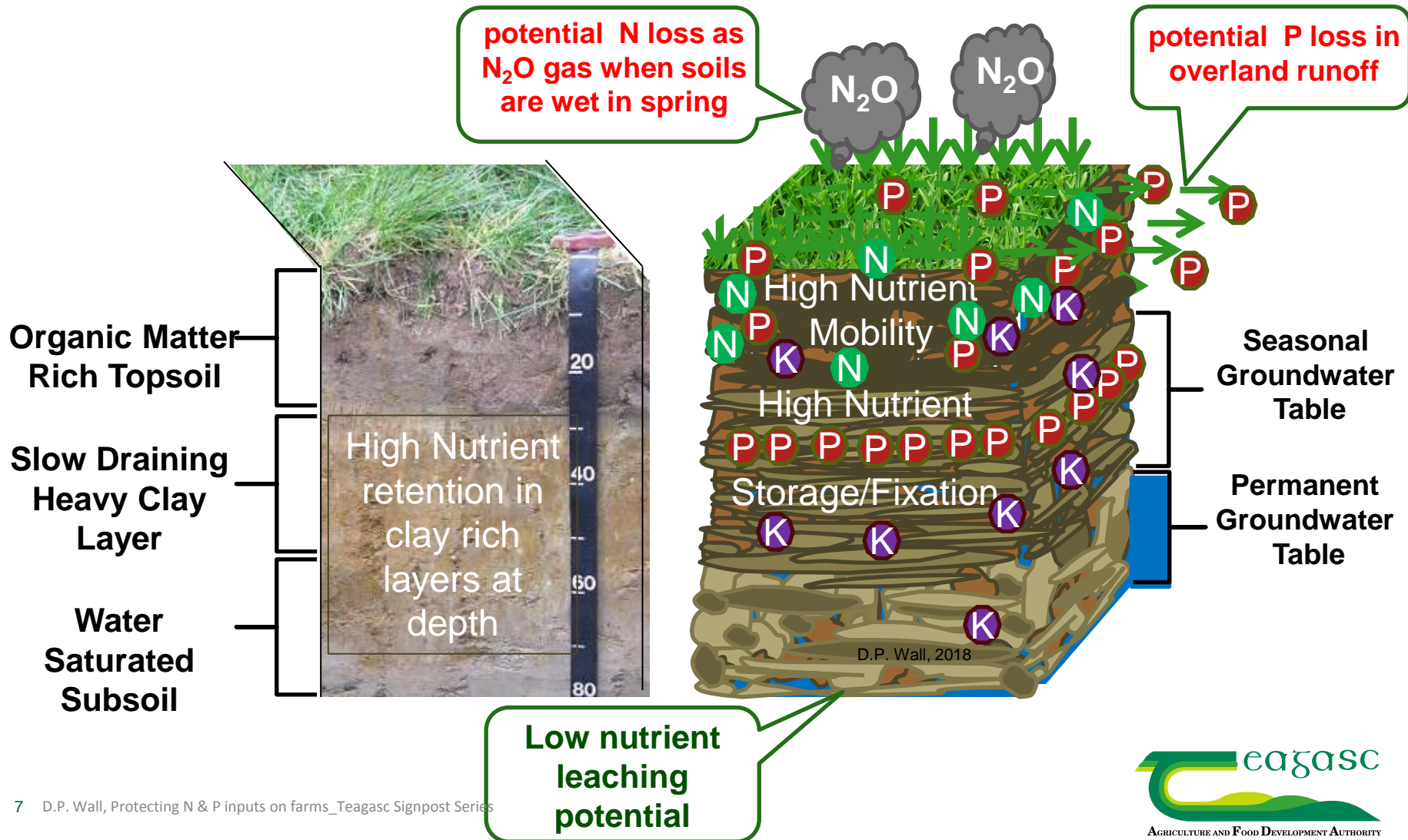
N_2O

>20% (O.M.) Organic Matter 0-40 cm
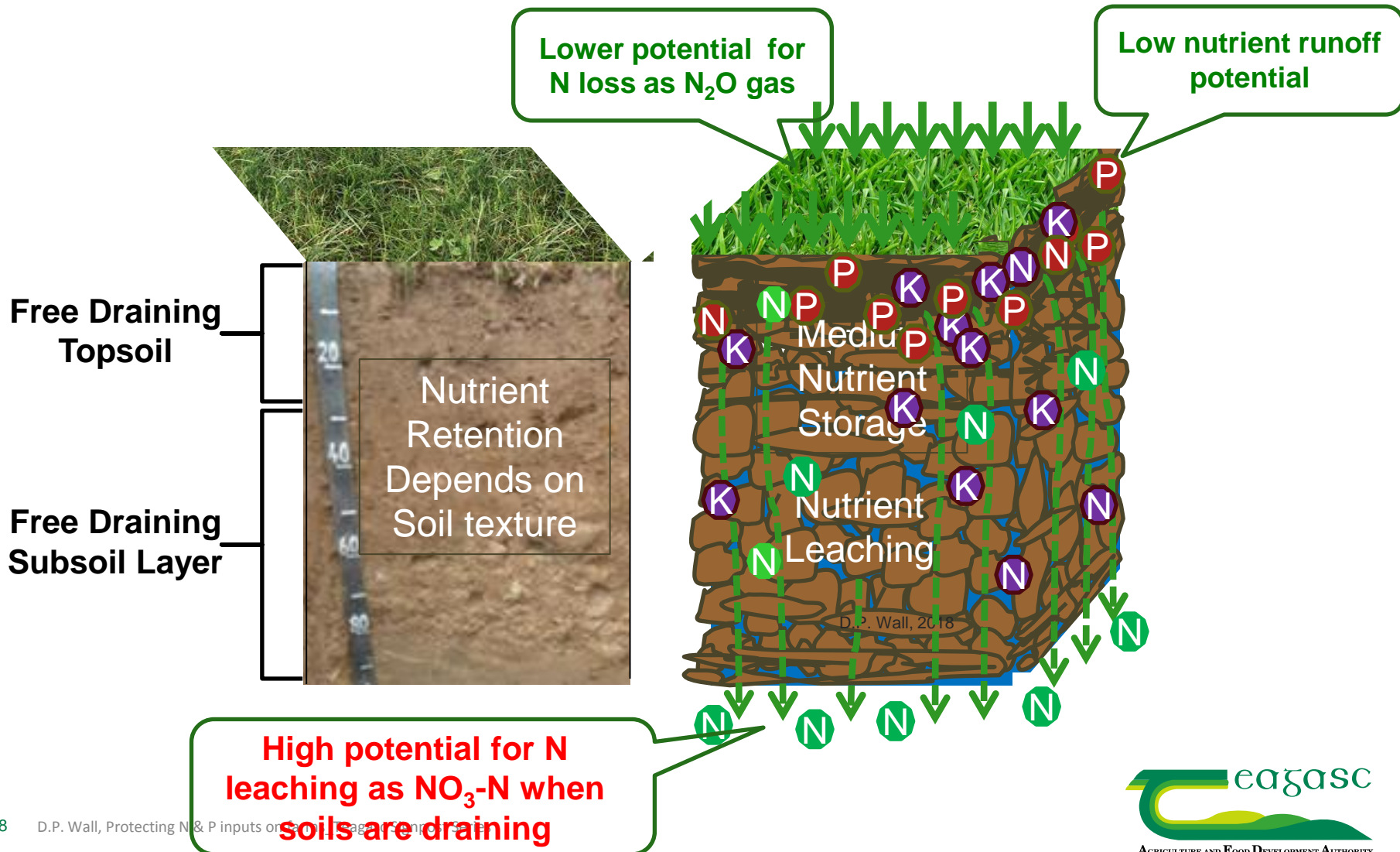
Oap
Oa
Oe
Oa'

Low Nutrient Retention

Low Mineral Matter

High Nutrient Mobility

Seasonal Groundwater Table

Permanent Groundwater Table

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Heavy Soil
Poorly Drained – Gleysol

potential N loss as N$_2$O gas when soils are wet in spring

N$_2$O

N$_2$O

potential P loss in overland runoff

Organic Matter Rich Topsoil

Slow Draining Heavy Clay Layer

Water Saturated Subsoil

High Nutrient retention in clay rich layers at depth

High Nutrient Mobility

High Nutrient Storage/Fixation

Seasonal Groundwater Table

Permanent Groundwater Table

Low nutrient leaching potential

D.P. Wall, 2018

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Light Soil
Freely Drained – Brown Earth

Lower potential for N loss as N_2O gas

Low nutrient runoff potential

Free Draining Topsoil

Free Draining Subsoil Layer

Nutrient Retention Depends on Soil texture

Medium Nutrient Storage

Nutrient Leaching

D.P. Wall, 2018

High potential for N leaching as NO_3-N when soils are draining

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What is your soil fertility level?

