The Fertilizer Association of Ireland
SPRING SCIENTIFIC MEETING 2024

'The Role of Balanced Nutrition in Sustainable Agriculture'

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[1]European Fertilizer Blenders Association; [2]Origin Fertilisers; [3]Goulding Soil Nutrition

Origin FERTILISERS

EUROPEAN FERTILISER BLENDERS ASSOCIATION

GOULDING SOIL NUTRITION

N N N N N N

N N N N N

N N N N N

P & K P & K P & K P & K

S S S S

Mg Mg Mg

Ca Ca Ca

Na Na

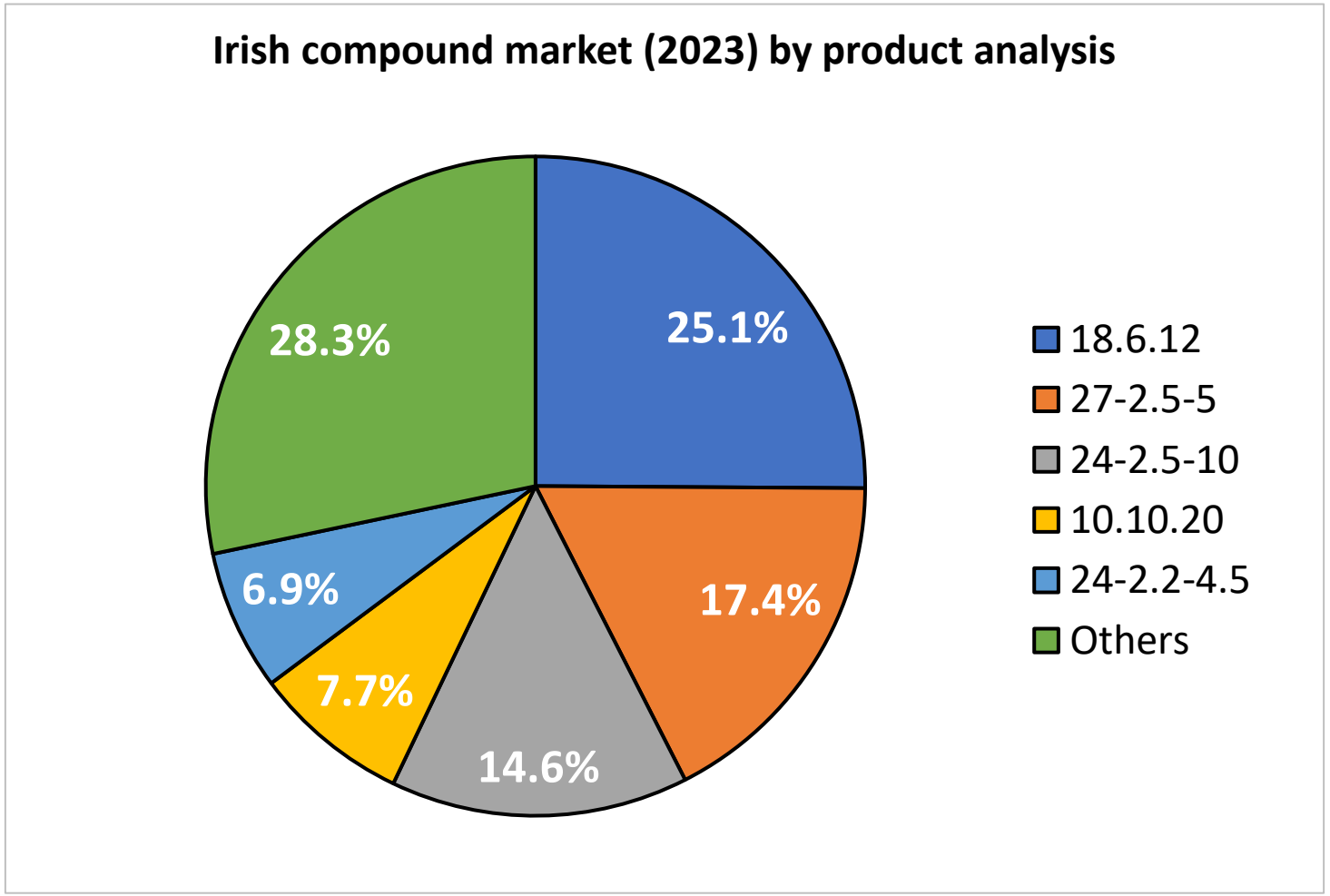
Micro-nutrients

"Beware of '*nitrogenous myopia*'!!"

