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

Nitrogen

Nutrient in-flows vs. Nutrient out-flows

Inputs >> Outputs?

Soil nutrient storage building Soil fertility?

Index 1

Index 2

Index 3

Index 4

Nutrient loss?

OUTPUTS

Meat
Milk
Crops
Org. Manure exports

D.P. Wall, Protecting N & P inputs on farms_Teagasc Signpost Series
What is the nutrient use efficiency at farm level?

Teagasc NFS, Sustainability Report 2018
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$_2$O gas

Potential P loss in shallow & surface runoff

>20% (O.M.) Organic Matter

0-40 cm

Low Nutrient Retention

Low Mineral Matter

Seasonal Groundwater Table

Permanent Groundwater Table

D.P. Wall, Protecting N & P inputs on farms, Teagasc Signpost Series
Heavy Soil
Poorly Drained – Gleysol

Potential N loss as N₂O gas when soils are wet in spring

Potential P loss in overland runoff

Low nutrient leaching potential

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

D.P. Wall, 2018

D.P. Wall, Protecting N & P inputs on farms_Teagasc Signpost Series
Light Soil
Freely Drained – Brown Earth

Free Draining Topsoil
Free Draining Subsoil Layer

Nutrient Retention Depends on Soil texture

High potential for N leaching as NO$_3$-N when soils are draining

Lower potential for N loss as N$_2$O gas

Low nutrient runoff potential

Nutrient Storage
Nutrient Leaching

D.P. Wall, 2018
What is your soil fertility level?

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

- 19.10% Deficient soil fertility
- 80.90% Soil fertility meeting agronomic optimum levels

Source: DAFM, 2018
Lime - the foundation for soil fertility
What is your soil pH level?

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

Wall, D.P. et al., 2017
Increased nutrient efficiency at optimum soil pH

Fox & Wall et al. (2020)

Nitrogen use efficiency (%)

- No P
  - Low Soil pH (<5.5)
  - High Soil pH (≥6.3)
- 40 kg/ha P

Agriculture and Food Development Authority
Lower GHG losses when soils are limed

Relative N loss as N$_2$O gas (%) vs Soil pH

Soil pH

Relative N loss as N$_2$O gas (%)

0 50 100

FACCE ERA-GAS

MAGGE-pH

AGRICULTURE AND FOOD DEVELOPMENT AUTHORITY
Benefits of balanced soil fertility
Nitrogen use efficiency as affected by soil phosphorus status

Why Build Soil Fertility?

Across 10 Grassland Soils

Relative fertiliser N use efficiency (%)

Data: Wall, et al., 2017 & Herlihy et al., 2004

Soil Phosphorus Index

V. Low
Low
Target
High

Up to 15% N is potentially wasted!!
Effect of Soil Fertility on Nitrogen Use Efficiency

\[
\text{NUE} (\%) = \left( \frac{\text{Total N uptake by Grass}}{\text{Total N Inputs}} \right) \times 100
\]

where

\[
\text{Total N uptake by Grass} = (\text{Grass yield} \times \text{Grass N concentration})
\]

\[
\text{Total N Inputs} = (\text{Fertiliser-N, Manure-N & Excreted-N, Concentrate feed–N} + \text{soil N supply})
\]

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

Wall, D.P. (2020) Teagasc
Well-drained soils
Poorly-drained soils

Pro Urea = Urea + Urease Inhibitor

D.P. Wall, Protecting N & P inputs on farms – Teagasc Signpost Series

D.P. Wall, 2017
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/