National soil Fertility in Ireland
pH ≥ 6.3, P and K ≥ Index 3

- 19.10%
- 80.90%

■ Deficient soil fertility

■ Soil fertility meeting agronomic optimum levels
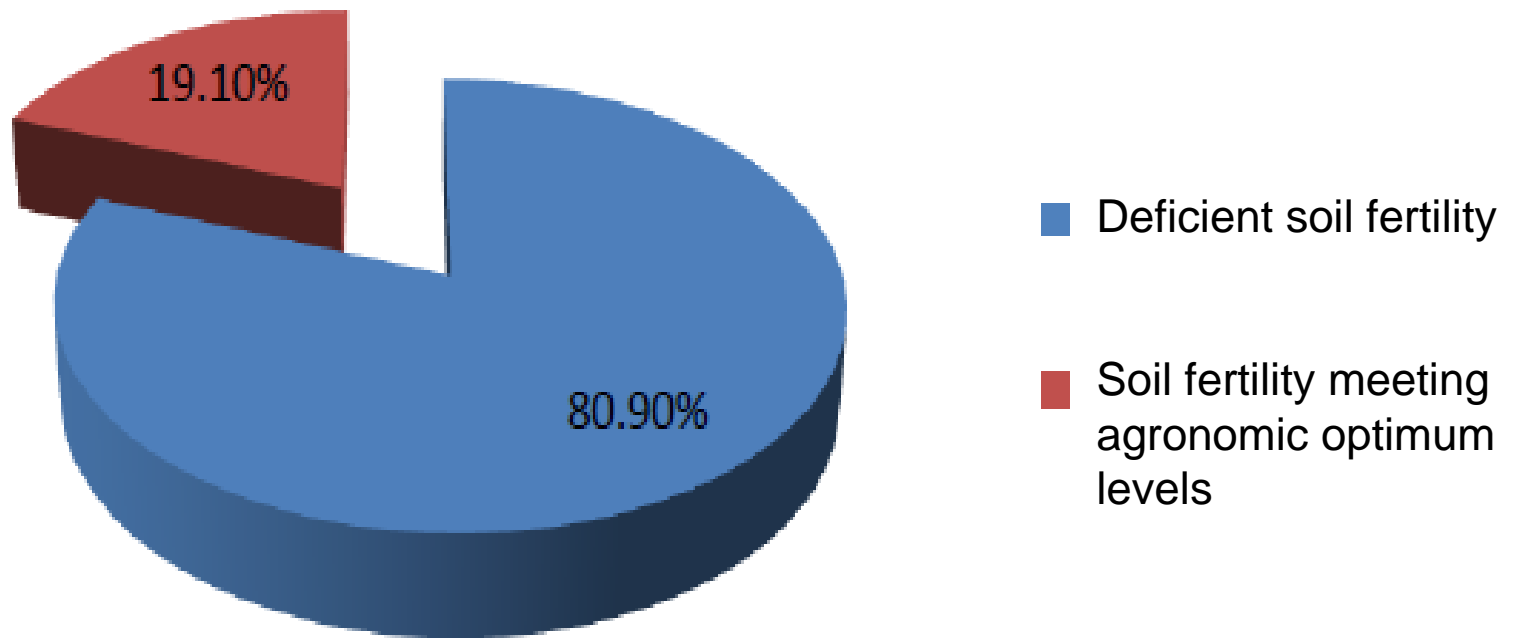
Source: DAFM, 2018

Lime - the foundation for soil fertility

What is your soil pH level?