EUROPEAN FERTILISER BLENDERS ASSOCIATION

Design the *'ideal'* compound fertiliser for sustainable farming

- ✓ High yields
- ✓ High forage quality
- ✓ Environmental policy



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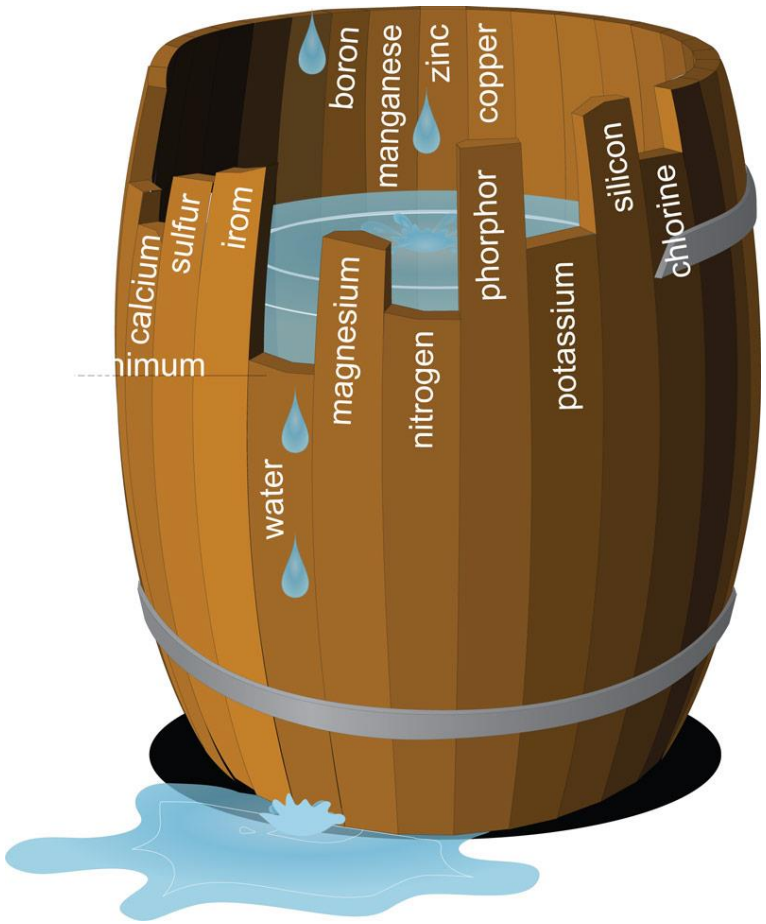
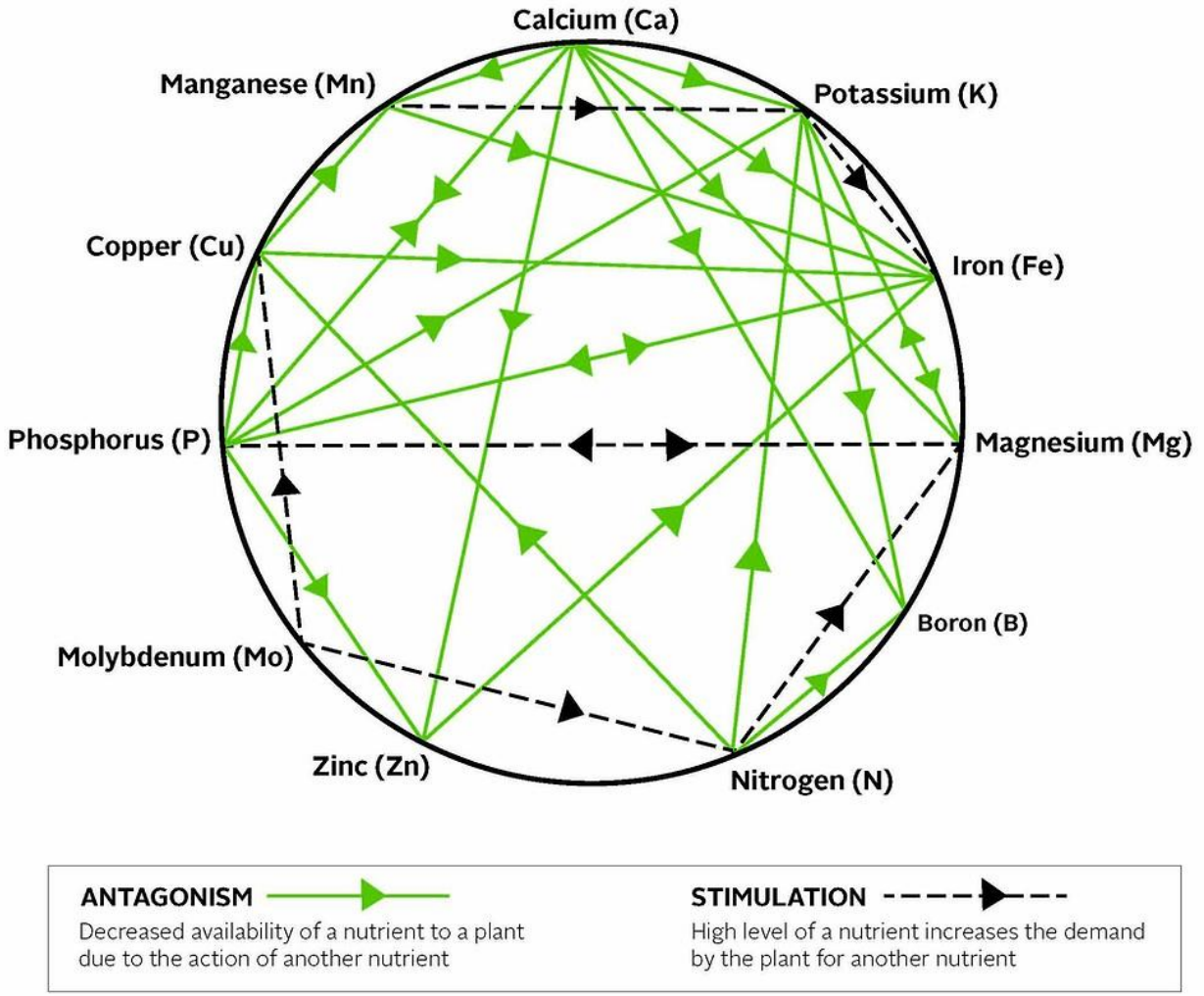
Design the *'ideal'* compound fertiliser for sustainable farming

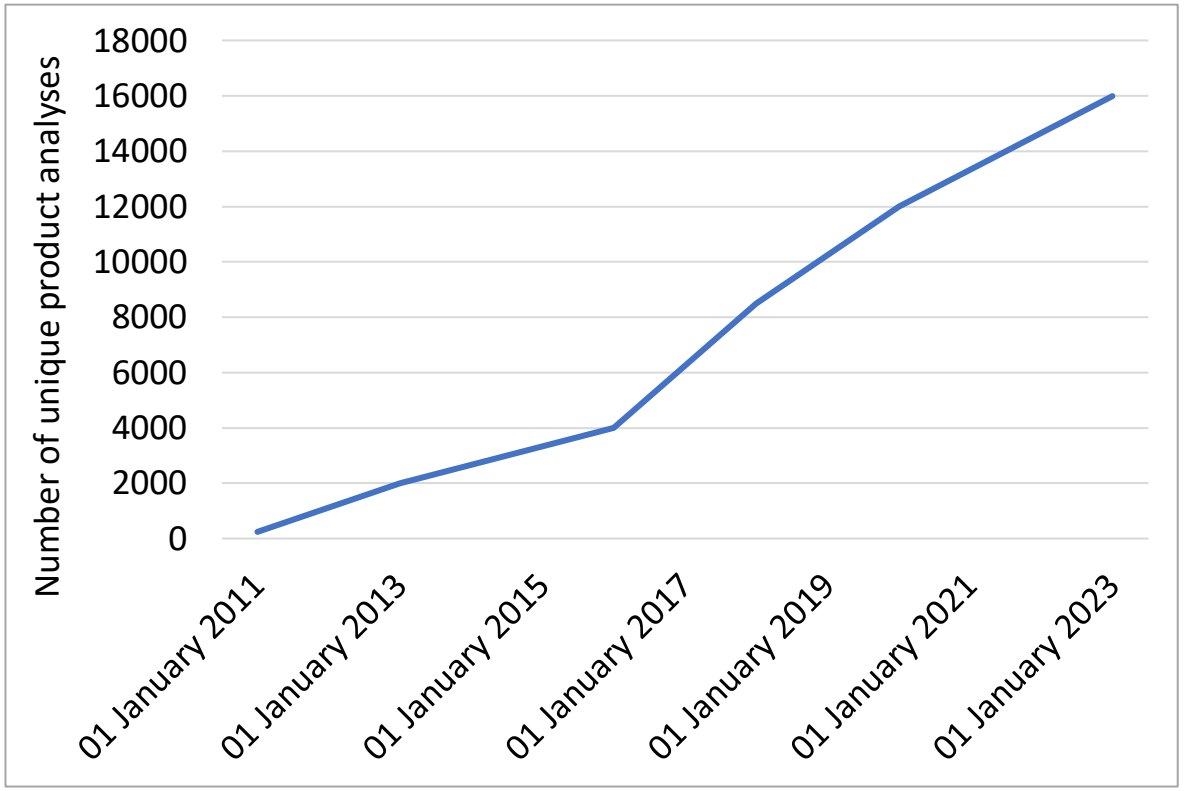




Increasing demand for prescription fertilisers

GB-based blender:

