

Nutrient Use Efficiency & Nutrient Balance

Liz Duffy

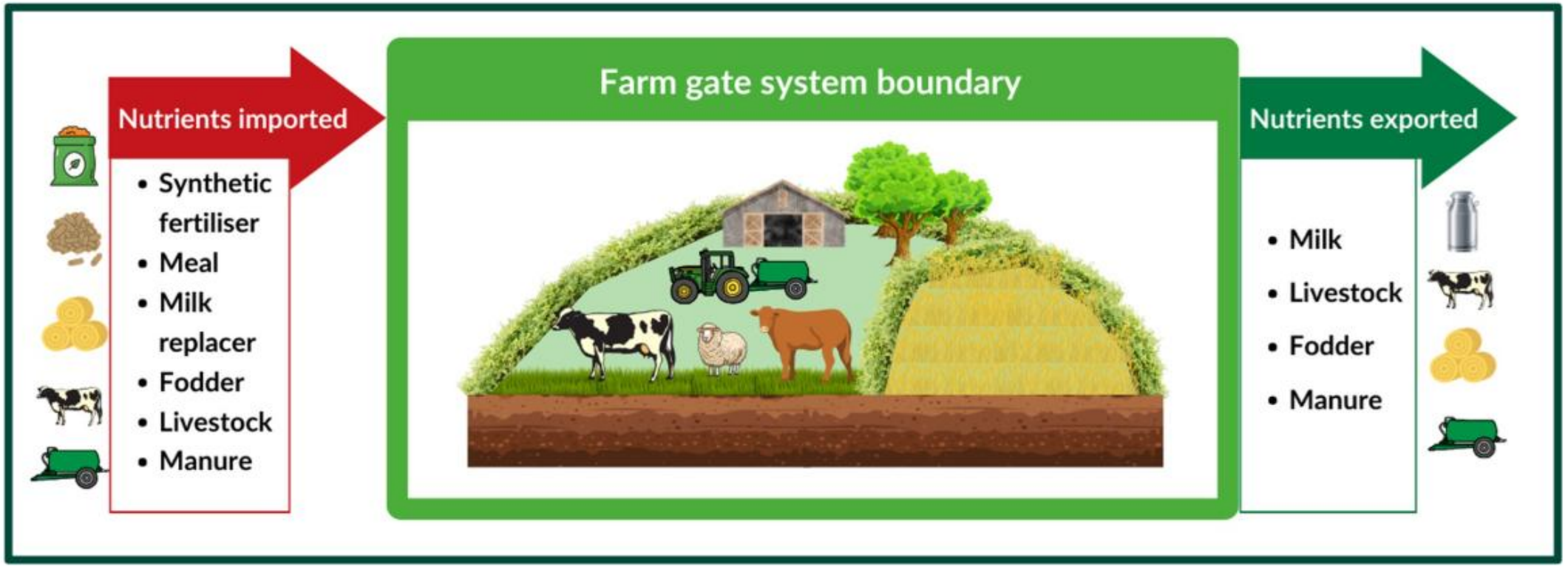
teagasc
Agriculture and Food Development Authority

Outline of Presentation

- What is nutrient balance?
- Link between N balance and nitrogen leaching
- How to use AgNav to identify nutrient surpluses
- Financial cost of nutrient losses/financial benefits of reducing losses
- Impact of measure adoption on environmental losses (GHGs and nutrient surplus)

What is nutrient balance?

The **difference between** all the **nutrients (N&P) coming onto the farm** and the **nutrients leaving the farm – whole farm figure**
This is expressed on a **Kg/Ha basis**.



*Nutrient balances are an indicator of nutrient loss risk.

*Nutrient balances can help identify management practices that may improve efficiency and decrease loss risks.

N & P Balance: Efficient Use of Inputs

N & P inputs









- Fertiliser
- Meal/forage
- Livestock
- Slurry

Emissions



Losses to water

N & P outputs





- Milk
- Livestock
- Forage
- Slurry

- Inputs minus outputs = Farm gate N,P surplus (kg/ha/yr)

- Indicator of potential N,P pollution

Nutrient balance

National Farm Survey Sustainability Report 2024

	N	P
Dairy average balance (kg/ha/yr)	*165*	*9.6*
Future Target – dependent on SR	130	10
Cattle average balance(kg/ha/yr)	*54.6*	*3.3*
Nutrient use efficiency dairy (%)	*25.2*	*60.8*
Future Target	35-50	70
Nutrient use efficiency cattle (%)	*27.3*	*74.2*

