

Improving Nitrogen Balance on Pasture-based Systems

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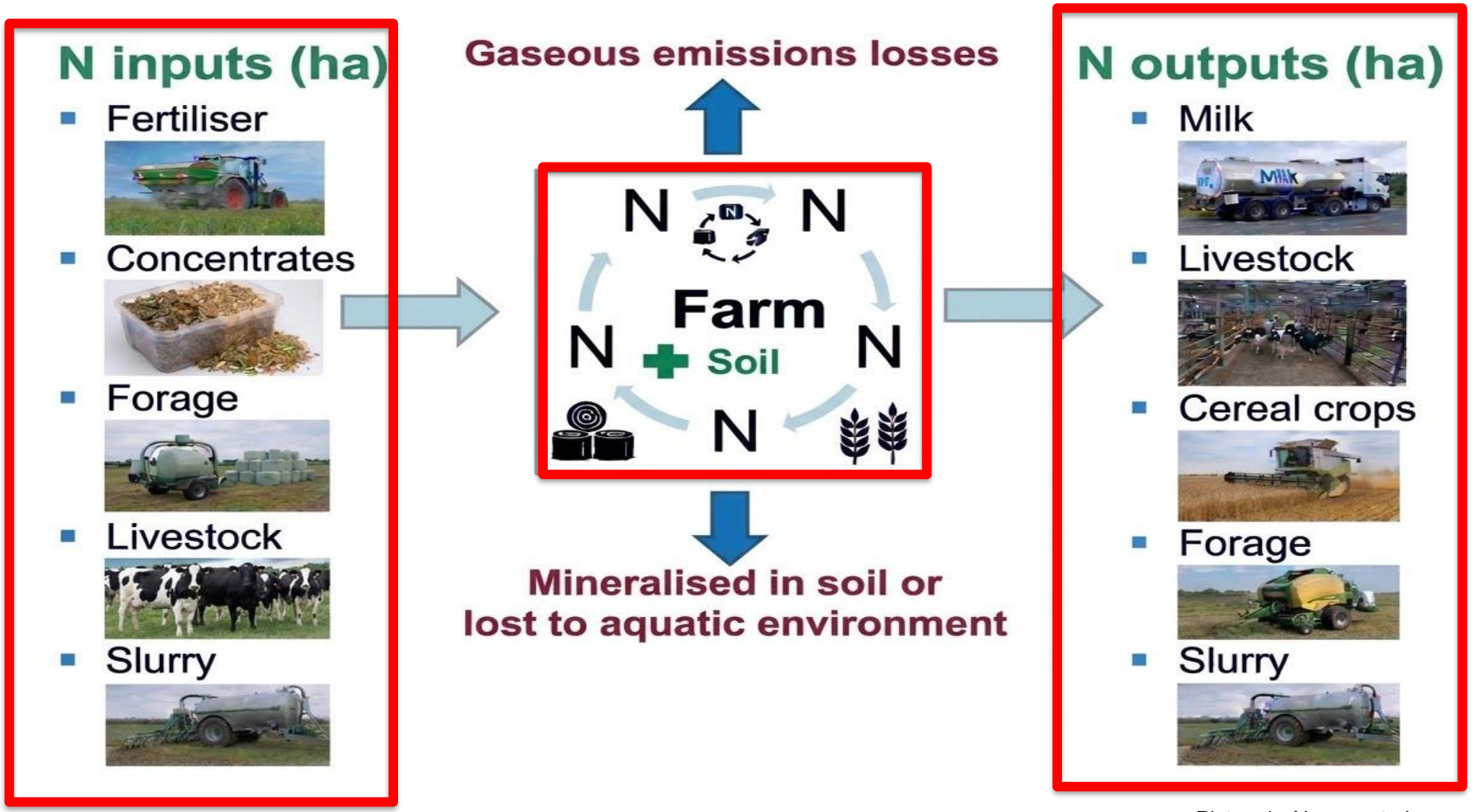
Overview

- Nitrogen the element
- Definition of a Farm-Gate N Balance and why does it matter?
- Are some farmers managing N better than others?
- Can we give farmers a benchmark to aim for?
  - “What gets measured gets managed”

Nitrogen

- Nitrogen is a chemical element with the symbol N
  - 78% of our atmosphere is made up of Nitrogen
- One of the most dynamic and challenging nutrients to manage
  - Moves freely through soil, water and air, and exists in multiple forms
- It is the key nutrient driving agricultural productivity
  - Forms the building blocks of proteins, chlorophyll and enzymes
- Nitrogen availability directly influences stocking rates, crop yields and overall farm output

What is an Farm-Gate N Balance?



Picture is AI generated

- All inputs & outputs put into a common currency – kg of Nitrogen
- N Balance = N input (ha) – N outputs (ha)
- Minimise N inputs & maximise N outputs

Why does Farm-Gate N Balance matter?

- N losses to water are defined by a complex web depending on things like:
  - Soil type
  - Hydrological pathways
  - Weather
  - Farm practice

- Ceteris paribus
  - Latin phrase that means "all other things being equal"

- All other things being equal the lower the Farm-Gate N Balance the lower the risk of N losses to the environment

- Better measure of risk than N use efficiency (N outputs / N Inputs).