- 120 products in 2011
- > 17,500 products in 2024
- Unique analyses reflects growing demand for prescription nutrition



ECONOMY

Blending model is changing

AGRONOMY

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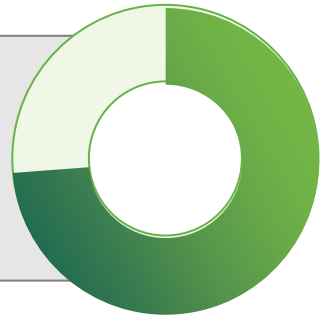
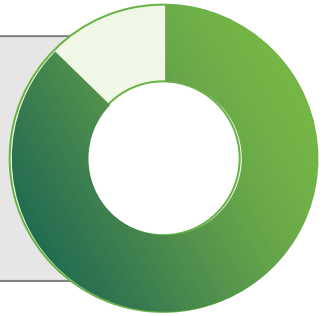
Demand drivers for prescription fertilisers

Nitrous oxide (N_2O)
93% from agriculture



Ammonia (NH_3)
99% from agriculture



Nitrate (NO_3)
85% from agriculture

Demand drivers for prescription fertilisers

SUSTAINABLE DEVELOPMENT GOALS

Farm to Fork Strategy
The European Green Deal

Ag Climatise

A Roadmap towards Climate Neutrality

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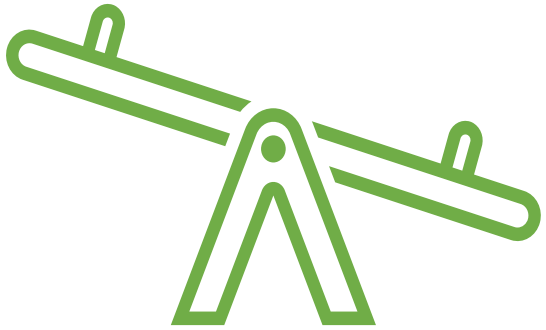
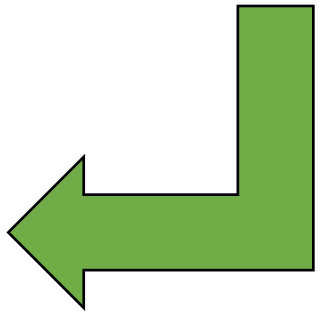
We need to re-think fertilisers of the future

1) Crop yield }
2) More focus on crop quality } Balanced, prescription nutrition
3) Environmental policy }



Re-think fertiliser:

- Value above price
- 4 R's – right product, rate, time & place
- Integrated nutrient management:
  - Soils Manures Crop
  - NUE CO_2e



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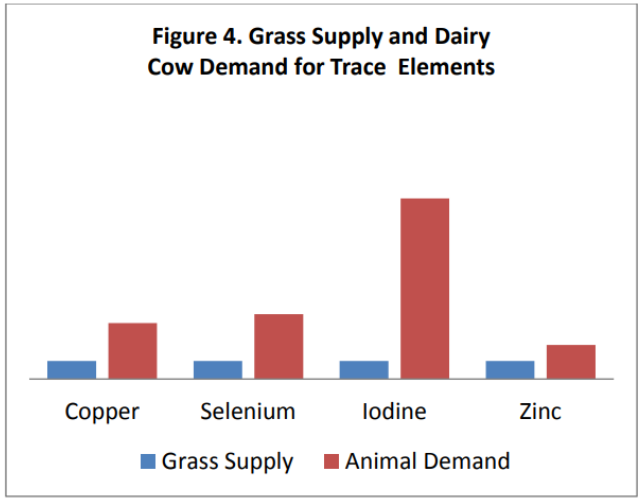
Balanced nutrition & forage quality

Nutrient	Typical concentration in grass (kg/t DM)
Nitrogen (N)	34.9
Phosphorus (P)	4.1
Potassium (K)	29.7
Sulphur (S)	2.9
Magnesium (Mg)	2.0
Calcium (Ca)	5.0
Sodium (Na)	2.0

Nutritional parameter
DM content
Protein
Energy
Digestibility
Water soluble carbohydrate
Fibre
Minerals – content & ratios



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Sodium (Na)	2.0
Selenium (Se)	0.3mg/kg

N:S ratio effects:

- DM % & yield
- DMD & ME
- True protein formation
- Do we apply sufficient S?
- Critical S level?

K:Mg & K:Na ratio effect:

- Risk of hypomagnesaemia
- Target K:Mg & K:Na < 20:1
- Optimum K:Mg & K:Na < 10:1
- Na in forage also increases WSC and DMI

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Nutritional parameter
DM content
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Energy
Digestibility
Water soluble carbohydrate
Fibre
Minerals – content & ratios

GrassCheck NI afbi AGRI-FOOD & BIOSCIENCES INSTITUTE

Grass Check GB

- 3-year grass mineral analysis project across NI & GB
- Evaluating temporal variation in mineral contents and ratios
- Evaluating correlations between mineral content and nutritional values
- Objective: prescription fertilisation to improve forage quality

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Balanced nutrition & forage quality

- Broad-spectrum integrated analyses are key to balanced nutrition
- Soil ⟷ manures ⟷ crop
- Nutrient management planning

Soil Characteristics	Result	Low	Normal	High
pH	5.0			
Org. Matter - DUMAS (%)	4.9			
C.E.C. (meq/100g)	6.9			
Major Nutrients	**Result**	**0 1 2- 2+ 3 4+**		
Phosphorus (ppm)	41			
Potassium (ppm)	162			
Magnesium (ppm)	86			
Secondary and Trace Nutrients	**Result**	**Deficient**	**Maintenance**	**High**
Calcium (ppm)	438			
Sulphur (ppm)	15			
Sodium (ppm)	18			
Boron (ppm)	0.85			
Copper (ppm)	3.9			
Iron (ppm)	665			
Manganese (ppm)	14			
Molybdenum (ppm)	< 0.01			
Zinc (ppm)	2.9			
Others				
Lime Req. (t/ha)	6.0			
Silt (%)	48.17			
Clay (%)	7.38			
Sand (%)	44.45			
SClass	Sandy Silt Loam			

Nutrient	Result	Low	Normal	High
Nitrogen (%)	2.24			
Phosphorus (%)	0.31			
Potassium (%)	1.17			
Calcium (%)	0.24			
Magnesium (%)	0.08			
Sulphur (%)	0.14			
Boron (ppm)	14.8			
Copper (ppm)	6.5			
Iron (ppm)	24			
Manganese (ppm)	139.5			
Molybdenum (ppm)	0.17			
Zinc (ppm)	26.1			

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Balanced nutrition in practice

On farm trial, Northumberland, 2021

‘Can liveweight gain of grass reared lambs be maintained or increased from birth to weaning at 16 weeks with 15% less nitrogen by using a prescription blended compound rather than applying straight nitrogen?’