Link between N balance and Nitrogen Leaching

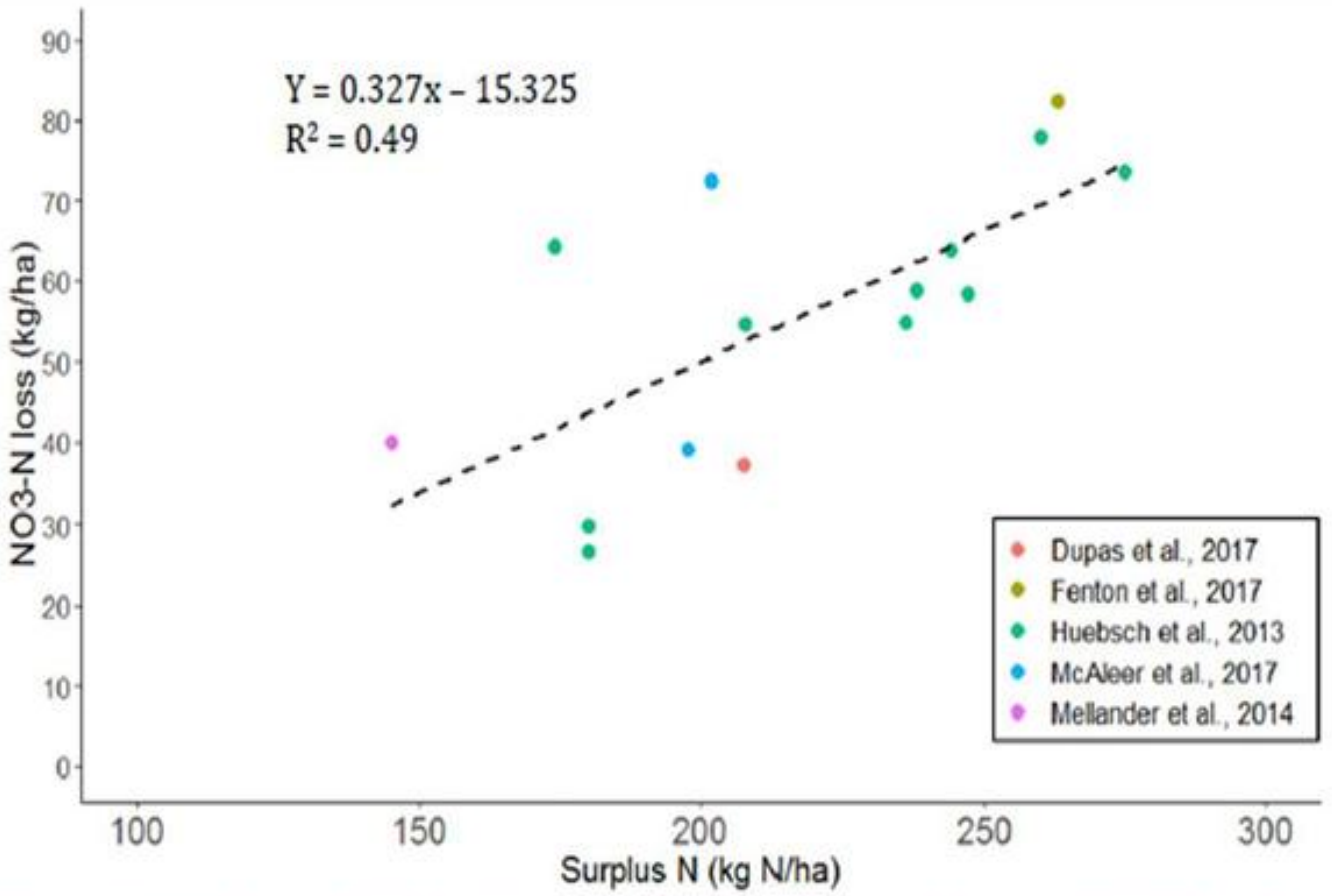
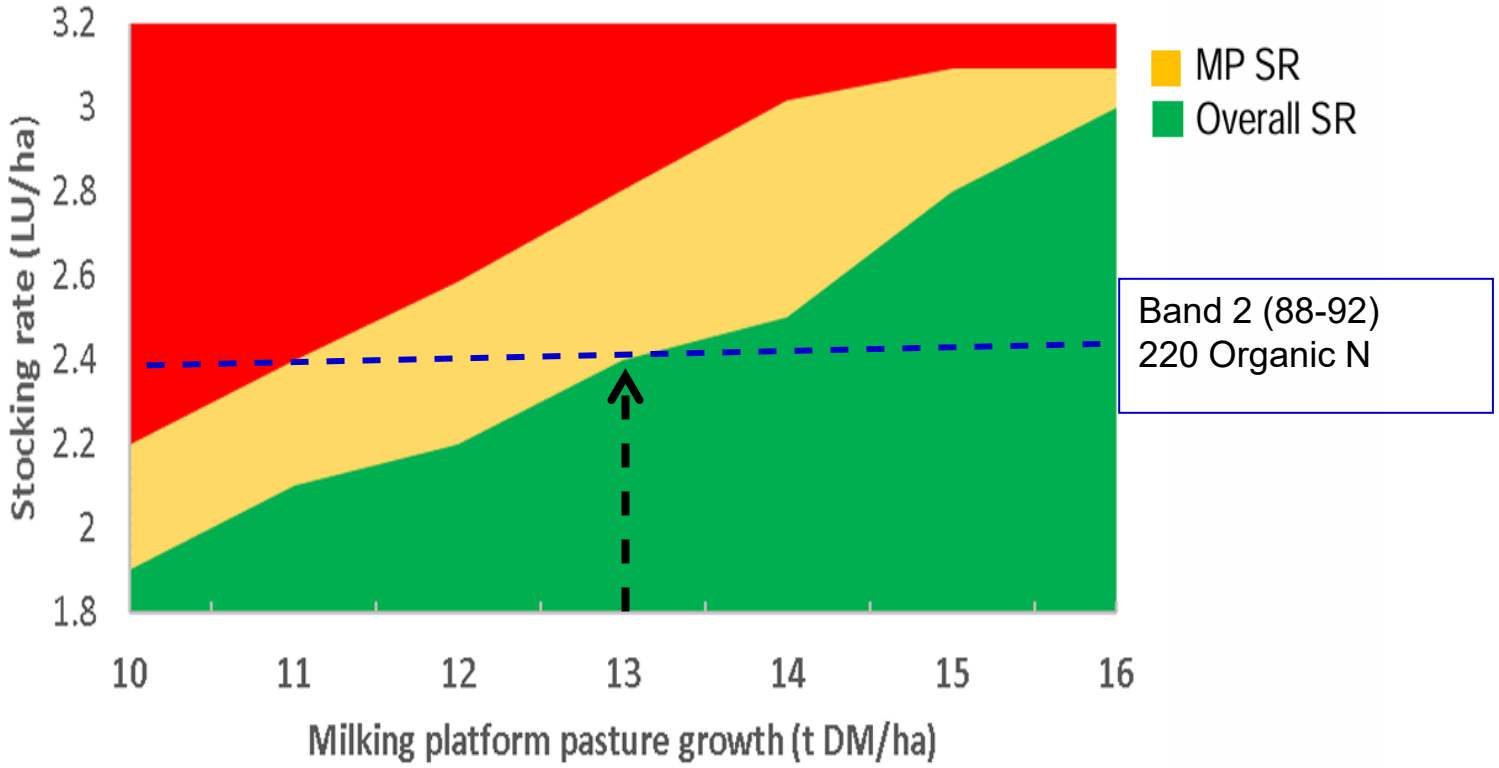