$$\geq pH\ 6.3{:}\ y = 12.48$$

$$< pH\ 6.3{:}\ y = -4.1322x^2 + 54.464x - 166.78$$

Wall, D.P. *et al.*, 2017

Legend:
- □ Farm 1
- ◇ Farm 2
- + Farm 3
- △ Farm 4
- ○ Farm 5
- + Farm 6

6.3
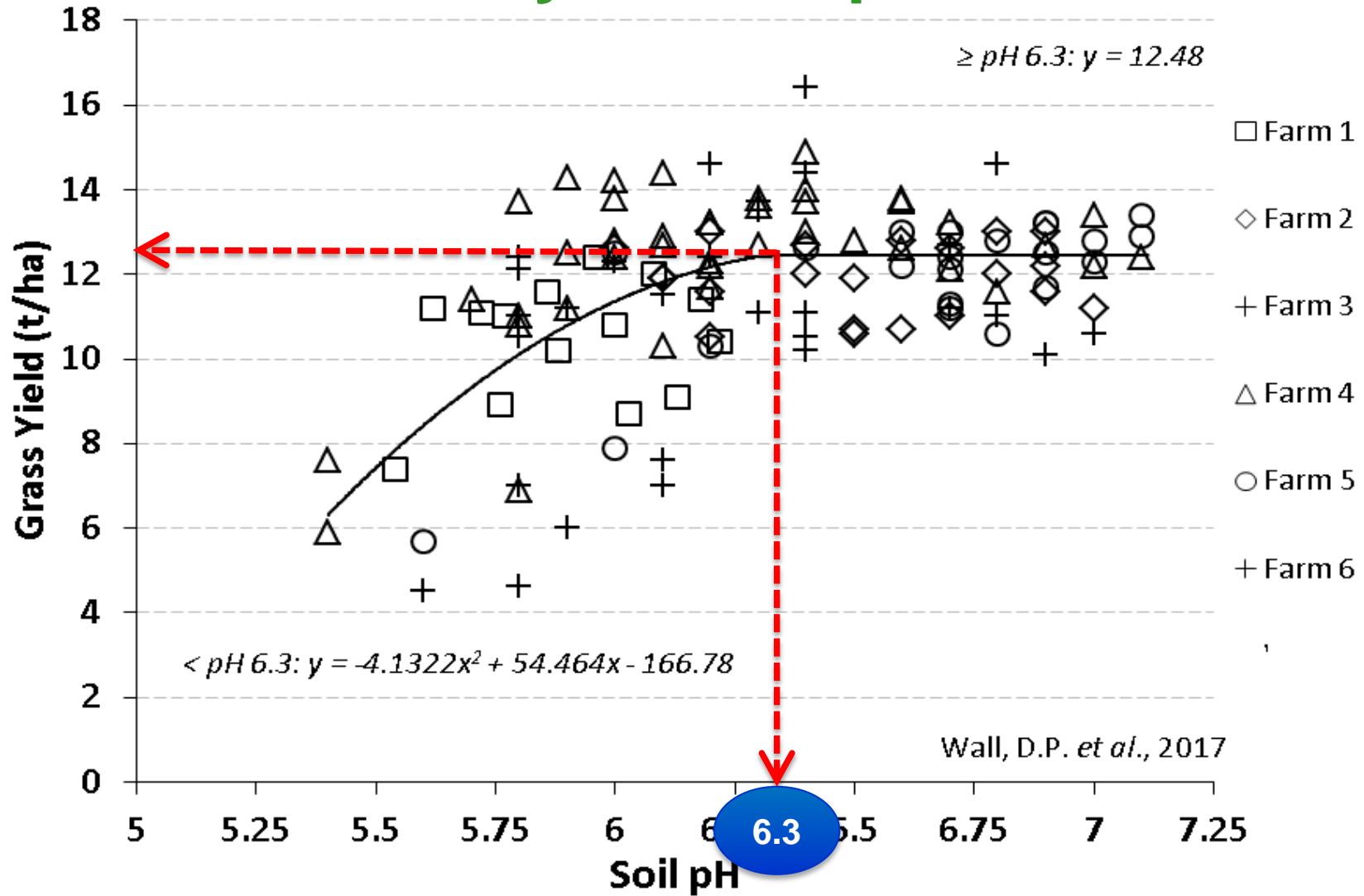
Soil pH and grass yield data measured across 6 grassland farms in Ireland