LIVESTOCK

The addition of sodium, selenium and sulphur to nitrogen fertiliser applications has successfully boosted growth rates of freshly weaned lambs by more than 17 per cent, according to a 2020 study. **Farmers Guardian** reports.

Balanced nutrition drives lamb growth rates

Lambs grazing pasture treated with sodium, selenium and sulphur benefited from improved growth rates.

An on-farm trial at Lemmington Hill Head, Northumberland, compared the daily liveweight gains of weaned lambs grazing pasture treated with nitrogen, sulphur, sodium and selenium [23-0-0+5SO3+5Na+selenium] to those grazing pasture treated with straight nitrogen only.

Fertiliser was applied in late June, with both products delivering 45kg/ha (18kg/acre) nitrogen in a single application.

The 278 Aberfield and Aberfield cross lambs involved in the trial entered the respective fields immediately after weaning on July 17 at around 12 weeks of age.

Over a 45-day period, ram lambs grazing pasture treated with sodium, selenium and sulphur benefited from a 22.6 per cent improvement in growth rates, while ewe lambs showed an 11.5 per cent improvement on average.

The results were likely due to improved forage intake according to Origin Fertiliser Nutrition Agronomist Abby Kellett.

"Sodium has a key role in synthesising sugars within grass which can be useful in improving grassland palatability and digestibility," she says.

"These two factors mean animals are encouraged to eat more forage – around 15 per cent more typically – and are able to make better use of the forage they consume."

To improve grassland palatability, RB209 recommends applying 10kg/ha (4kg/acre) sodium regularly throughout the growing season.

This is due to its high mobility within the soil which makes the nutrient vulnerable to leaching losses.

Host farmer James Drummond says: "At the first weighing, lambs grazing pasture treated with sodium were performing significantly better.

"The gains started to level out towards the end of the trial, which backs up the theory that sodium should be applied little and often for maximum effect."

Better metabolism due to the inclusion of selenium within the fertiliser grade was also thought to be a contributing factor.

Deficient

"Selenium increases an animal's ability to convert food into energy due to its association with thyroid function and yet 90 per cent of UK soils are currently deficient in this critical element," adds Miss Kellett.

On average, lambs grazing pasture treated with the multi-nutrient fertiliser gained 7.45kg/head (165g/head/day) on average compared to 6.33kg/head (141g/head/day) for the straight nitrogen group.

At a hypothetical lamb value of 200p/kg liveweight, this extra weight gain was worth around £2.24/head.

When factoring in stocking rates, which were maintained at around 24 lambs per ha (10 lambs/acre), and fertiliser costs, the average return on investment from using a more balanced fertiliser equated to £32.82/ha (£13.28/acre).

In addition to improved profitability, Mr Drummond saw benefit in feeding the soil as opposed to supplementing livestock.

"Improving and protecting soil on farm is essential," he says.

"Where there is known deficiency in our livestock, addressing them from the ground up is a no-brainier for me."

LEMMINGTON HILL HEAD TRIAL

THIS year, a similar trial is underway at Lemmington Hill Head where growth rates are being measured for lambs grazing pasture treated with ammonium nitrate (34.5 per cent) at 348kg/ha (140kg/acre) versus a prescription fertiliser grade [23-7-0+8Na+9SO3+Mn+Mo+Se+Zn] at 440kg/ha (178kg/acre).

The prescription grade met the nutritional requirements identified by a broad-spectrum soil analysis.

The pasture treated with the prescription fertiliser received 15 per cent less nitrogen compared to the ammonium nitrate treated pasture and yet initial forage results have shown a 26.5 per cent increase in nitrogen in the grass.

Miss Kellett says: "For nitrogen to be utilised effectively within the plant it is important that all other nutrients including micronutrients are at optimum levels.

Nutrients

"So it was not a massive surprise that the grade which contributed less nitrogen, but a wider range of nutrients, resulted in more nutritional grass with a higher nitrogen content.

"In fact, the pasture receiving the prescription fertiliser had a higher concentration of nearly every nutrient which was measured – macro and micro."

Rather than assessing lamb growth post-weaning, this time lamb weights are being recorded at birth, eight weeks, [illegible] weeks) and 16 weeks, applied in the [illegible] throughout the [illegible]

On weighing, Mr Drummond [illegible] improvement in grazing pasture [illegible] prescription N [illegible] head/day on a [illegible] 330g/head/day [illegible] nitrate group.

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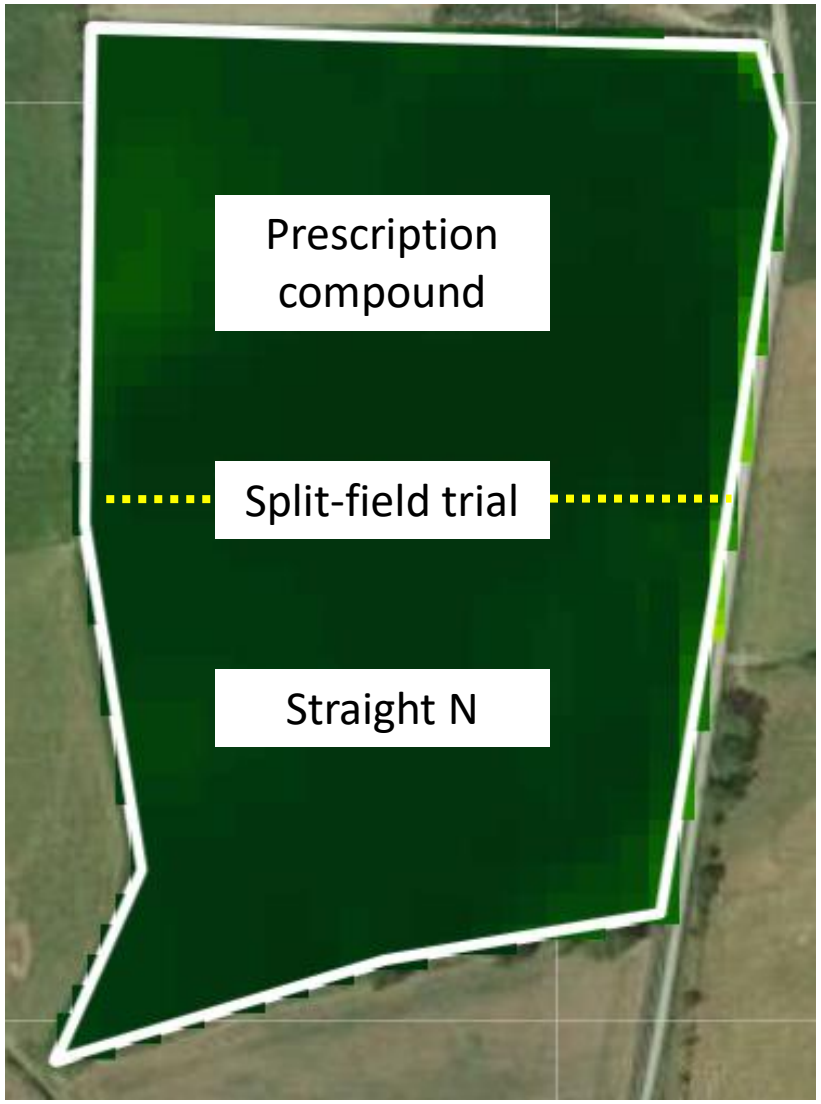
Balanced nutrition in practice



- 8.4ha field – split into 2 x 4.2ha blocks
- 54 ewes with twin lambs on each side of split-field (25 lambs/ha)
- More added at 8-week weights to match grass growth (34 on each side)
- Fertiliser applied in 3 equal splits – around 4-5 weeks apart
- Lamb weights collected at birth, 8 weeks & weaning
- Grass yield measured weekly – plate meter
- Forage analysis fortnightly (mineral & quality)

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Balanced nutrition in practice

Trt. no.	Product type	Fertiliser analysis	Appln. kg/ha
1	Straight N	34.5% N	349
2	Prescription blended compound	23-4.8-0 + 3.6 S, 6 Na 0.0015 Se, 0.03 Zn	439

Nutrient applied	Straight N	Prescription blend
Nitrogen (N)	120 kg	101 kg
Phosphorus (P)		21 kg
Sulphur (S)		16 kg
Sodium (Na)		26 kg
Selenium (Se), g/ha		6.6 g
Zinc (Zn), g/ha		132 g
Total nutrient (kg/ha)	120	224.139

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Balanced nutrition in practice

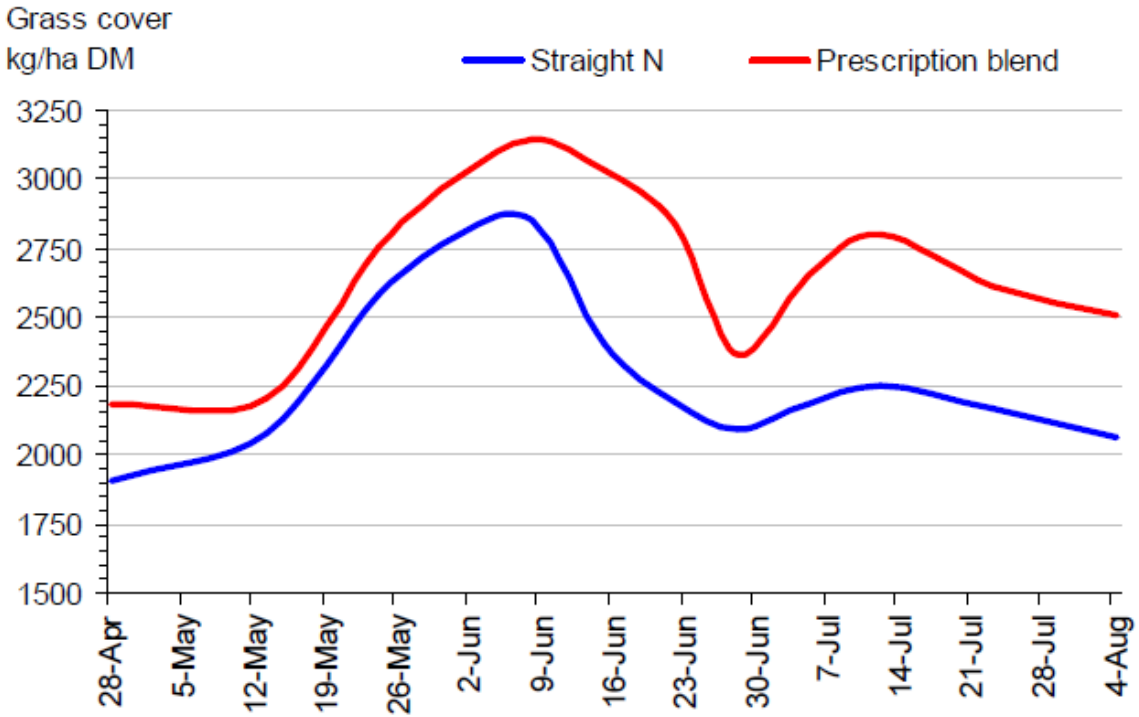

Figure 10: *Grass cover (kg/ha DM) for each of the fertiliser treatments, 2021.*

Parameter	Block 1 (straight N)	Block 2 (prescription fertiliser)
Nitrogen (%)	2.46	3.28
Sulphur (%)	0.160	0.293
N:S ratio	15.4:1	11.2:1
Crude protein (%)	15.38%	20.50%

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Balanced nutrition in practice

