

Multispecies Grasslands: Influence of Mixture **Composition on Nitrous Oxide**





Trinity College Dublin Coláiste na Tríonóide, Baile Átha Cliath The University of Dublin

Emissions and Nitrogen Use Efficiency





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Introduction

- The Multi4More project is a collaborative research endeavor funded by DAERA-DAFM between AFBI, Teagasc, UCD and TCD.
- Three experimental sites are replicated at AFBI Crossnacreavy, Teagasc Johnstown Castle, and UCD Lyons Estate.
- This project aims to bridge the knowledge gap on the effect of multispecies, integrating legumes and herbs (Figure 1), on N₂O emissions and nitrogen (N) use efficiency in grasslands compared to ryegrass monocultures.



Project Objectives

- **Uncover Complex Dynamics:** Examine N₂O emissions, N use efficiency and agronomic performance within multispecies.
- Quantify Diversity Effects: Measure species diversity effect on total yield and nitrogen replacement value.
- Assess Mixture Effects: Evaluate species mixture effect on N_2O emissions intensity and total nitrogen yield.
- Mitigate Environmental Impact: Assess the efficacy of multispecies swards as a mitigation strategy to reduce overall N fertiliser use and improve N use efficiency, thereby contributing to sustainable agriculture.

Research Protocol and Future Plan

Multi4More Plots at Crossnacreevy - COTTAGE FIELD

G1 L1L2H1H2 G1G2L1L2HHR H1H2 G1G2L1L2HHR G1G2L1L2HHR G1G2L1L2HHR L1L2 G1G2L1L2HHR H1H2 G1G2L1L2 G1G2L1L2 G1G2L1L2 G1G2L1L2 H1H H1H2 G1G2L1L2 G1G2L1L2 G1G2L1L2 G1G2L1L2 G1G2L1L2 H1H H1H2 G1G2L1L2 G1G2L1 G1G1G1G1G1G1G1 G1G	109	103	97	91	85	79	73	67	61	55	49	43	37	31	25	19	13	7	1
	G1	L1L2H1H2	G 1G 2L 1L 2H1H2	H1H2	G1G2L1L2H1H2	G 1G 2L 1L 2H1H2	L1L2	G1L1	G1G2	G 1G 2L 1L 2H1H2	H1H2	G 1G 2L 1L 2H1H2	G1	G1G2	L1L2H1H2	G1G2L1L2	51G2L1L2H1H	H1H2	G1
2m	2 m																		
2m	2m																		
		104	98	92	86	80	74	68	62	56	50	44	38	32	26	20	14	8	2
2m 110 104 98 92 86 80 74 68 62 56 50 44 38 32 26 20 14 8		104	98	92	86	80	74	68	62	56	50	44	38	32	26	20	14	8	

Figure 1: Grass-Legume-Herb, **6-Species Mixture**

1. Experimental Design

- Randomised block design To investigate relationship between mixture composition and fertiliser treatment on N_2O emissions and N use efficiency (Figure 2).
- 2. Experimental Setup
- In May 2023, 111 experimental plots were sown across a

111	105	99	93	87	81	75	69	63	57	51	45	39	33	27	21	15	9	3
L1L2H1H2	G1G2H1H2	G 1 G 2 L 1 L 2 H 1 H 2	G1	H1H2	G1G2	G 1 G 2 L 1 L 2 H 1 H 2	G1	G1G2L12	G1	G1G2H1H2	G 1G 2L 1L 2H1H2	G1G2H1H2	G1G2L1L2H1H2	G1G2	G1G2H1H2	G 1G 2L 1L 2H1H2	G1L1	G 1G 2L 1L 2H1H2

106	100	94	88	82	76	70	64	58	52	46	40	34	28	22	16	10	4
G 1G 2L 1L 2H1h2	G1L1	L1 L2	L1L2	G1L1	G 1G 2L 1L 2H1H2	G 1 G 2 L 1 L 2 H 1 H 2	G 1 G 2 L 1 L 2 H 1 H 2	H1H2	G1G2	G1	G1L1	G 1 G 2 L 1 L 2 H 1 H 2	31G2L1L2H1H	G 1G 2L 1L 2H1H2	G1G2	G1	G1G2L1L2H1H2

107	101	95	89	83	77	71	65	59	53	47	41	35	29	23	17	11	5
G1 G2 L1 L2 H	▲ L1L2	L1L2	L1L2	G1L1	G1	G 1G 2L 1L 2H1H2	H1H2	G1L1	L1L2	G1L1	G 1G 2L 1L 2H1H2	L1L2H1H2	L1L2	L1L2H1H2	L1L2H1H2	G1L1	G 1G 2L 1L 2H1H2