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Development Authority

Increased nutrient efficiency at optimum soil pH

Fox & Wall et al. (2020)
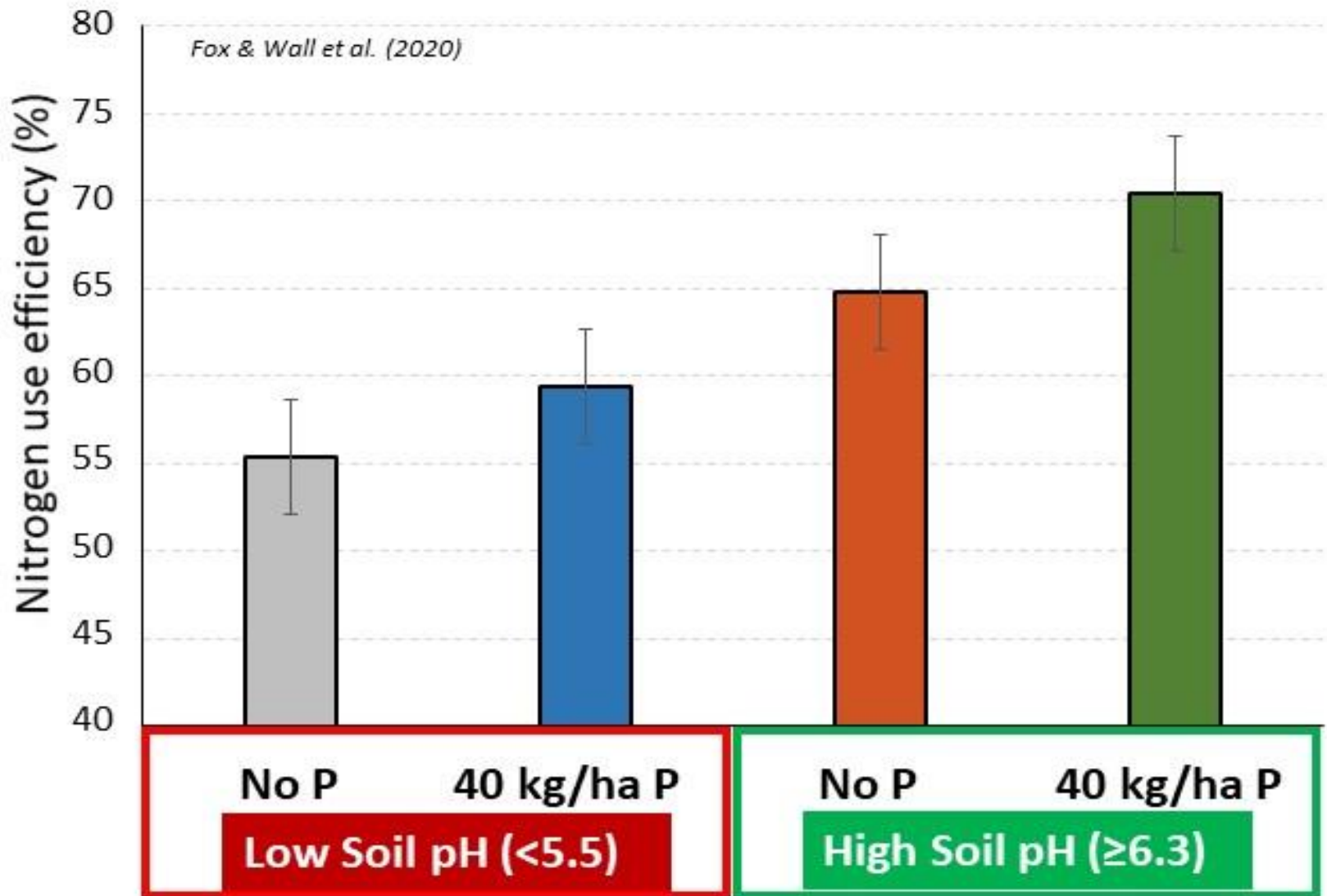
Lower GHG losses when soils are limed
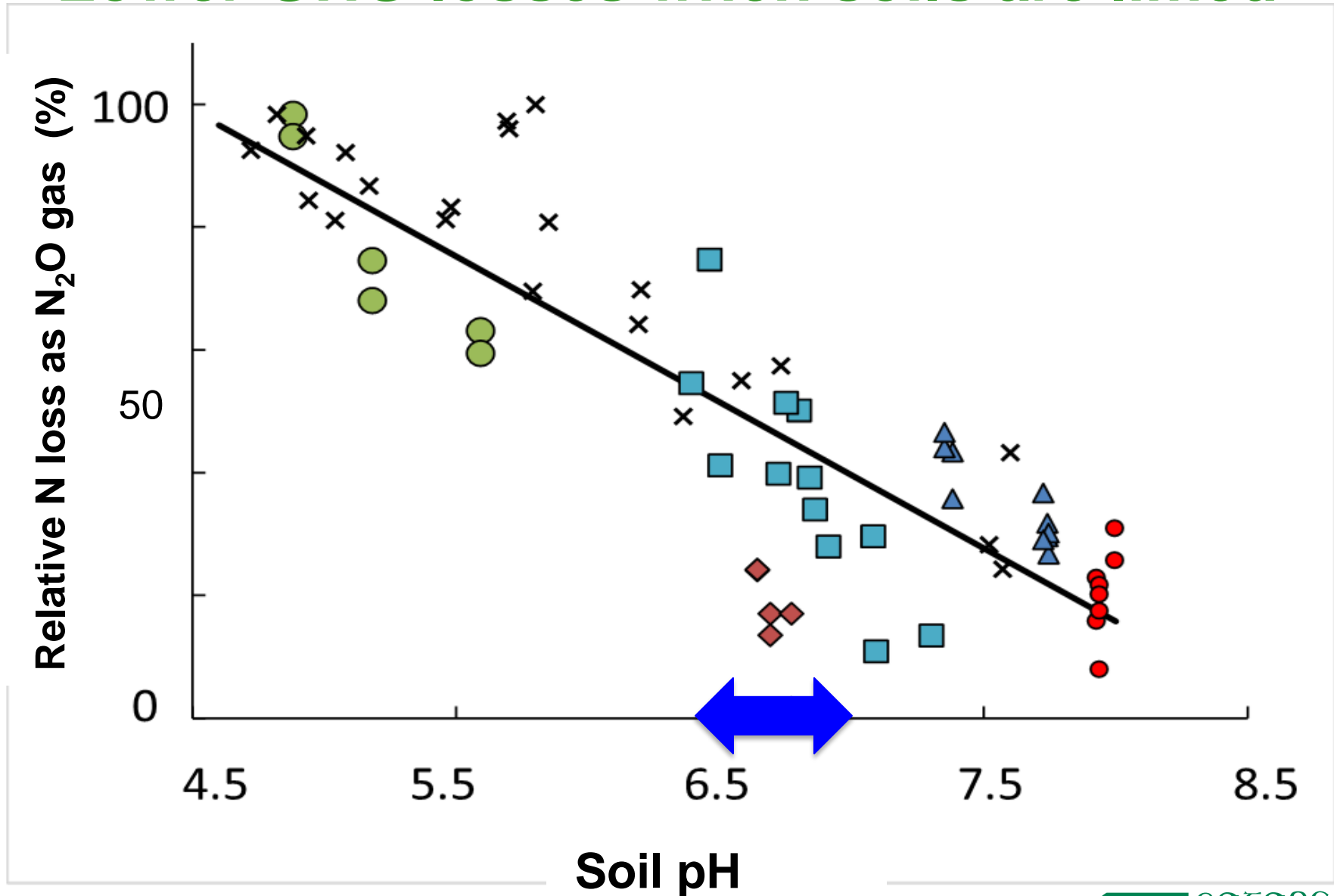
Benefits of balanced soil fertility