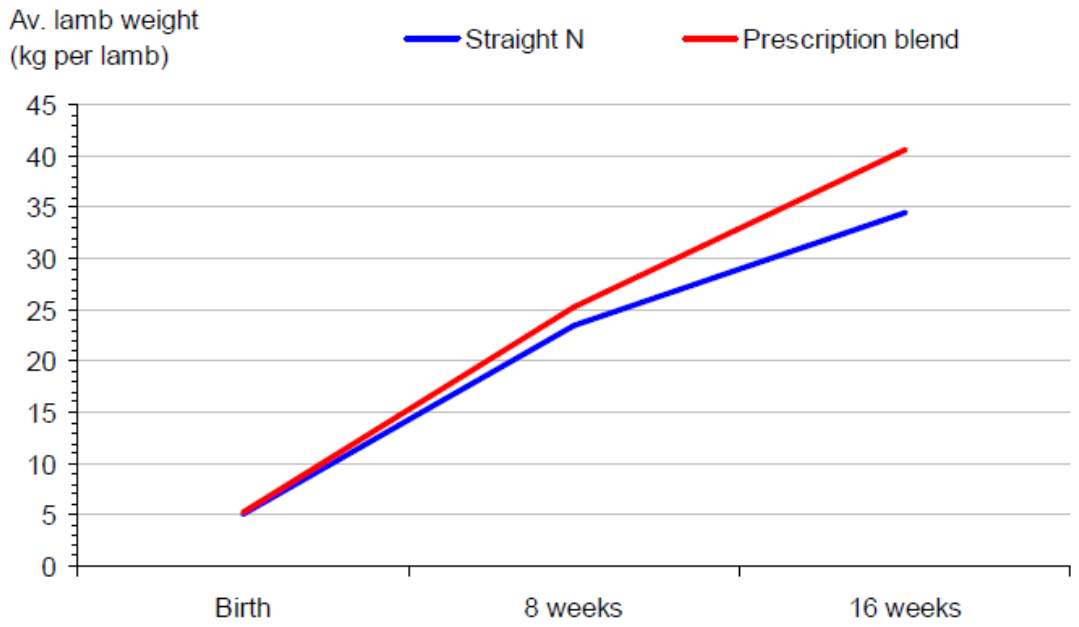

Figure 11: *Cumulative average weight gain by fertiliser treatment.*

Return on investment:

- £4.86 : £1.00

Measurement	Straight N	Prescription blend	Difference +/- %
Inorganic N, kg/ha	120	101	- 15.8%
LWG to 16 wks, kg/ha	735	884	+ 20.3%
LWG per kg N applied	6.13	8.75	+ 42.7%

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Balanced nutrition and environmental policy

Measure	Pathway 1	Pathway 2	Description of mitigation measure
N-reducing measures (Liming, legumes, LESS)	20% (322,590 tonnes N by 2030)	30% (285,757 tonnes N by 2030)	Reduction in total N
Fertiliser Formulation (Protected Urea, Low-N compounds)	100% 65% 50%	100% 95% 65%	Straight Urea to PU CAN to PU Nitrate-based to ammonium based compounds
Reduced Age of Finishing	2 months	3 months	Reduction in average age at finish of prime beef cattle
Feed Additives	40% 45%	50% 65%	Feed additive to dairy cows during grazing Feed additive to cattle during housing
Diversification Impacts (Destocking & Use of Digestate)	54,849 LU 520,000m^3	137,963 LU 3,500,000m^3	Displacement of animal numbers Volume of digestate
Manure Management	25% dairy 15% other	40% dairy 20% other	Slurry aeration or acidification

Source: Marginal Abatement Cost Curve (MACC) 2023, Teagasc

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Balanced nutrition & PU-compounds in agronomic trials

Trial conducted by National University of Ireland – Galway, 2019

'Is there any difference in forage yield and quality between a prescription blended compound and a 'standard' analysis complex compound?'

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Balanced nutrition & PU-compounds in agronomic trials

Trt. no.	Product type	Fertiliser analysis	kg/ha	Nutrient applied (kg/ha
1	Complex compound	24-2.5-10	500	120-12.5-50
2	Blended compound	24-2.5-10	500	120-12.5-50
3	Prescription blended compound (CAN-based)	19-2-9 + 2.5 S, 3.0 Na, 0.001% Se	633	120-12.5-57 + 15.8 S + 19 Na + 6.33g/ha Se
4	Prescription blended compound (PU-based)	24-2.5-11.3 + 3.1 S, 3.7 Na, 0.00125% Se	500	120-12.5-57 + 15.8 S + 19 Na + 6.33g/ha Se

- Broad spectrum soil analysis pre-trial
- 24-6-12 identified as ‘best fit’ of commercially available complex compounds
- Soil analysis identified potential deficit in potassium, sulphur, sodium & selenium
- Prescription blended compound applied the same N & P with additional K and the inclusion of S, Na & Se

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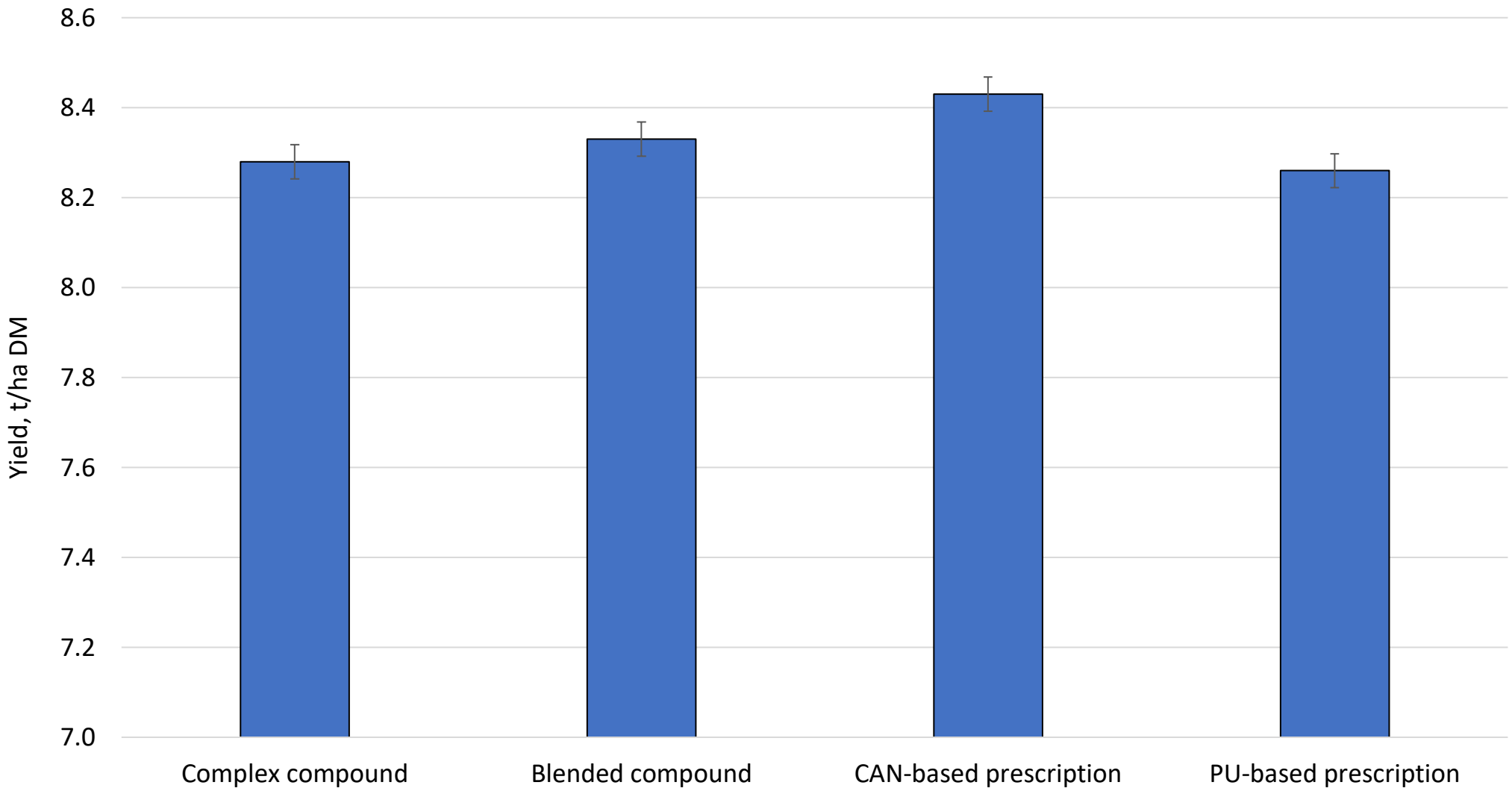
NUI grass trial, DM yield (t/ha)



