Nutrient budgeting to improve nutrient use efficiency

Christine Watson, Crop & Soil Systems, SRUC Research
Nutrient management

- **N**
- **PK**
- **Micronutrients**

*Image shows the flow of nutrient management with external inputs leading to livestock and crop products, genetic resources, and soil & environmental resources. Management decisions & farm systems design are also highlighted.*
Nutrient budgeting – a useful tool

**Specialist Cropping System**

- **Inputs**
  - $N_2$ fixation
  - Deposition
  - Fertiliser
  - Manure

- **Outputs**
  - Crop products
  - Losses

**Mixed System**

- **Inputs**
  - Feed
  - $N_2$ fixation
  - Deposition
  - Fertiliser
  - Manure

- **Outputs**
  - Animal products
  - Crop products
  - Losses

**Specialist Livestock System**

- **Inputs**
  - Feed

- **Outputs**
  - Animal products
  - Losses
  - Manure

(Based on Oenema & Pietrzak 2002)
Farmgate nutrient budgets

**INPUTS** e.g.
- Feed
- Seed potatoes
- Bedding
- Fertilizers
- Manure
- Mineral supplements
- Livestock

**OUTPUTS** e.g.
- Milk
- Meat
- Eggs
- Livestock
- Cereals
- Potatoes

Watson et al. 2012
Are nutrient budgets useful?

- Losses are uneconomic
- How can you make the best of purchased nutrients?
- Protection of the environment
- Not an exact science – but a simple tool
- Use with soil analysis
N fixation estimates

A snapshot in time

Nesme et al. 2012
P budgets organic farms
SW France
Things to consider

• Inputs > product outputs = loss
• Product outputs > inputs = mining fertility
• Trends are important – positive or negative?
• Helping to get the balance right (inputs/outputs but also ratios of nutrients)
• In organic systems few sources are single nutrients (feed, green waste, seaweed)!
• Timescale – need to cover a rotation

• in = out
N inefficiency? Surplus v input on 56 organic dairy farms (kg N ha⁻¹)

\[
\begin{array}{ccc}
\text{N input} & \text{Output} & \text{Surplus} \\
118 & 28 & 90 \\
(36 - 293) & (8 - 76) & (2 - 217)
\end{array}
\]

\[R^2 = 0.93\]
Organic and conventional dairy production at 5 European sites

Nitrous oxide emissions

(A) Nitrous oxide emissions (kg N ha\(^{-1}\) yr\(^{-1}\))

- AUS
- DK
- FIN
- ITA
- UK

Emissions as a function of input

(B) N\(_2\)O emission (kg N ha\(^{-1}\) yr\(^{-1}\))

\[ y = 1.4 + 0.016x, \quad r^2 = 0.56 \]

- □ Conventional
- ○ Organic

Petersen et al. 2006
So, things to think about....

• What alternatives are available?
• N is easiest?
• Where will P and K come from?
• Consider analysing products
• What about other (macro and micro) nutrients?
• IOTA guidance note