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Are some farmers better at managing N?

- Look to the available data
- Teagasc National Farm Survey
  - Dairy Farms
  - Study period 2020-2024
  - 280 farms x 5 years (Pooled sample)
  - Population weights applied (15,000 dairy farms over the period)
- Compare Farm-Gate N Balance again peers of a similar stocking rate
- Is there room for some farmers to improve?

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Stocking Rate Bands

Organic N Band (kg N/ha)	Stocking Rate (cows/ha)	Sample
<125	<1.36	140
126–150	1.37–1.63	145
151–175	1.64–1.90	300
176–200	1.91–2.17	380
201–225	2.18–2.45	265
226–250	2.46–2.71	170

Livestock type	Total Nitrogen kg/year
Dairy cow band 1 (<4,500 kg milk yield)	80
Dairy cow band 2 (4,500 – 6,500 kg milk yield)	92
Dairy cow band 3 (>6,500 kg milk yield)	106
Suckler cow	65
Calf (0 to 90 days of age)	1
Cattle (aged 91 days and older)	20
Cattle (female 1-2 years old)	55
Cattle (male 1-2 years old)	61
Cattle > 2 years	65
Upland ewe & lambs	7
Lowland ewe & her lambs	13
Upland hogget	4
Lowland hogget	6

Average results across Stocking Rate Bands

Organic N Stocking Rate Band	N Balance kg/ha ***	Herd Size (cows) ***	Concentrates (cow) ***	Chemical N (kg/ha) ***	Grass Utilisation ha (Tonnes /DM) ***	kg FPCM (Cow) **	Net Protein (adults/ha) ***	Gross margin (€/ha) ***
Organic N Ha<=125 (<1.36 cows/ha)	90.8	48.7	1,166	96.2	4.6	5,440	8.8	€1,336
Organic N Ha 126-150 (1.37-1.63 cows/ha)	121.4	71.6	1,165	124.2	6.7	5,732	12.2	€1,886
Organic N Ha 151-175 (1.64-1.90 cows/ha)	142.0	91.6	1,155	144.4	7.8	5,951	14.3	€2,325
Organic N Ha 176-200 (1.91-2.17 cows/ha)	172.4	108.8	1,244	171.1	8.7	6,133	17.0	€2,743
Organic N Ha 201-225 (2.18-2.45 cows/ha)	196.0	138.1	1,306	189.5	9.9	6,274	19.7	€3,079
Organic N Ha 226-250 (2.46-2.71 cows/ha)	209.9	142.5	1,320	201.1	10.9	6,359	22.2	€3,498

***1% Level, **5% level, *10% level, n/s=not significant

- But averages can hide a lot
- What about within each individual stocking rate band?

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Looking within Stocking Rate Bands – Top 4

- Splitting farmers into 5 equal groups in terms of N balance performance: Very good to very poor

- Very Poor farms stocked at 1.64 to 1.90 cows/ha had a greater N Balance than the Average farms stocked at 2.46 to 2.72 cows/ha

Organic N Ha 151-175 (1.64-1.90 cows/ha)	N Balance kg/ha***
Very good	84.8
Good	114.2
Average	135.1
Poor	161.1
Very poor	209.1
Organic N Ha 176-200 (1.91-2.17 cows/ha)	**N Balance kg/ha*** **
Very good	107.0
Good	145.3
Average	171.5
Poor	195.2
Very poor	241.5
Organic N Ha 201-225 (2.18–2.45 cows/ha)	**N Balance kg/ha*** **
Very good	115.6
Good	165.4
Average	190.2
Poor	218.9
Very poor	276.8
Organic N Ha 226-250 (2.46–2.71 cows/ha)	**N Balance kg/ha*** **
Very good	134.0
Good	171.5
Average	197.2
Poor	233.2
Very poor	297.1

