Grow more with less resources:
Co-cropping cereals with legumes to maintain productivity and soil health in Scotland

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Introduction

- Cereal production covers about 410, 000 hectares in Scotland[1].
- Urgent need to grow more food with less land and water resources globally[2].
- Nature-based solutions (NBS) such as co-cropping cereals (e.g., barley) with legumes (e.g., peas) could potentially maintain soil health, improve soil carbon and land productivity[3].

Overall PhD Aim

To examine the role of agricultural co-cropping systems in sustainable water use and carbon sequestration in a temperate system.

Fig. 1: Co-cropping of cereals and legumes, Balruddery Farm, Dundee, Scotland, UK

Aim and Objectives of this Study

Aim: To characterise temporal variability of crop productivity and carbon sequestration in barley-pea co-cropping systems

Objectives are to:

1. Quantify crop productivity and soil carbon.
2. Compare two crop genotype traits.

Methods

- Field trial in springs of 2022 and 2023.
- Intact soil cores and loose soil taken at 0-5cm (topsoil) and 25-30cm (deep soil) depths.
- Key soil property measurements
  - Soil carbon
  - Soil nitrogen
  - Bulk density
  - Soil water retention curve
- No fertiliser or inputs used.
- Soil carbon (%) measured using a flash combustion elemental analyser.

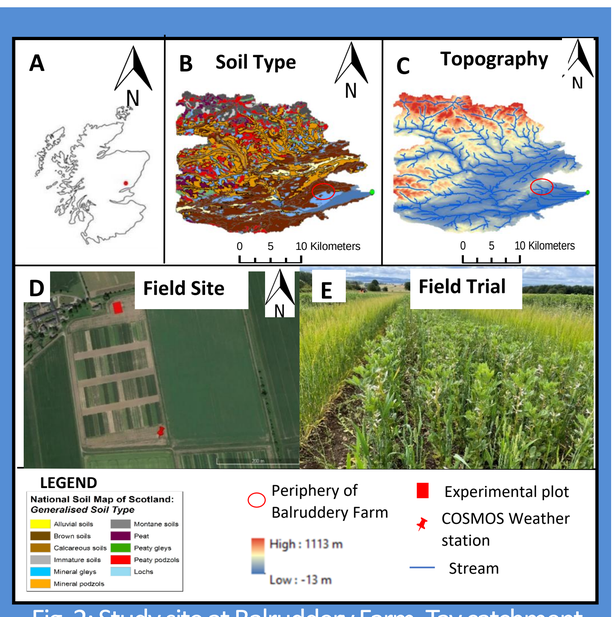

Fig. 2: Study site at Balruddery Farm, Tay catchment, Dundee, Scotland, UK

Table 1: Two contrasting barley varieties and one pea variety designed in 5 treatments.

S/N	Treatments	Shortened name
1	Barley (Laureate) monoculture	Barley1_mono
2	Barley (Sassy) monoculture	Barley2_mono
3	Pea (LG Stallion) monoculture	Pea_ mono
4	Laureate and LG Stallion	Barley1+ Pea
5	Sassy and LG Stallion	Barley2+Pea

Co-crops principles:

- Deep + shallow root traits
- Cereal + legume
- Mix ratio: 70 % - 30%

Results

- Barley co-crop maintained productivity despite 70% of seed rate.
- Laureate maintained 100% and 108% of monocrop yield in 2022 and 2023, respectively.
- Sassy had 94% and 100% of monocrop yield in 2022 and 2023, respectively (Fig. 3).
- Peas senesced before harvesting due to stress.
- Different responses of the barley genotypes were due to phenotypic plasticity in the absence of competition from the peas.

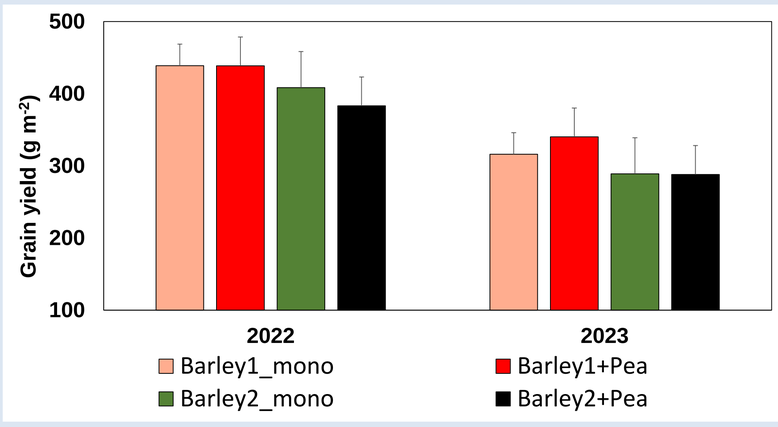

Fig. 3: Temporal variability of barley grain yields in the treatments. Sowing rate in co-cropping is 70% of monocultures.

- