Testing the effects of grassland swards for yield, greenhouse gas emission mitigations and soil health.

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Introduction

- Reduce greenhouse gas emissions (N_2O)
- Reduce N inputs (less N fertiliser)
- Provide yield with mixed swards
- Sustain soil health

None-Grass Species

Red Clover (*Trifolium pratense*)

- N-fixation 150 to 250 kg N ha^{-1},
- Crude Protein 15 – 22%
- Help with weed suppression
- Deeper tap root

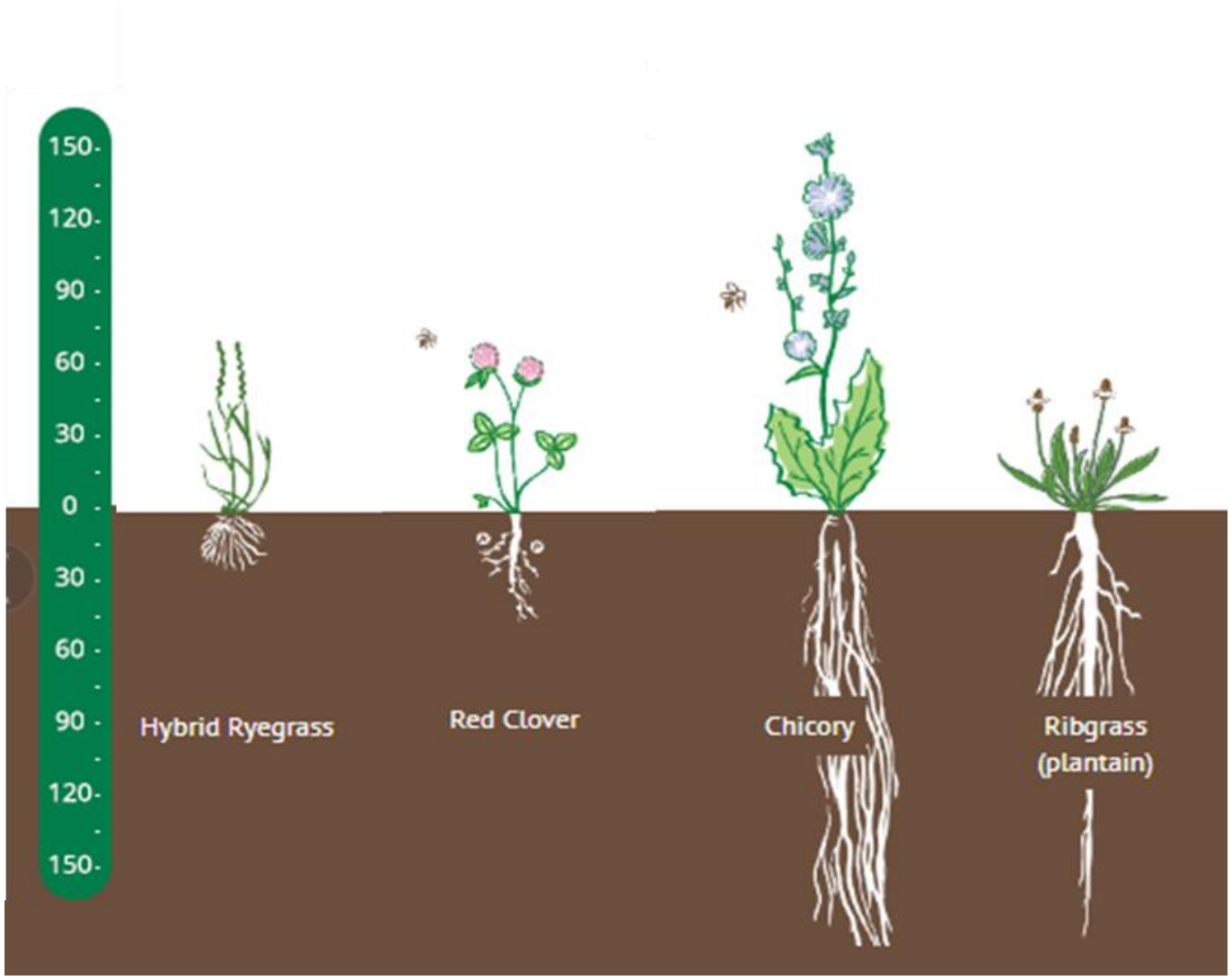
Chicory (*Cichorium intybus*)

- Deep Rooting and tolerates lower pH soils (~pH 5)
- Crude Protein 14 to 24%, ME 13/14 MJ kg^{-1} DM
- Doesn't cause bloat
- High in K, Na, Ca, S, B, Mn and Zn

Tonic Plantain (*Plantago lanceolata*)

- Deep rooting and more persistent than Chicory
- Very palatable most of the time for sheep and cattle
- Drought tolerant
- Good source of Ca, Na, Cu and Se

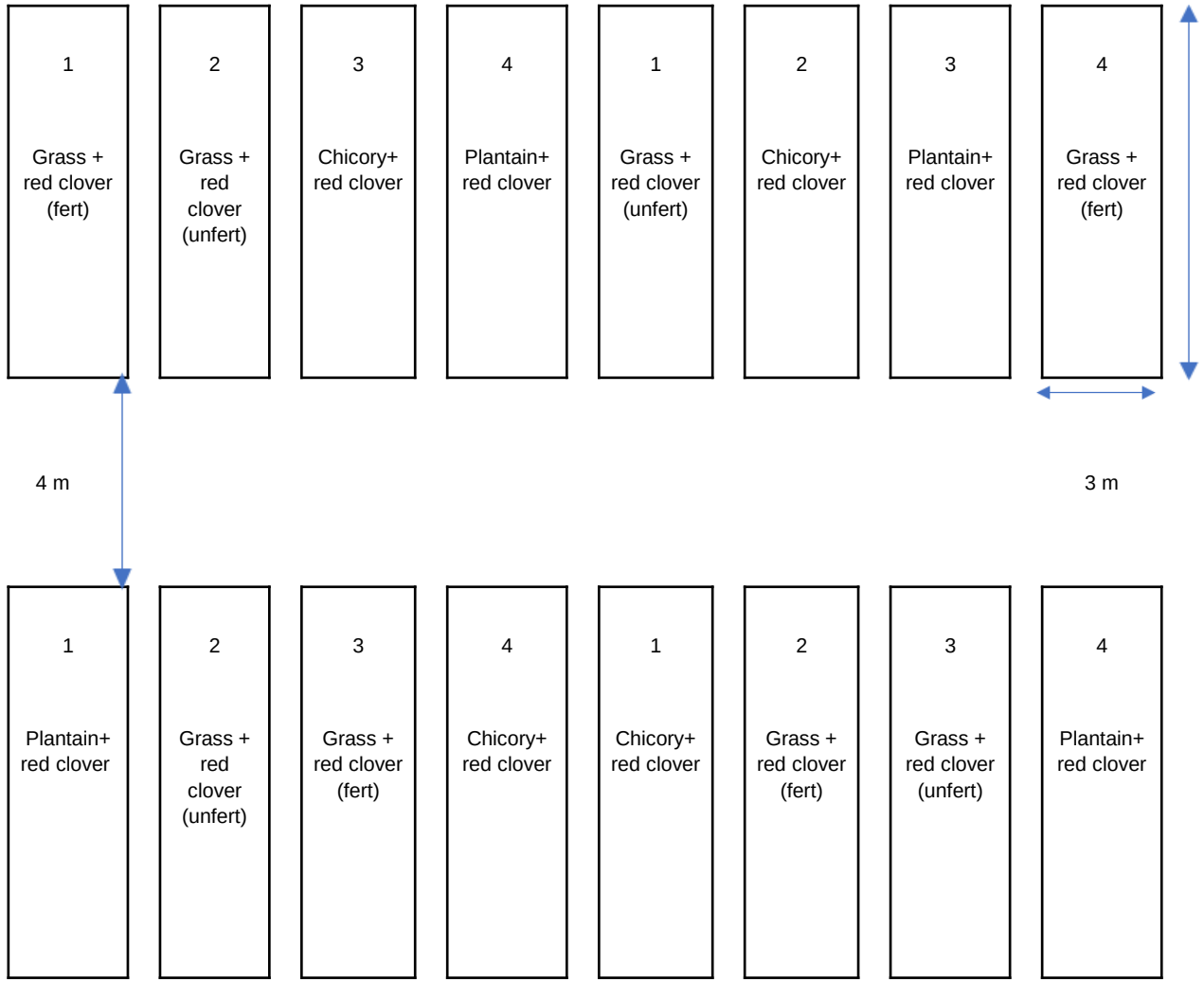
Rooting lengths



Site Information

Country	Site Name	Area	Soil Type	Annual rainfall (mm)	Mean max. air temp. (ºC)	Mean min. air temp. (ºC)
France	Laqueuille	Auvergne	Clay loam	1060	24.3	-8.8
Latvia	Jelgava	Poki	Sandy clay loam	540	21.3	-4.9
Poland	Września	Wielkopolska	Clay	548	19.8	-0.6
Scotland	Barony	Dumfries	Sandy/loam	1181	13.1	6.1

Experimental layout



All plots soil sampled initially and the end of 1st and 2nd years. Analysed for pH, P, K, PNM, LOI, Mg, structure and bulk density

Sward mixtures

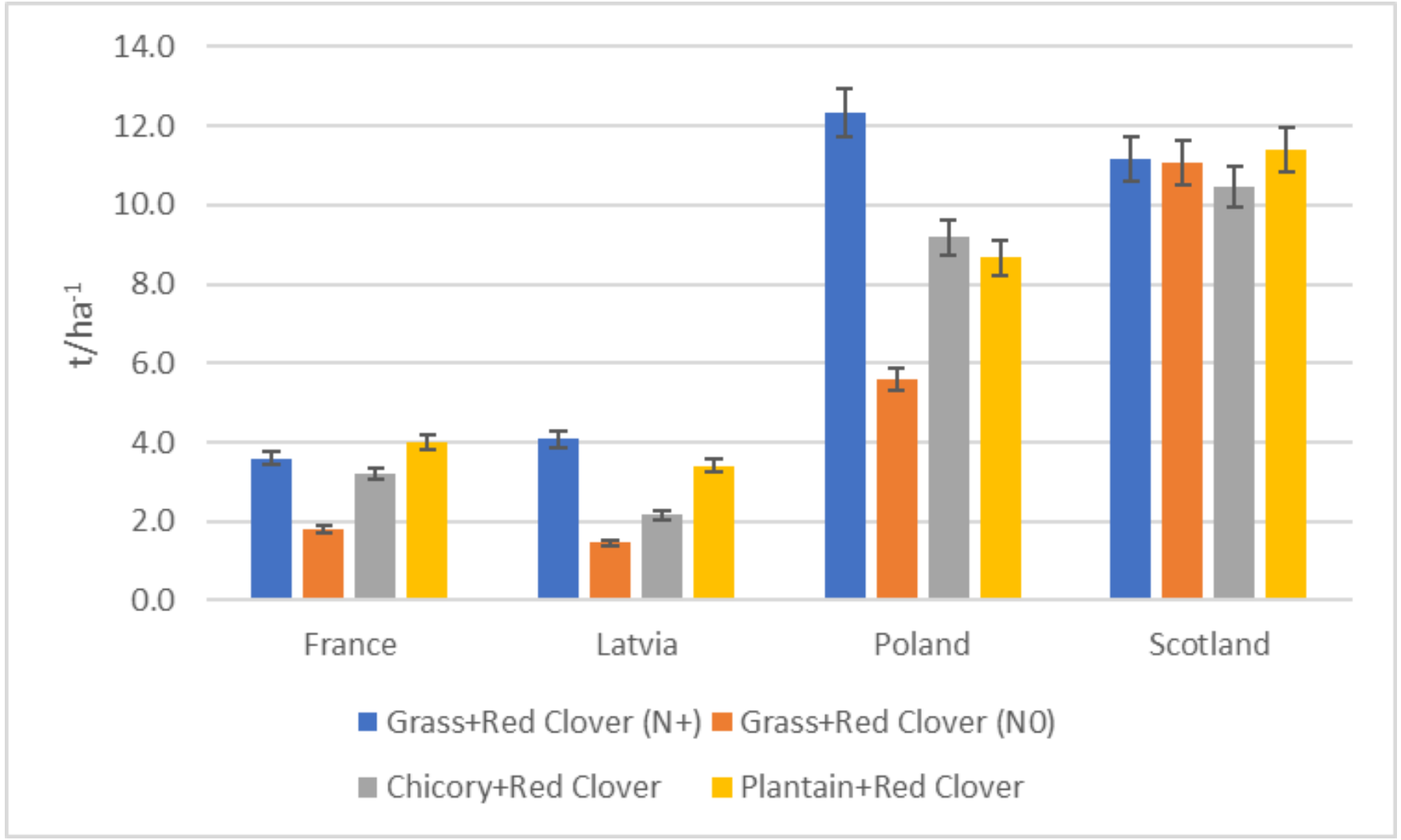
- Perennial Ryegrass/Red Clover
  (+ fertiliser 150 kg N ha^{-1})
- Perennial Ryegrass/Red Clover
- Chicory/Red Clover
- Tonic Plantain/Red Clover

French plots

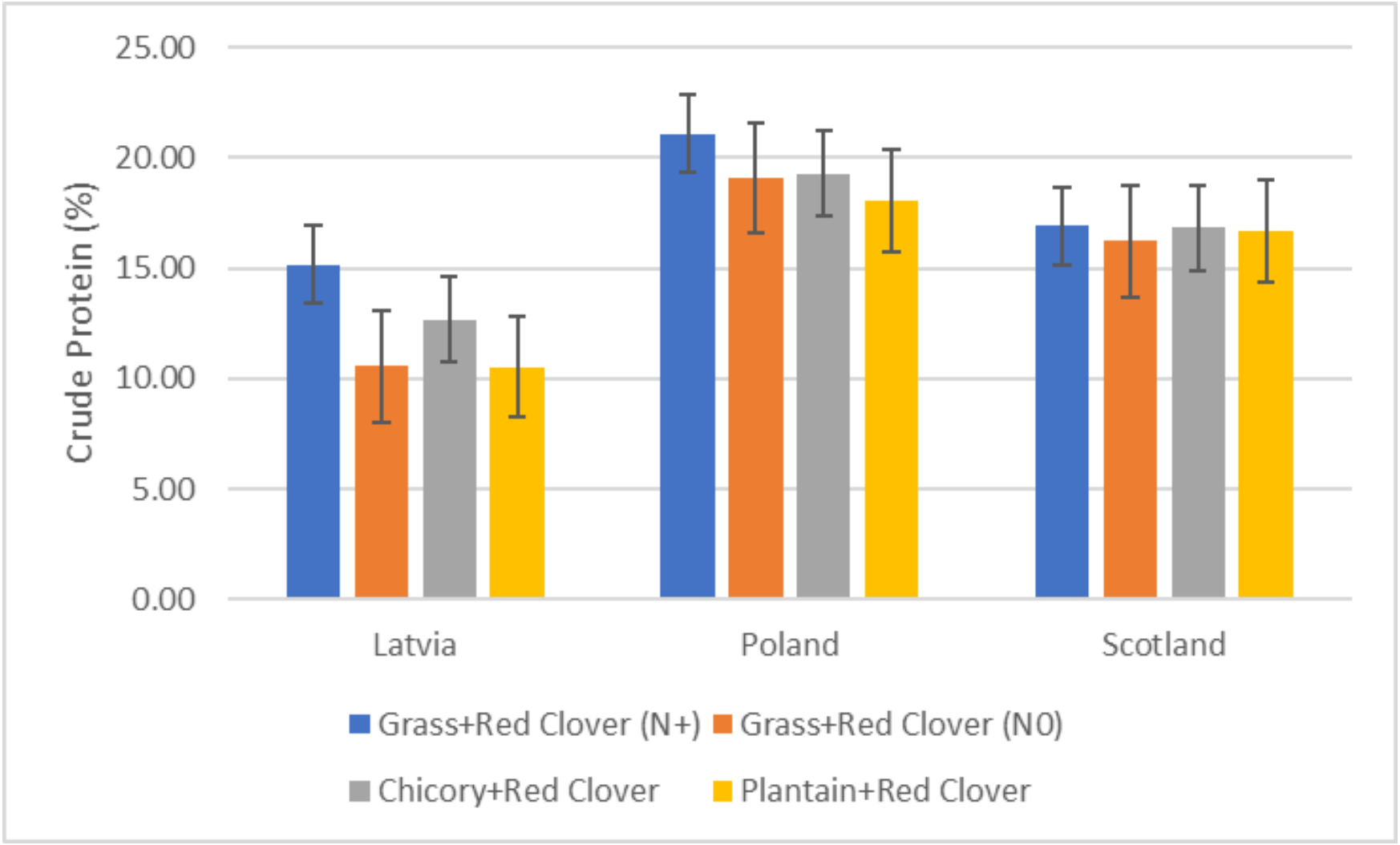
Scottish plots

Ran for two years:
2021 and 2022

Yields – Dry matter (t ha^{-1})



Crude protein (%)



Static chambers for gas sampling

Static gas chambers

Two chambers per plot

Opaque polypropylene chambers (0.4 m diameter)

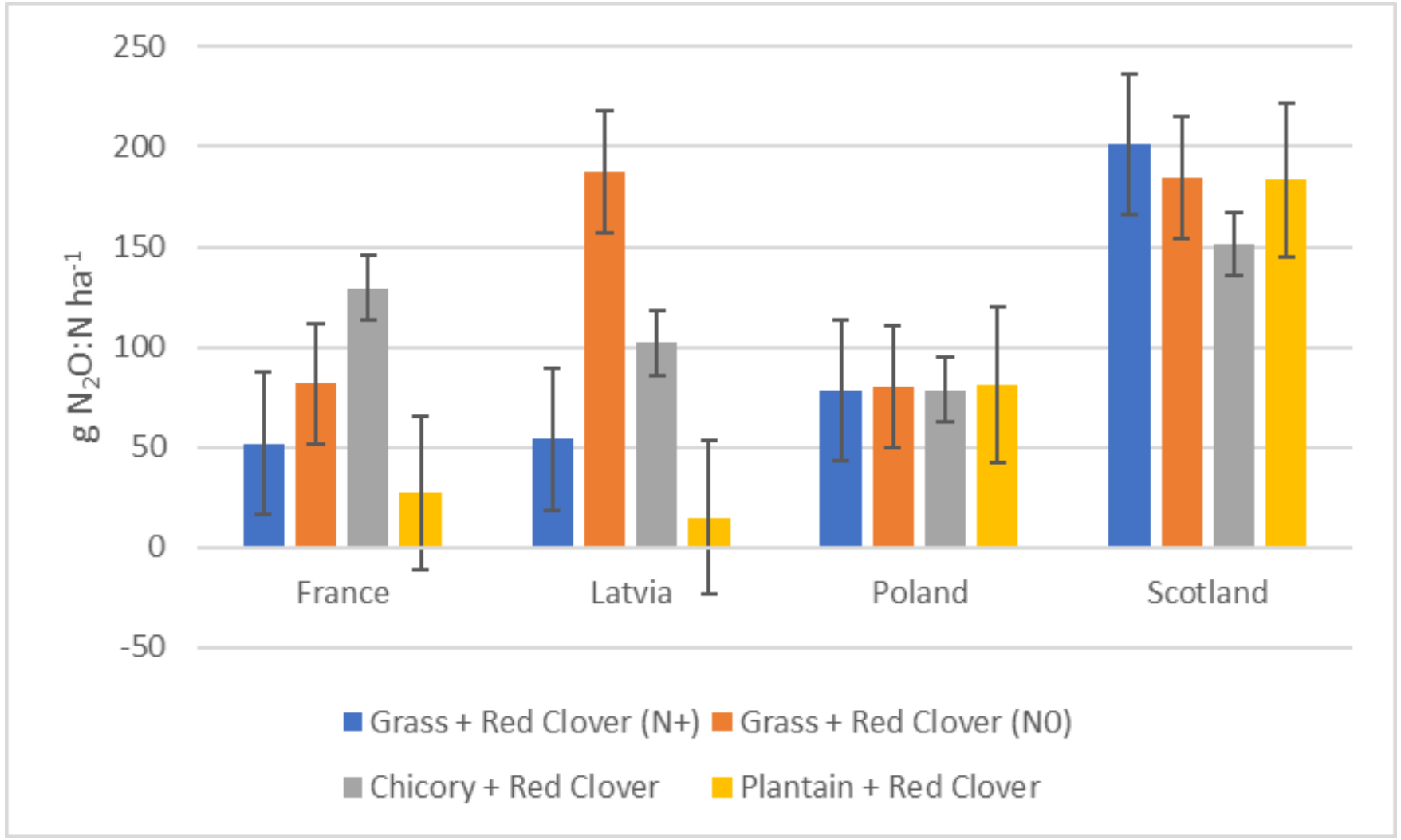
Metal lids and three-way tap for sampling

Sampled between March to end October

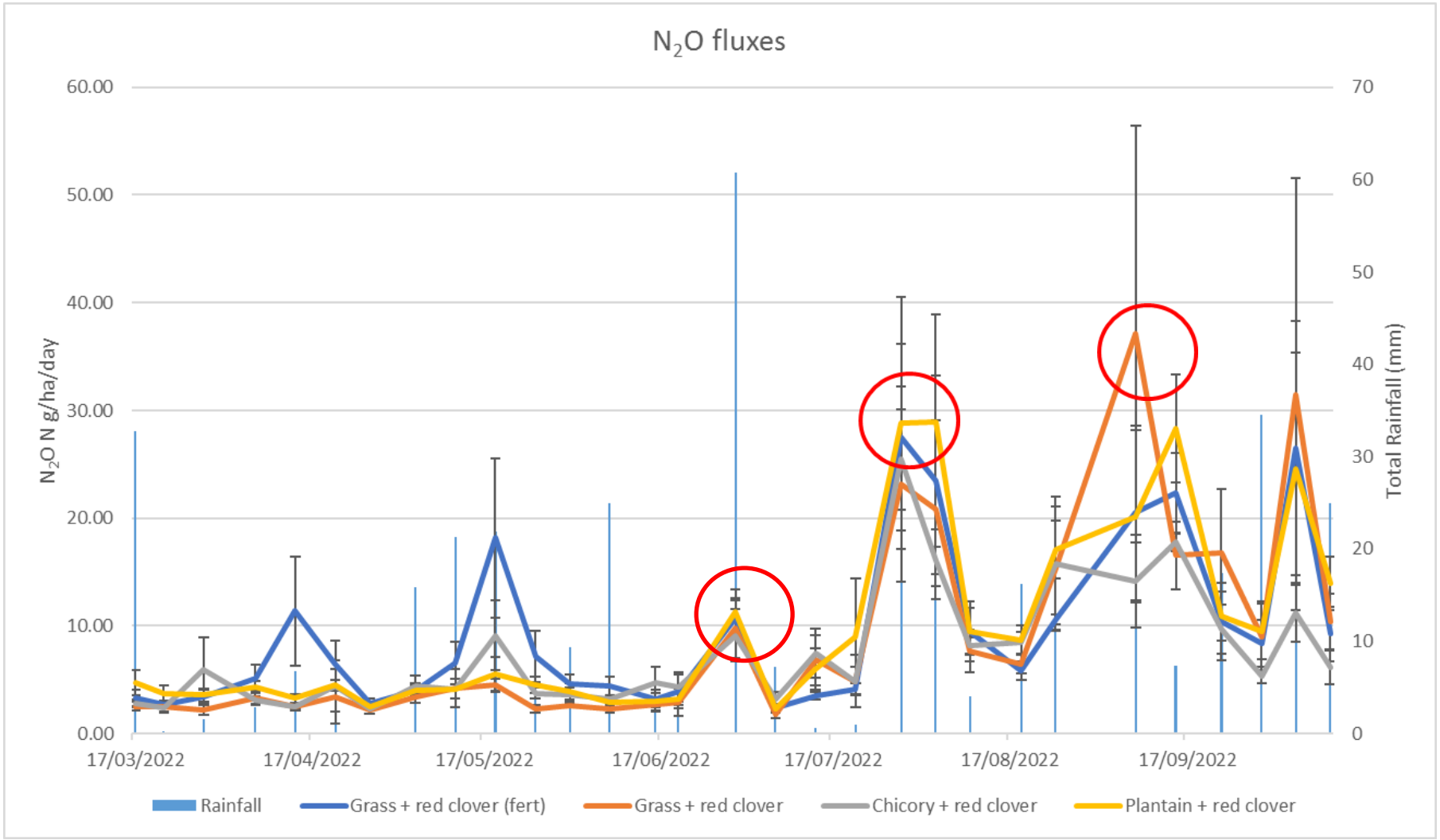
Analysed for N_2O, CO_2 and CH_4

Gas Chromatography

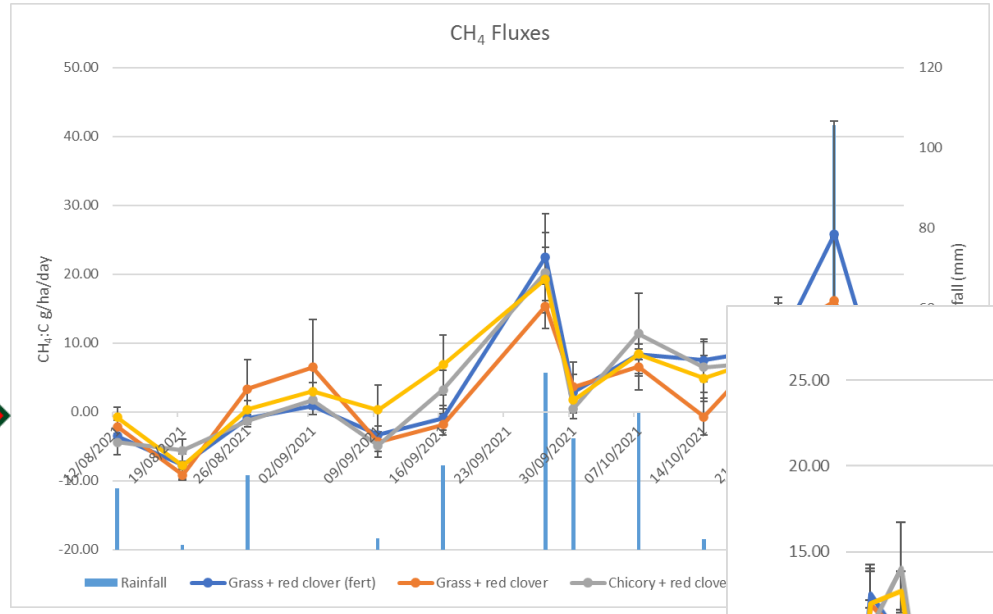
Nitrous Oxide (N_2O) Emissions

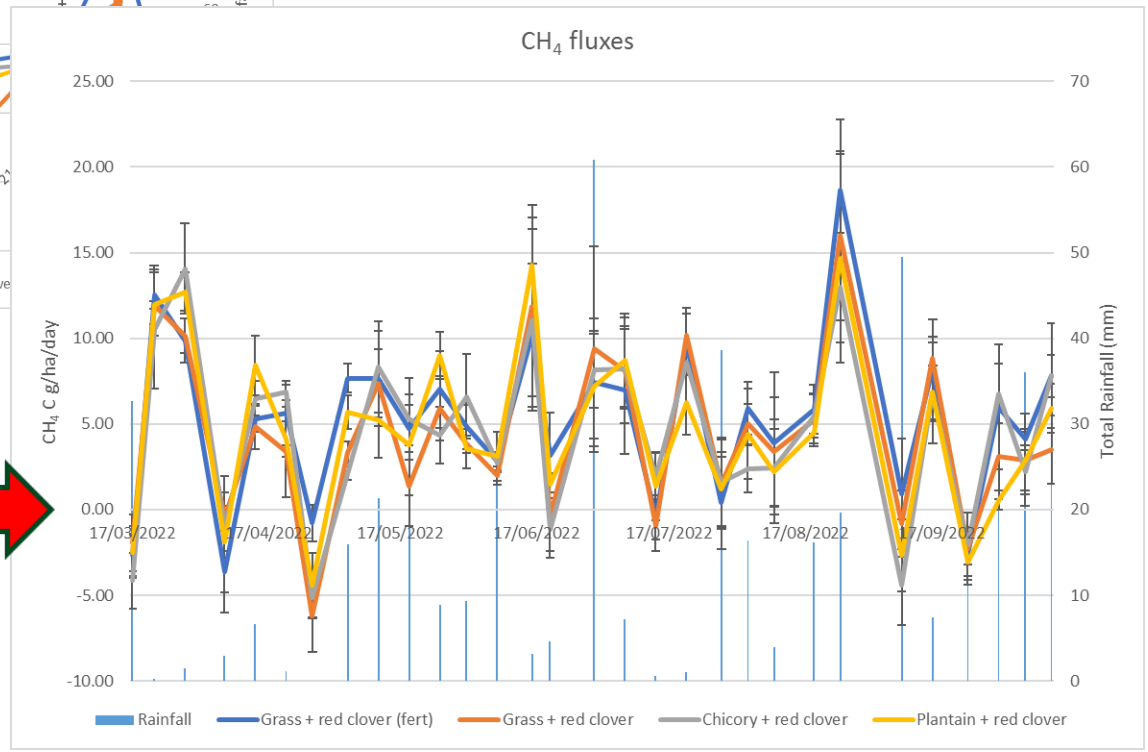


Weekly Fluxes 2022 – N_2O



Methane emissions





Soil Health

- No significant differences reported between the mixed swards for the chemical analysis of the soil.

- Some general changes for all swards between initial soil sampling and end of year 2

- Visual Evaluation of Soil Structure showed a significantly improved structure for the

  Plantain and Red Clover for the Scottish plots (p>0.02) as well as PMN (p>0.01).