Looking within Top 4 Stocking Rate Bands

Organic N Ha 151-175 (1.64-1.90 cows/ha)	N Balance kg/ha ***	Herd Size (cows) **	Concentrate Fed (Cow) ***	Chemical N (kg/ha) ***	Grass utilization (t DM/ha) (n/s)	kg FPCM (cow) **	Net Protein (people/ha) **	Gross margin (€/ha) (n/s)
Good	114.3	88.1	1,086	117.6	7.8	5,870	13.7	2,413
Average	135.2	87.0	1,102	138.1	7.9	5,906	13.9	2,300
Poor	160.8	93.4	1,167	161.8	7.6	5,788	14.3	2,089
Very poor	210.0	107.2	1,424	205.3	7.8	6,364	15.5	2,348
Organic N Ha 176-200 (1.91-2.17 cows/ha)	**N Balance kg/ha *** **	**Herd Size (cows) (n/s)**	**Concentrate Fed (Cow) *** **	**Chemical N (kg/ha) *** **	**Grass utilization (t DM/ha) (n/s)**	**kg FPCM (cow) ** **	**Net Protein (people/ha) ** **	**Gross margin (€/ha) (n/s)**
Good	144.9	111.1	1,246	143.3	8.7	6,056	16.2	2,699
Average	171.2	108.5	1,292	166.9	8.5	6,178	16.6	2,776
Poor	195.2	111.4	1,209	196.4	9.0	6,144	17.8	2,925
Very poor	241.4	115.7	1,385	235.6	8.8	6,614	18.6	2,758
Organic N Ha 201-225 (2.18–2.45 cows/ha)	**N Balance kg/ha *** **	**Herd Size (cows) *** **	**Concentrate Fed (Cow) *** **	**Chemical N (kg/ha) *** **	**Grass utilization (t DM/ha) (n/s)**	**kg FPCM (cow) ** **	**Net Protein (people/ha) (n/s)**	**Gross margin (€/ha) (n/s)**
Good	165.2	126.1	1,148	166.9	10.2	6,086	19.5	3,132
Average	190.0	115.9	1,242	185.0	10.0	6,245	20.0	3,287
Poor	218.7	170.7	1,318	215.0	9.5	6,438	20.8	3,132
Very poor	277.8	154.4	1,705	251.8	9.7	6,779	19.5	3,023
Organic N Ha 226-250 (2.46–2.71 /ha)	**N Balance kg/ha *** **	**Herd Size (cows) *** **	**Concentrate Fed (Cow) *** **	**Chemical N (kg/ha) *** **	**Grass utilization (t DM/ha) (n/s)**	**kg FPCM (cow) ** **	**Net Protein (people/ha) (n/s)**	**Gross margin (€/ha) (n/s)**
Good	171.8	138.8	1,253	167.4	10.8	6,111	20.9	3,378
Average	197.5	138.9	1,291	187.8	10.4	6,258	22.2	3,464
Poor	233.7	141.4	1,376	219.1	10.7	6,627	22.7	3,502
Very poor	294.4	172.6	1,615	269.0	10.7	6,599	22.2	3,417

***1% Level, **5% level, *10% level, n/s=not significant

Benchmarking

Organic N Ha<=125	N Balance kg/ha (mean)	Move to Good (kg N ha)	Improve by 1 Group (kg N ha)
Good	65.7	0.0	0.0
Average	84.6	-19.0	-19.0
Poor	107.5	-41.8	-22.8
Very poor	166.1	-100.4	-58.6
Organic N Ha 126-150	**N Balance kg/ha (mean)**	**Move to Good (kg N ha)**	**Improve by 1 Group (kg N ha)**
Good	101.4	0.0	0.0
Average	121.2	-19.8	-19.8
Poor	137.9	-36.4	-16.6
Very poor	175.3	-73.9	-37.5
Organic N Ha 151-175	**N Balance kg/ha (mean)**	**Move to Good (kg N ha)**	**Improve by 1 Group (kg N ha)**
Good	114.2	0.0	0.0
Average	135.1	-20.9	-20.9
Poor	161.1	-46.9	-26.0
Very poor	209.1	-94.9	-47.9
Organic N Ha 176-200	**N Balance kg/ha (mean)**	**Move to Good (kg N ha)**	**Improve by 1 Group (kg N ha)**
Good	145.3	0.0	0.0
Average	171.5	-26.2	-26.2
Poor	195.2	-49.9	-23.7
Very poor	241.5	-96.2	-46.3
Organic N Ha 201-225	**N Balance kg/ha (mean)**	**Move to Good (kg N ha)**	**Improve by 1 Group (kg N ha)**
Good	165.4	0.0	0.0
Average	190.2	-24.8	-24.8
Poor	218.9	-53.5	-28.7
Very poor	276.8	-111.3	-57.8
Organic N Ha 226-250	**N Balance kg/ha (mean)**	**Move to Good (kg N ha)**	**Improve by 1 Group (kg N ha)**
Good	171.5	0.0	0.0
Average	197.2	-25.7	-25.7
Poor	233.2	-61.7	-36.0
Very poor	297.1	-125.7	-64.0
Aggregate N Reductions ('000 tonnes)	-	165.929	95.327

- 2 benchmarking options explored

1. Everyone to achieve results of the “good group” within stocking rate band

2. Everyone to improve by 1 groups withing stocking rate band)

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Looking Forward

- Every farm should calculate their N balance - AGNAV
- Need to compare to a benchmark N balance relative to farm S.R. vs One size fits all approach
  - What should the ambition level / benchmark be set at?
- Management Strategies
  - Soil fertility (soil pH)
  - Precision application of fertilisers (right place, right rate, right time)
  - Reduction in quantity and crude protein content of concentrates
  - Clover (white & red)
  - Greater N recovery from organic manures

Conclusion

- There is potential to reduce nitrogen (N) balance at all stocking rates
- Reducing N balance does not necessarily compromise farm performance
  - Gross margin, grass utilisation and net protein per hectare
- The two key management factors within farmers control
  - Precision N fertiliser application and concentrate supplementation per cow
- Opportunity for a targeted advisory initiative to support grassland farmers in reducing N balance?
  - Potential to reduce N losses to aquatic environment

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