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Why Build Soil Fertility?

Across 10 Grassland Soils

Relative fertiliser N use efficiency (%) vs Soil Phosphorus Index

Up to 15% N is potentially wasted!!
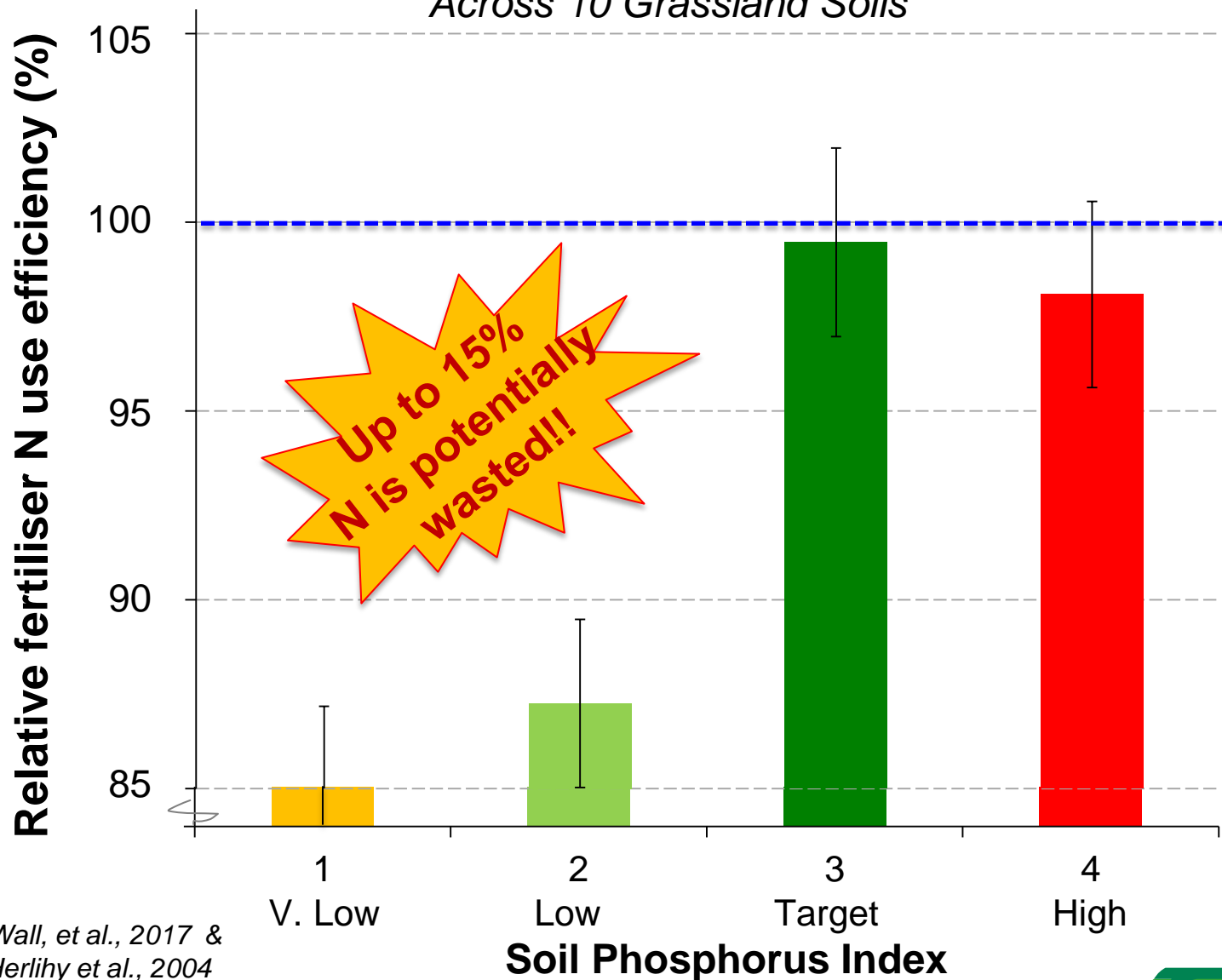
Data: Wall, et al., 2017 & Herlihy et al., 2004

