Multispecies Grasslands: Influence of Mixture Composition on Nitrous Oxide Emissions and Nitrogen Use Efficiency

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Multi4More

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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 N_2O emissions and nitrogen (N) use efficiency in grasslands compared to ryegrass monocultures.

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

Project Objectives

- **Uncover Complex Dynamics:** Examine N_2O 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

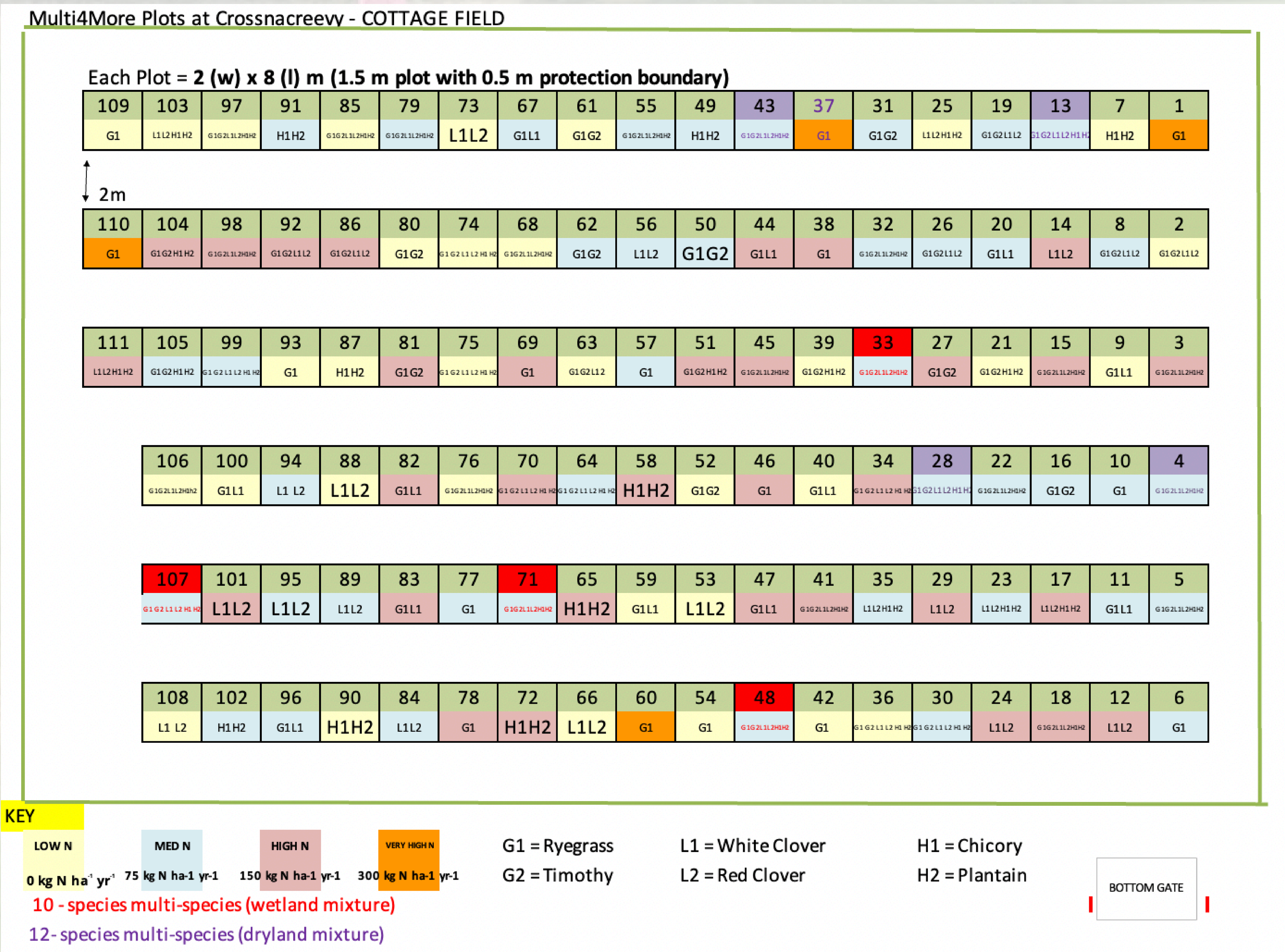

Figure 2: Plot Layout

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 gradient of species proportions (Figure 3).