P value 1.003; LSD 0.463, no statistical difference between treatments

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Balanced nutrition & PU-compounds in agronomic trials

Trt. no.	Product type	Forage mineral content (%)					Se (mg/kg)	N:S ratio
		N	P	K	S	Na		
1	Complex compound	3.74	0.268	1.644	0.197	0.275	0.036	19:1
2	Blended compound	3.52	0.274	1.473	0.192	0.281	0.033	18:1
3	Prescription comp (CAN based)	3.95	0.236	1.684	0.308	0.428	0.109	13:1
4	Prescription comp (PU based)	3.64	0.289	1.630	0.308	0.440	0.108	12:1

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Balanced nutrition & PU-compounds in agronomic trials

Trt. no.	Product type	Crude protein	Energy	WSC	D-value
		kg/ha	KJ/ha	kg/ha	
1	Complex compound	1,937	84,870	429.7	65.54
2	Blended compound	1,835	86,215	430.7	65.87
3	Prescription comp (CAN-based)	2,082	88,009	529.4	66.15
4	Prescription comp (PU based)	1,882	86,234	523.7	66.54

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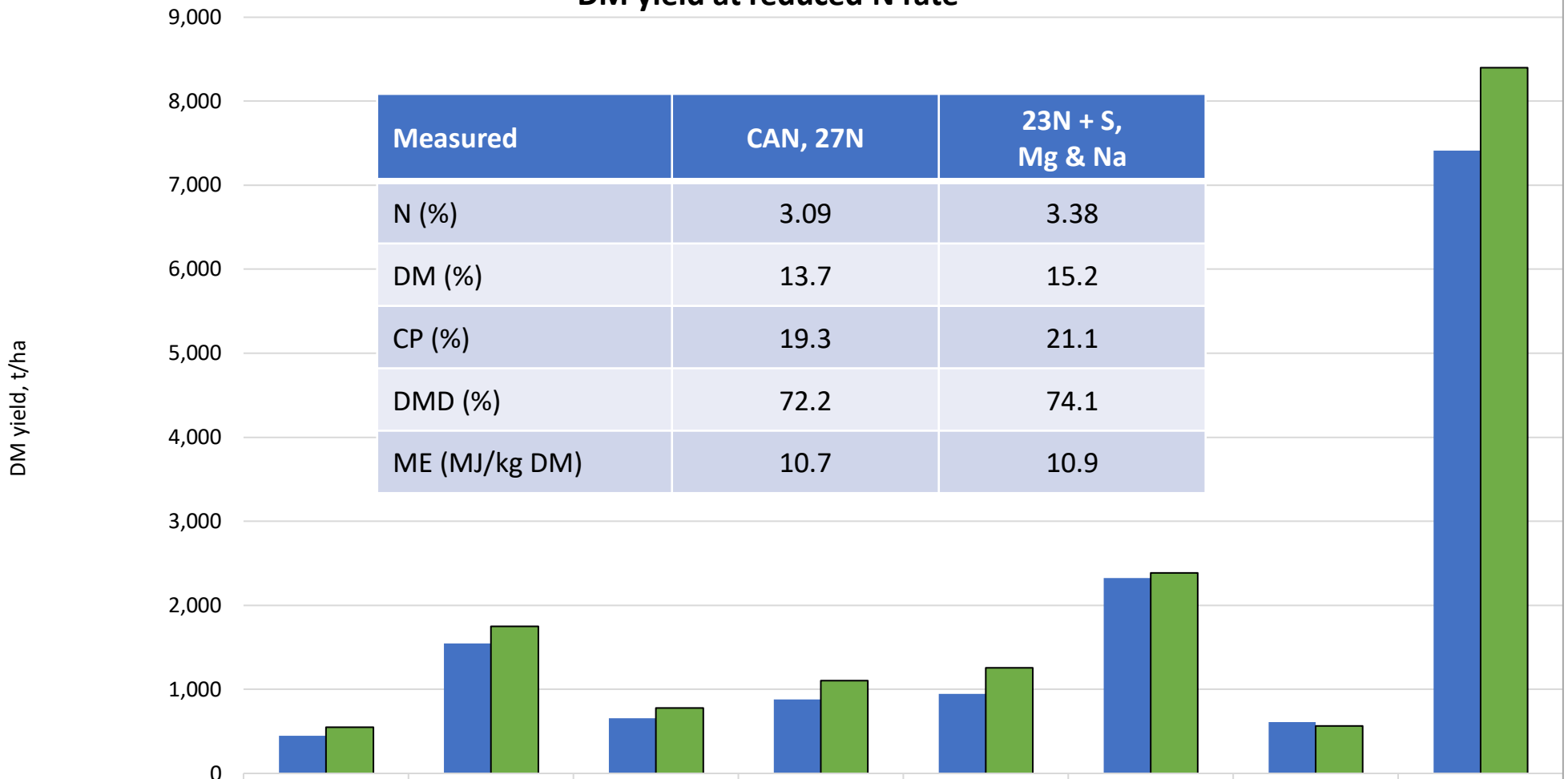
Farm trial, Co. Galway, 2023
DM yield at reduced N rate

Measured	CAN, 27N	23N + S, Mg & Na
N (%)	3.09	3.38
DM (%)	13.7	15.2
CP (%)	19.3	21.1
DMD (%)	72.2	74.1
ME (MJ/kg DM)	10.7	10.9



	1st grazing	2nd grazing	3rd grazing	4th grazing	5th grazing	6th grazing	7th grazing	Total
CAN, 27N	450	1548	655	880	945	2325	610	7413
23N + S, Mg & Na	550	1750	780	1105	1257.5	2388	567	8397