Figure 1.2. Relationship between surplus N and groundwater NO3-N loss from the reviewed literature on well-drained soils

- There is a strong correlation between nitrogen balance and nitrogen leaching
- Potentially Up to **30% of N surplus** can be lost to groundwater on well-drained soils

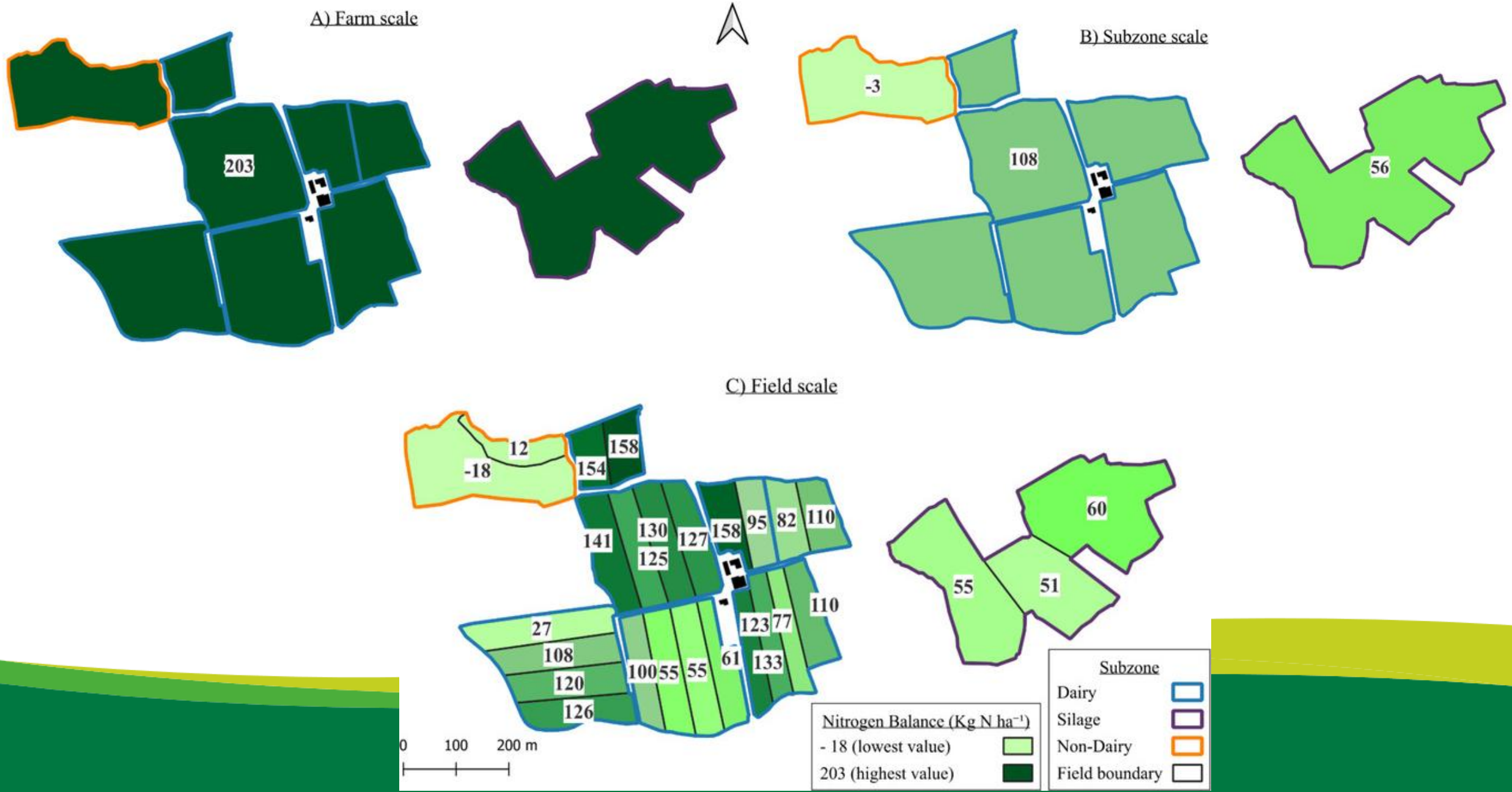
Importance of Nutrient Distribution



Important point:

- N surplus figure doesn't fully reflect variation in nutrient surpluses across the farm.
- MP SR and export of nutrients off MP have significant impact on N surplus variation across the farm

Importance of Nutrient Distribution (1)