108	102	96	90	84	78	72	66	60	54	48	42	36	30	24	18	12	6
L1 L2	H1H2	G1L1	H1H2	L1L2	G1	H1H2	L1L2	G1	G1	G 1G 2L 1L 2H1H2	G1	G1G2L1L2H1H2	G 1 G 2 L 1 L 2 H 1 H 2	L1L2	G 1G 2L 1L 2H1H2	L1L2	G1

|--|

75 kg N ha-1 yr-1 150 kg N ha-1 yr-1 300 kg N ha-1 yr-1 10 - species multi-species (wetland mixture) 12-species multi-species (dryland mixture)

L1 = White Clover G1 = Ryegrass G2 = Timothy L2 = Red Clover

H1 = Chicory H2 = Plantain BOTTOM GATE

gradient of species proportions (Figure 3).

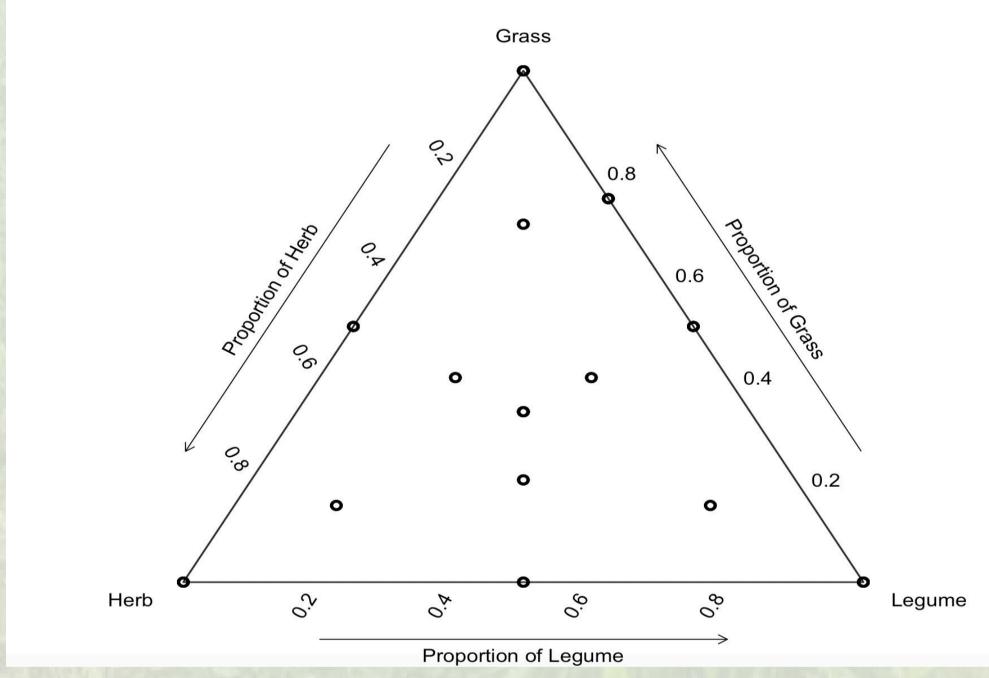


Figure 2: Plot Layout

3. N₂O Measurements

- Over a two-year period, N₂O emissions will be measured using the static chamber method (Chadwick *et al.*, 2014).
- Chambers consist of a base inserted into the ground and a lid placed on top during gas sampling (Figure



Figure 3: Simplex Mixture Design of Species Proportions

4. Statistical Analysis

• To investigate the impact of species proportion on N₂O emissions, N use efficiency and yield, a regression-based approach, the Diversity-Interaction model (Kirwan et al., 2009) will be employed.

4). • N₂O samples will be extracted from the chamber through gas-tight septa and transferred to preevacuated vials for gas chromatography analysis.

Figure 4: N₂O Static Chamber

This model assesses the influence of ulletspecies identity and diversity effect across different species proportions and N fertilizer treatments on N₂O emissions, enabling predictions for diverse community compositions.

References:

Chadwick, D. R. et al. (2014) 'Optimizing chamber methods for measuring nitrous oxide emissions from plot-based agricultural experiments', European Journal of Soil Science, 65(2), pp. 295–307. doi: 10.1111/ejss.12117. Kirwan, L. et al. (2009) 'Diversity-interaction modeling: estimating contributions of species identities and interactions to ecosystem function', Ecology, 90(8), pp. 2032–2038. doi: 10.1890/08-1684.1.

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