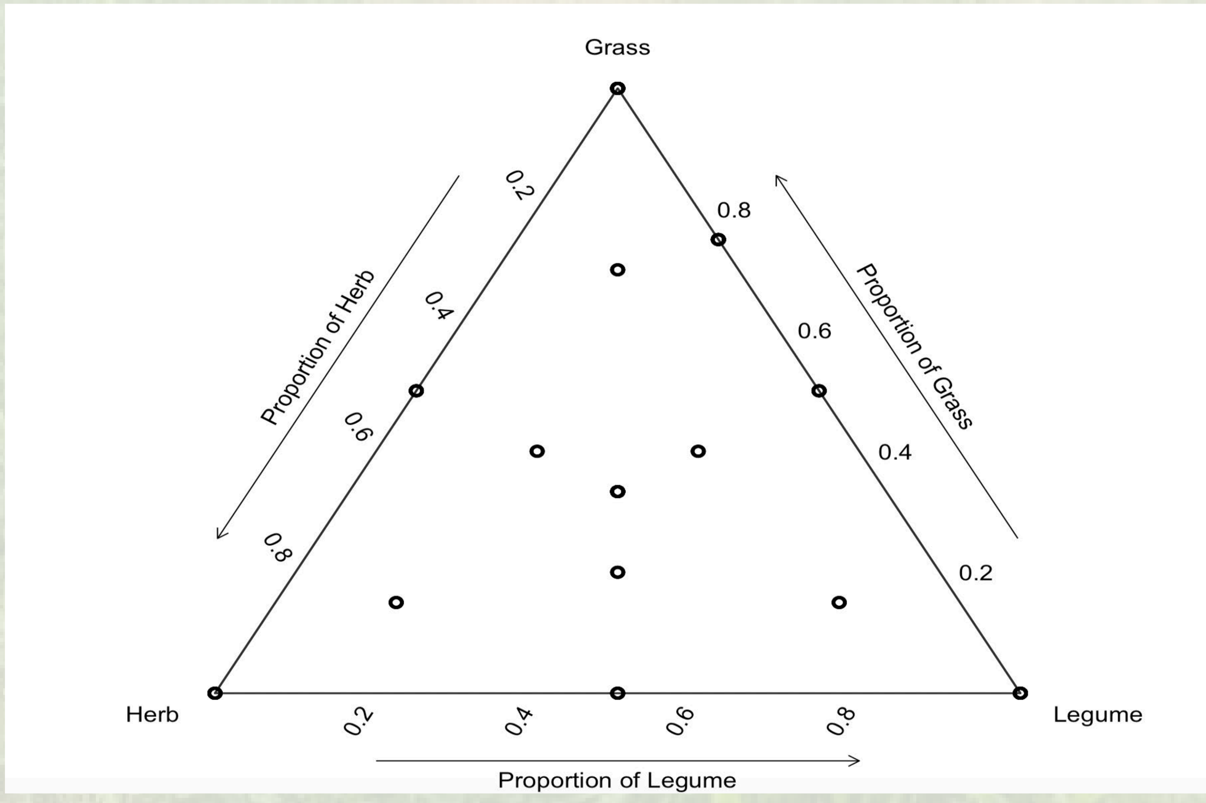

Figure 3: Simplex Mixture Design of Species Proportions

3. N_2O Measurements

- Over a two-year period, N_2O 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 4).
- N_2O samples will be extracted from the chamber through gas-tight septa and transferred to pre-evacuated vials for gas chromatography analysis.

Figure 4: N_2O Static Chamber

4. Statistical Analysis

- To investigate the impact of species proportion on N_2O emissions, N use efficiency and yield, a regression-based approach, the Diversity-Interaction model (Kirwan *et al.*, 2009) will be employed.
- This model assesses the influence of species identity and diversity effect across different species proportions and N fertilizer treatments on N_2O 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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