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Effect of Soil Fertility on Nitrogen Use Efficiency

$$\text{NUE (\%)} = \left(\frac{\textbf{Total N uptake by Grass} = \text{(Grass yield * Grass N concentration)}}{\textbf{Total N Inputs} = \text{(Fertiliser-N, Manure-N \& Excreted-N, Concentrate feed–N + soil N supply)}} \right) \times 100$$
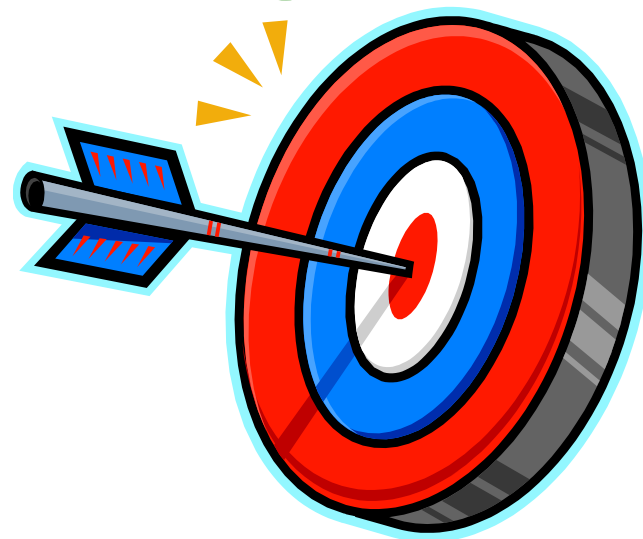

Wall, D.P. (2020) Teagasc

Figure: Effect of soil fertility on percentage nitrogen use efficiency across grassland fields (n=446) over 2 years on dairy farms in Ireland