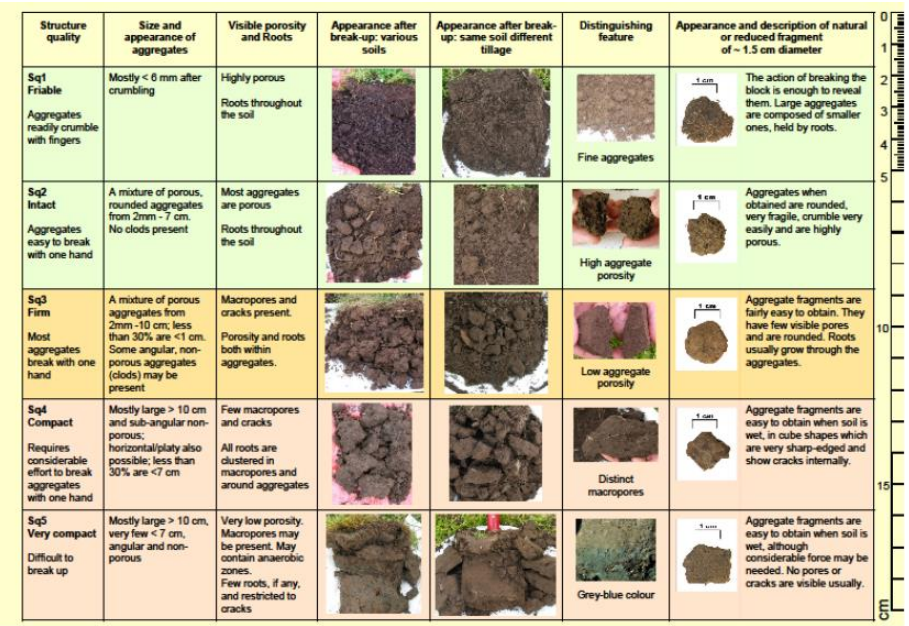
  Similar in the Latvian plots for:

  Plantain and Red Clover and Chicory and Red Clover

- Indication from the Latvian plots of a gain in soil organic C for:

  Plantain and Red Clover (+0.09%) and

  Chicory and Red Clover (+0.10%)



Structure quality	Size and appearance of aggregates	Visible porosity and Roots	Appearance after break-up: various soils	Appearance after break-up: same soil different tillage	Distinguishing feature	Appearance and description of natural or reduced fragment of ~ 1.5 cm diameter
Sq1 Friable Aggregates readily crumble with fingers	Mostly < 6 mm after crumbling	Highly porous Roots throughout the soil			Fine aggregates	The action of breaking the block is enough to reveal them. Large aggregates are composed of smaller ones, held by roots.
Sq2 Intact Aggregates easy to break with one hand	A mixture of porous, rounded aggregates from 2mm - 7 cm. No clods present	Most aggregates are porous Roots throughout the soil			High aggregate porosity	Aggregates when obtained are rounded, very fragile, crumble very easily and are highly porous.
Sq3 Firm Most aggregates break with one hand	A mixture of porous aggregates from 2mm -10 cm; less than 30% are <1 cm. Some angular, non-porous aggregates (clods) may be present	Macropores and cracks present. Porosity and roots both within aggregates.			Low aggregate porosity	Aggregate fragments are fairly easy to obtain. They have few visible pores and are rounded. Roots usually grow through the aggregates.
Sq4 Compact Requires considerable effort to break aggregates with one hand	Mostly large > 10 cm and sub-angular non-porous; horizontal/platy also possible; less than 30% are <7 cm	Few macropores and cracks All roots are clustered in macropores and around aggregates			Distinct macropores	Aggregate fragments are easy to obtain when soil is wet, in cube shapes which are very sharp-edged and show cracks internally.
Sq5 Very compact Difficult to break up	Mostly large > 10 cm, very few < 7 cm, angular and non-porous	Very low porosity. Macropores may be present. May contain anaerobic zones. Few roots, if any, and restricted to cracks			Grey-blue colour	Aggregate fragments are easy to obtain when soil is wet, although considerable force may be needed. No pores or cracks are visible usually.

0 1 2 3 4 5 10 15 cm

Conclusions

- Dry matter yields similar to the Grass and Red Clover (fert.) for most of the countries (not Poland)
- Generally similar or increased dry matter yields for Plantain and Red Clover and Chicory and Red Clover compared with Grass and Red Clover (unfert.)
- Chicory and Red Clover crude protein similar to Grass and Red Clover (fert.)
- Reduced N_2O emissions for Chicory and Red Clover or Plantain and Red Clover
- Plantain - deeper roots maintaining or improving soil structure
- Mitigation (reduced GHG emissions), reducing inorganic N inputs (cost and CO_2), potential adaptation from deeper roots (more drought tolerant)

Thank you

Any Questions?