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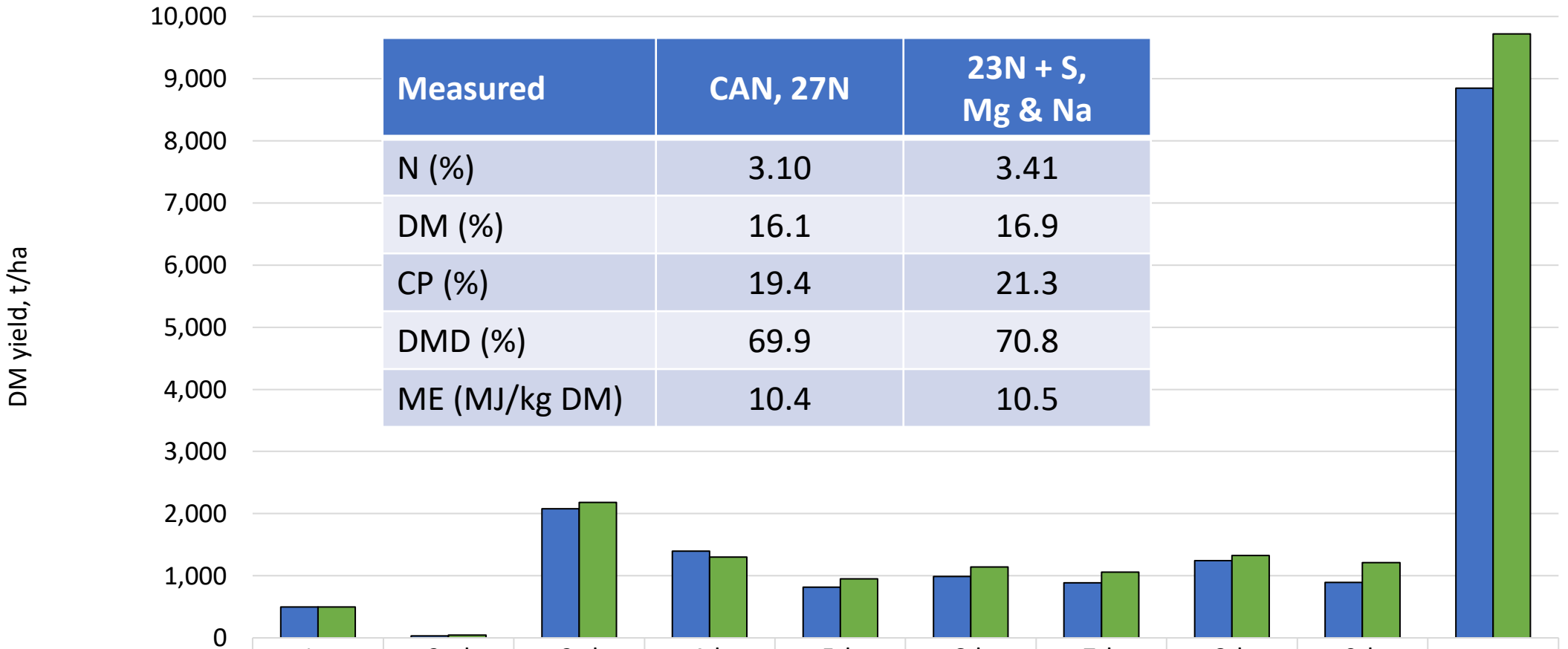
Farm trial, North Tipperary, 2023
Balanced nutrition to mitigate reduced N rate

Measured	CAN, 27N	23N + S, Mg & Na
N (%)	3.10	3.41
DM (%)	16.1	16.9
CP (%)	19.4	21.3
DMD (%)	69.9	70.8
ME (MJ/kg DM)	10.4	10.5



	1st grazing	2nd grazing	3rd grazing	4th grazing	5th grazing	6th grazing	7th grazing	8th grazing	9th grazing	Total
CAN, 27N	500	35	2077	1400	820	990	890	1247	892	8851
23N + S, Mg & Na	500	48	2182.5	1300	948	1143	1062	1325	1215	9723

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Fertiliser formulation – switch from nitrate to ammonium compounds

Compound	Nitrate-N % NO_3^-	Ammonium-N % NH_4^+	NO_3^- : NH_4^+	N_2O reduction cf. CAN
27-2.5-5	12.0	15.0	0.80	31%
24-2.5-4.5	11.2	12.8	0.88	37%
10-10-20	0.5	9.5	0.05	43%
18-6-12	6.2	11.8	0.53	44%

Source: Gebremichael et al. 2021

Adding sulphur as ammonium sulphate will further increase the proportion of ammonium-N and improve nutrient balance

Compound	Nitrate-N % NO_3^-	Ammonium-N % NH_4^+	NO_3^- : NH_4^+	N_2O reduction cf. CAN
27-2.5-5	11.0	16.0	0.69	?
24-2.5-4.5	9.6	14.4	0.67	
10-10-20	0.0	10.0	0.00	
18-6-12	5.0	13.0	0.38	

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Clover to mitigate reduced mineral N

- Increased use of legumes is listed in Ag Climatise & MACC as mitigation for reduced N

- Teagasc Clover 150 project

    1) Reduce Nitrogen (N) Surplus <130 kg N/ha and an increase N use efficiency >40%

    2) ≤ 150 kg N fertiliser/ha

    3) Average sward clover content of 20 – 25%

    4) ≥ 14 t DM/ha grown

- Do we fully understand the specific nutrient requirements of clover?

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NUE-Leg, UK R & D project

- 4-year, £4.7M R & D project, industry / academia consortium
- Objectives:
  1) Breed new legume varieties with increased N fixation (300kg/ha N)
  2) Prescription fertilisers for legume swards and N fixation
  3) Develop digital tools for legumes
  4) Reduce emissions from livestock farming (N_2O, CH_4 & NH_3)
  5) Create full LCA carbon footprint for livestock farming

NUE-Leg project partners:

- Germinal
- Origin Enterprises
- Muller
- Pilgrim
- Dovecote Park
- Aberystwyth Univ / IBERS
- James Hutton Institute
- Agrecalc
- Defra / UKRI
- LEAF (Linking Environment & Farming)
- CIEL (Centre of Innovation Excellence in Livestock)

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Conclusions

- Balanced nutrition can play a key role in sustainable farming
- Balancing profitable productive agriculture with environmental protection
- Improving crop quality
- Mitigating reductions in mineral nitrogen fertiliser
- Requires a collective re-think in our approach to mineral fertilisers
- Needs a collaborative approach: fertiliser industry, farmers, researchers & policy makers

Thank you!

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