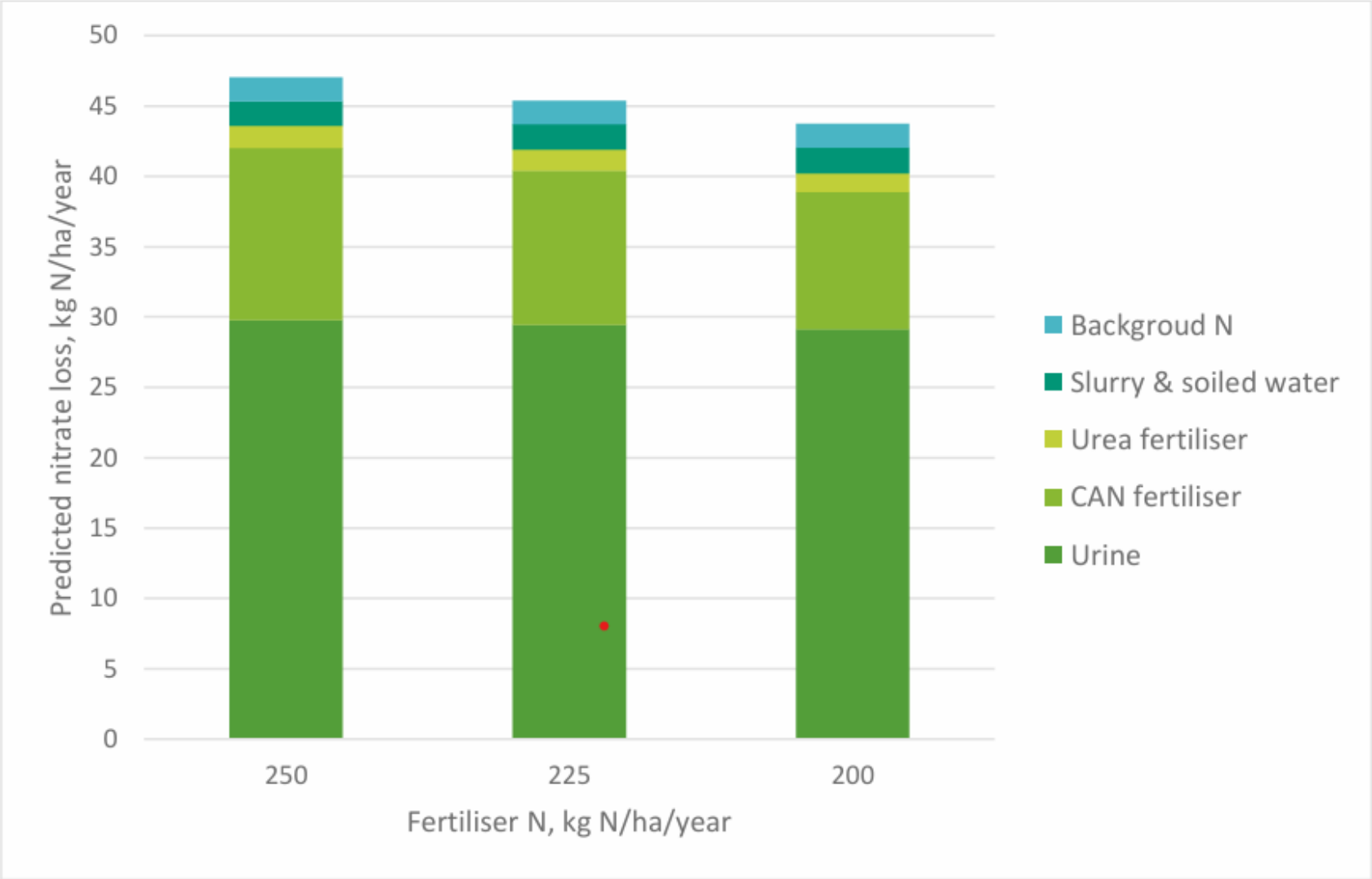


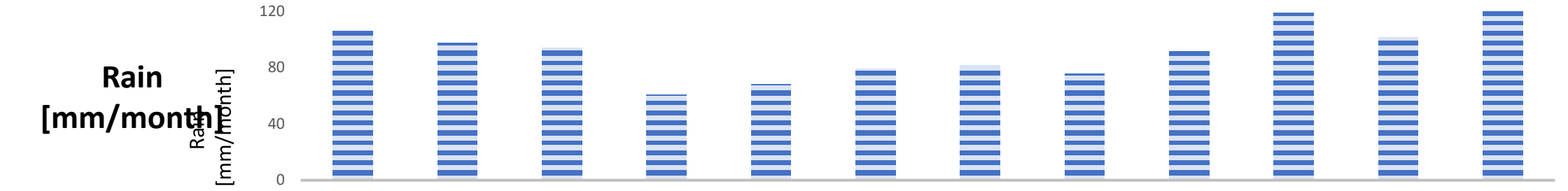
Figure 3.1. The impact of fertiliser N on predicted nitrate losses from a well-drained spring-calving grass-based dairy farm operated at a stocking rate of 250 kg organic N/ha.

Sources of nitrate loss

Urine patch:
200–1,000 kg Nitrogen/ha

Timoleague

Rainfall generated 4 times more discharge in winter than in summer





Source: Dr. Per-Erik Mellander, Agricultural Catchments Programme, Johnstown Castle, Teagasc