D.P. Wall, 2017

Pro Urea = Urea + Urease Inhibitor
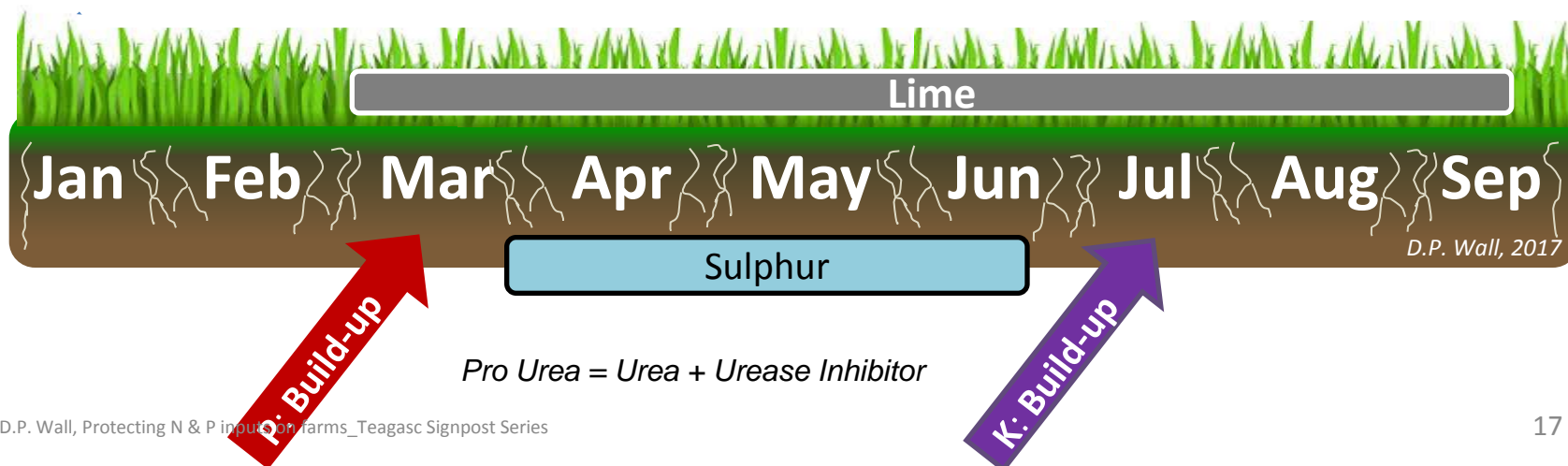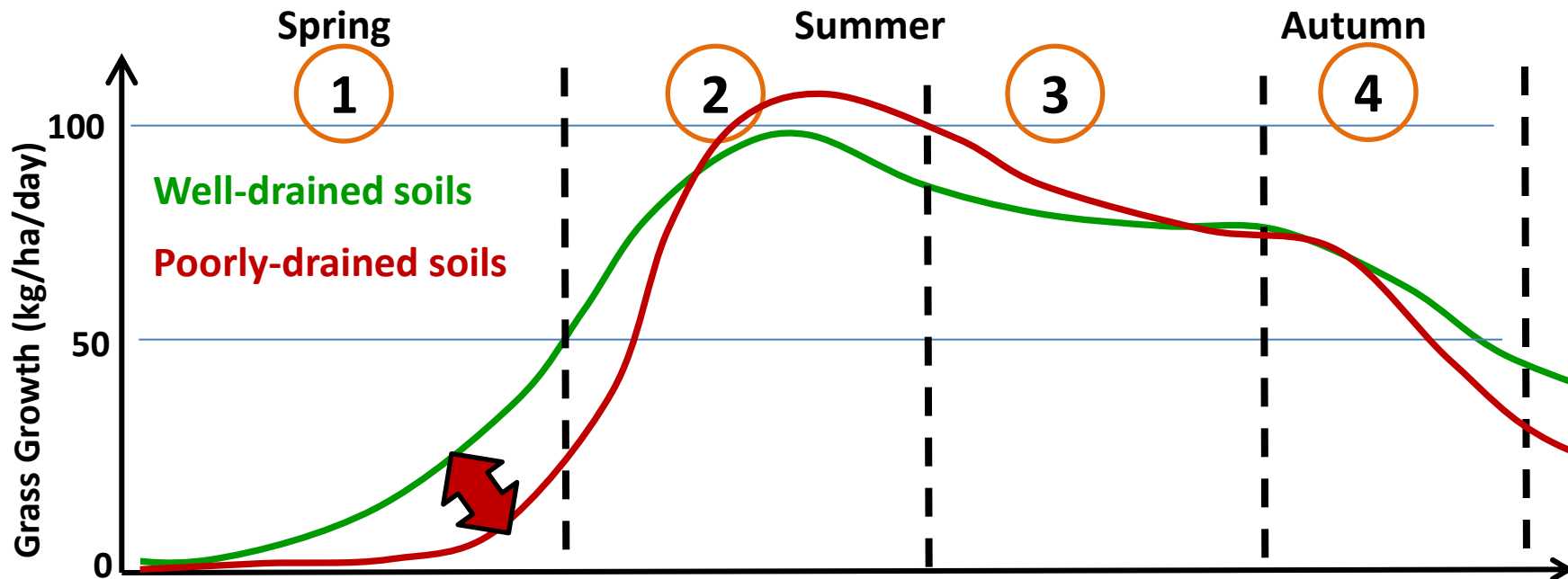
Soil Fertility Management Targets

- Have soil analysis for whole farm

- Soil pH between 6 and 6.5 in all fields

- P and K Index 3 in all fields

  - Index 4 is a resource → Exploit it

  - Index 1 & 2 → identify and nourish

- Optimise slurry first – then top up with fertilizer as required

- Nutrient inputs in proper balance

  - Fertilizer planning is key!

- **Soil fertility & fertiliser management are key to maintaining a economically & environmentally sustainable farming business!**

https://www.teagasc.ie/crops/soil--soil-fertility/

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