Portion rainfal that results river flo

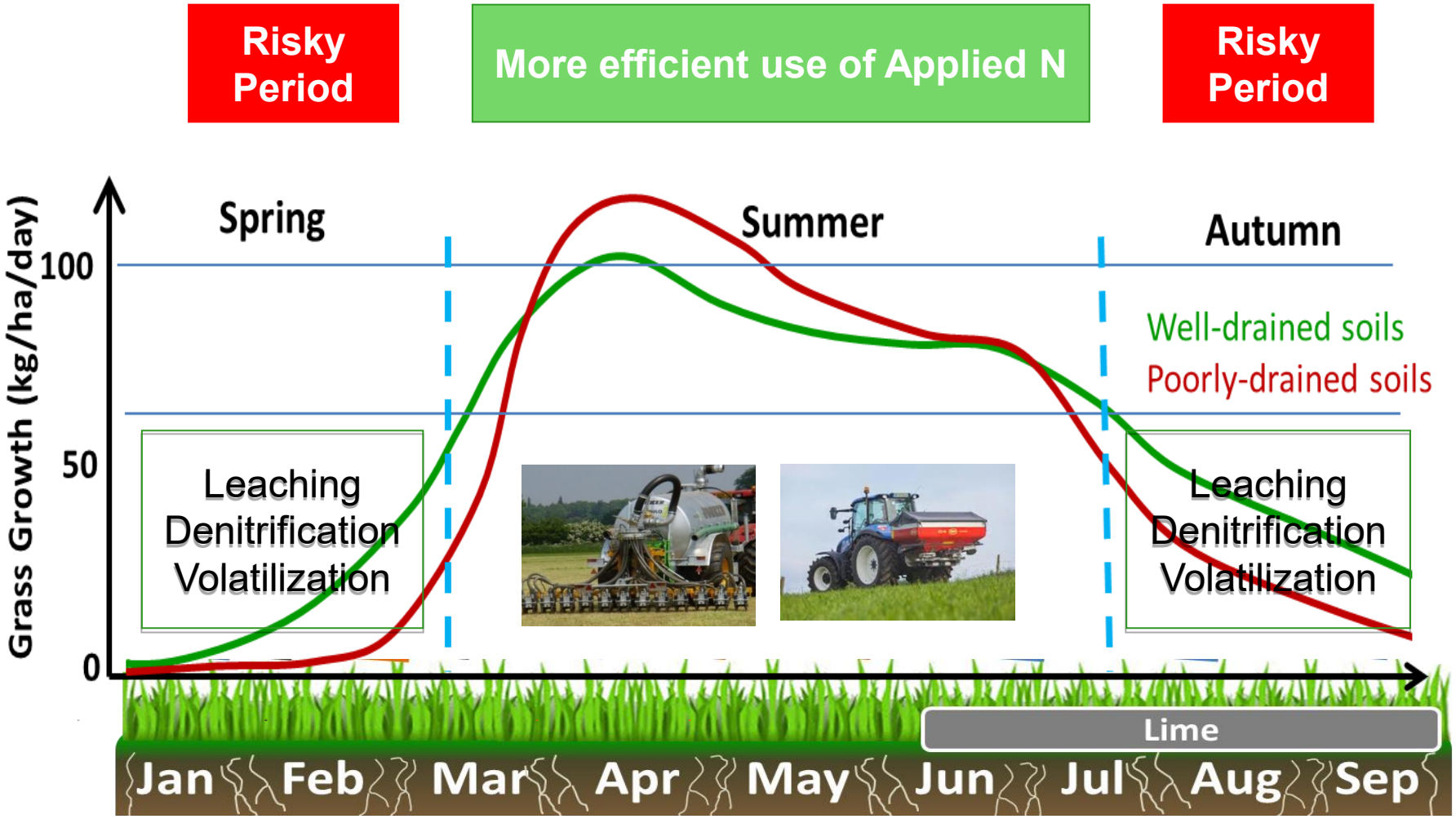


Up to 7 times more N and 5 times more P losses in months during closed period

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly N Kg/ha:	**7.92**	**5.54**	**5.06**	**3.20**	**1.70**	**1.10**	**0.91**	**0.87**	**1.31**	**3.49**	**6.17**	**7.42**
% of Annual:	18%	12%	11%	7%	4%	2%	2%	2%	3%	8%	14%	17%
Monthly P Kg/ha:	**0.165**	**0.120**	**0.101**	**0.047**	**0.025**	**0.039**	**0.030**	**0.032**	**0.046**	**0.117**	**0.108**	**0.187**
% of Annual:	16%	12%	10%	5%	2%	4%	3%	3%	5%	12%	11%	18%

Annual Average
44.7 N
kg/ha/yr
1.02 P

Using N More Efficiently

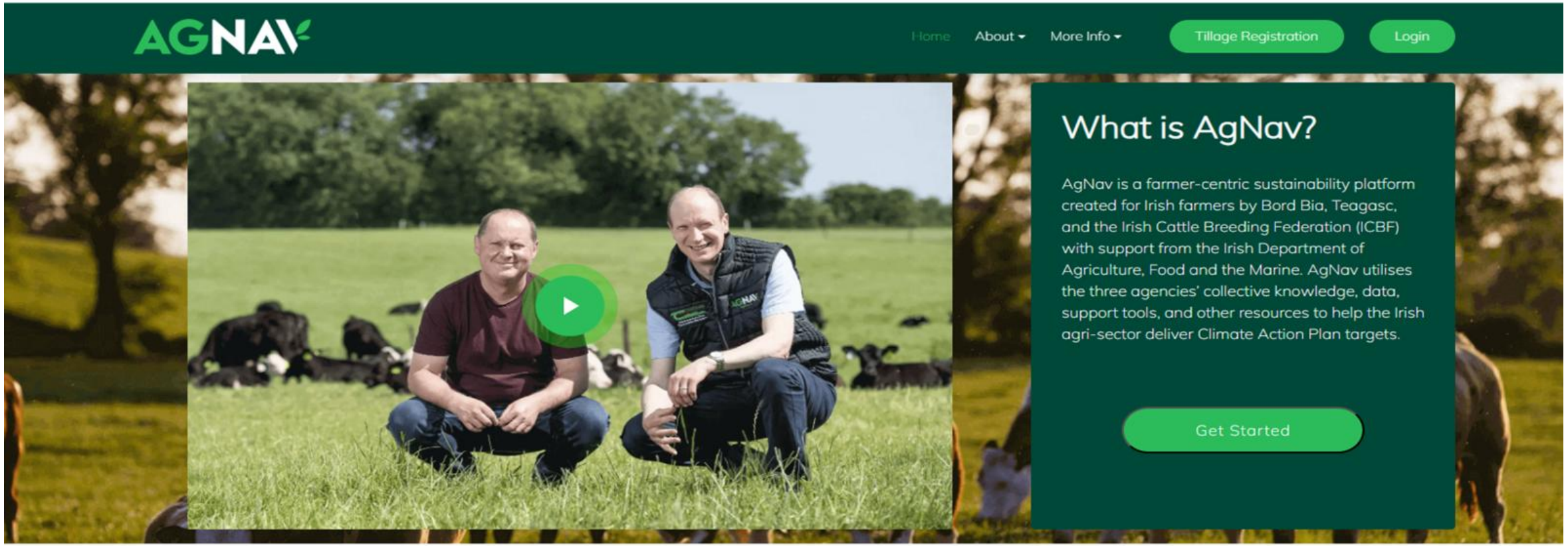


Measures to reduce N surplus and N loss (contd)

	Measure
	**Appropriate Stocking Rate**
	**Clover & Multispecies Swards** Reduce chemical N use
	**Lower Concentrate & Crude Protein Use**
	**Increase Pasture Output** Genetics & grassland management
	**Improve Soil Fertility** Including lime & sulphur application
	**Minimum-Till Reseeding**
	**Improved Slurry Application & Distribution**
	**Management of Critical Source Areas**
	**Reduce Point Source Losses**

Questions.....

AGNAV


AGNAV
Home
About
More Info
Tillage Registration
Login
What is AgNav?
AgNav is a farmer-centric sustainability platform created for Irish farmers by Bord Bia, Teagasc, and the Irish Cattle Breeding Federation (ICBF) with support from the Irish Department of Agriculture, Food and the Marine. AgNav utilises the three agencies' collective knowledge, data, support tools, and other resources to help the Irish agri-sector deliver Climate Action Plan targets.
Get Started

Dairy farm case study

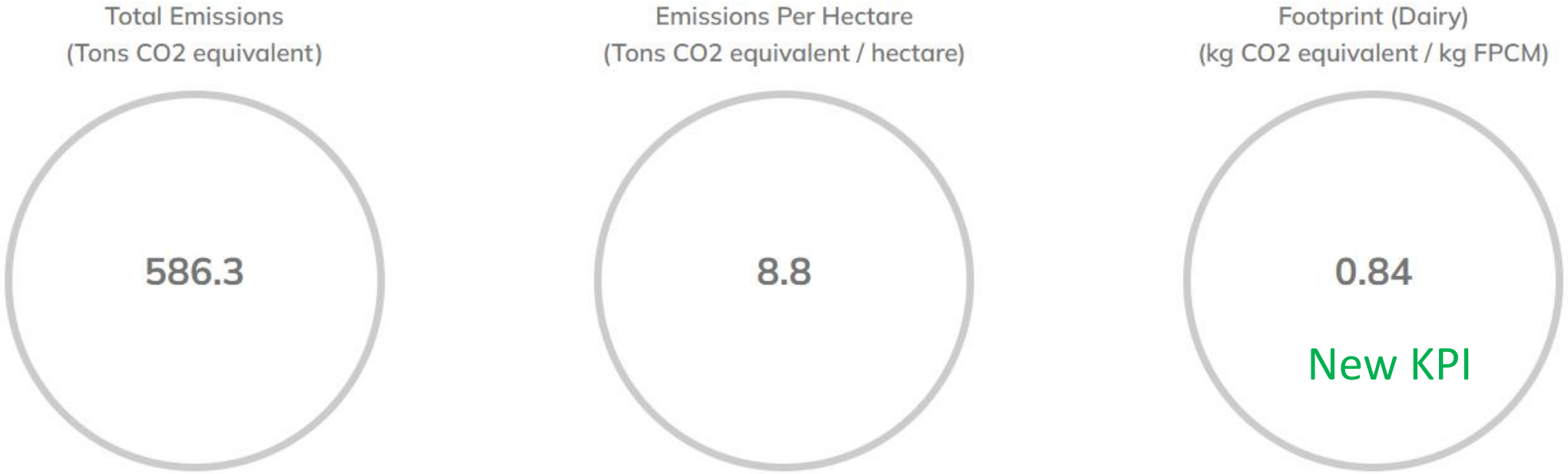
	Dairy Cows	110	5,418 kg Milk Produced @ 3.78% Protein & 4.96% Fat **486 kg Milk Solids**
	Calves	**45**	
	Heifers (current 22% repl rate)	15	
	**Land Area**	**76.48 ha** **10ha Tillage**	**WFSR** 1.65 **LU/Ha** **GSR 176kg Org N** **MP SR: 3.3LU/ha**

Heifer Calf at 3 weeks	€350/calf value
Replacement Heifer Variable Costs	€737/heifer
Dairy Cow Variable Costs	€1,128/cow

Financial Assumptions

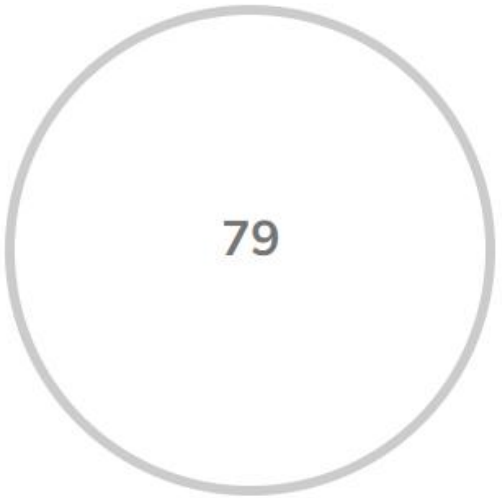
CAN	€415/tonne
NBPT Urea	€575/tonne
Urea	€525/tonne
10-10-20	€595/tonne
13-6-20	€530/tonne
18-6-12	€530/tonne

Dairy Farm GHG emissions 2024



Dairy farm nutrient balances

Nutrient Balance N
(kg Nitrogen / Hectare)



National Average: 147

Lower 10%: 50

Nutrient Balance P
(kg Phosphorus / Hectare)



National Average: 9.7

Nitrogen

	Input (kg/ha)	Output (kg/ha)	Balance (kg/ha)
Feed	29	0	29
Manure	0	0	0
Synthetic Fertiliser	103	N/A	103
Milk	N/A	53	-53
Livestock	9	9	0
Total	141	62	79

Phosphorus

	Input (kg/ha)	Output (kg/ha)	Balance (kg/ha)
Feed	5.7	0	5.7
Manure	0	0	0
Synthetic Fertiliser	17.1	N/A	17.1
Milk	N/A	8.1	-8.1
Livestock	3.5	3.4	0.1
Total	26.3	11.5	14.8

Dairy farm case study (contd)

12 Steps to reduce GHG emissions	Farm Action to reduce GHG emissions	Financial Benefit	Farm GHG Reduction
1	Optimum Soil pH (6.5 to 6.8)		
2	Optimum P & K Fertility		
3	Make best use of manures	€14,447	4%
4	Grow Clover / Multispecies		
5	Reduce N by 25% (44%)		
6	Apply NBPT Protected Urea	€1,257	1%
7	Improve genetic / breeding	€6,095	4%
8	Improve dairy beef genetics	€3,540	(4.5%)
9	Better grassland management	€1,386	1.5%
10	Increase milk solids	€4,512	3.5%
11	Better manage hedgerows and plant trees	N/A	N/A
12	Establish Required field margins	N/A	N/A
Financial Savings & Total Emissiosn Reduction		€31,237	13 %

Steps 1-4 contributed to a 63% reduction in chemical nitrogen use through greater nutrient use efficiency.

This reduced the farm N surplus figure from 216kgN/ha to 79kgN/ha

Greater **NUE** resulted in **reduced N surplus** and over **€14k worth of savings**

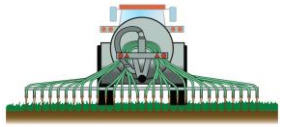
Step 1. Apply lime to correct pH

Step 1 – Apply Lime			
Soil pH & Lime	**Agronomic Benefits**	**Economic Benefit**	**Emission Reduction**
	Rye grass swards Correct soil pH 6.3 (Large soil N supply from pH 5.5 to 6.3) Correcting soil pH = 16% reduction in N usage Clover swards pH 6.5 to 6.8	N reduction of 38kgN/ha N cost savings **€53/ha**	**%**
Economic benefit = €4,053 *(CAN - €415/t Pro Urea -€575/t Av. Cost/ kg N = €1.39)*			

Step 2. Build soil fertility to optimum levels

Step 2 – Soil Fertility			
Soil P & K Fertility	**Agronomic Benefits**	**Economic Benefit**	**Emission Reduction**
	Build Maintain P & K Index 3 **12.5% Saving in N** **by Optimum P & K**	N reduction of 30kgN/ha N cost savings **€42/ha**	**%**
Economic benefit = €3,212 *(CAN - €415/t Pro Urea -€575/t Av. Cost/ kg N = €1.39)*			

Step 3: Make better use of organic manures

Step 3 Make Better Use of Organic Manures – LESS			
Reduce N, P & K Requirements	**Agronomic Benefits**	**Economic Benefit**	**Emission Reduction**
	Spring application of Cattle LESS Slurry – 40% N recovery 'v' 25% for splash plate	**900m³ Cattle Slurry** **LESS + 0.3kgN** **270kg x €1.39** **€375** **(+3.5kgN/ha)**	**%**
Cost savings = €375 *(CAN - €415/t Pro Urea -€575/t Av. Cost/ kg N = €1.39)*			

Step 4: Incorporate white clover

Step 4 Incorporate White Clover			
Reduce N, P & K Requirements	**Agronomic Benefits**	**Economic Benefit**	**Emission Reduction**
	Reduce chemical N by 64kgN/ha	N reduction of 64kgN/ha Show N cost savings **€89/ha**	**%**
Cost savings = €6,807 *(CAN - €415/t Pro Urea -€575/t Av. Cost/ kg N = €1.39)*			

Step 5: Reduce chemical N through better NUE

Step 5 Reduce chemical N by 25% Combined N Reduction = Lime + Soil Fertility + LESS + Clover			
Reduce chemical N by 25%	**Agronomic Benefits**	**Economic Benefit**	**Emission Reduction**
	Farm N reduction 135kgN/ha	**N cost saving €188/ha Replace tonnes of fertilisers**	**4%**
Cost savings = €14,447 *(CAN - €415/t Pro Urea -€575/t Av. Cost/ kg N = €1.39)*			

Summary

- Soil Fertility – pH, P & K
- Reseeding
- Clover/MSS
- Use of Organic Manures
- Nutrient Distribution (Milking Platform Stocking rate)
- Closed Period (4 R's – time, location, product, rate)
- Management.....
- Good technical efficiency = improve farm sustainability

	Measure
	**Appropriate Stocking Rate**
	Clover & Multispecies Swards Reduce chemical N use
	**Lower Concentrate & Crude Protein Use**
	**Increase Pasture Output** Genetics & grassland management
	Improve Soil Fertility Including lime & sulphur application
	**Minimum-Till Reseeding**
	Improved Slurry Application & Distribution
	**Management of Critical Source Areas**
	**Reduce Point Source Losses**

Using N More Efficiently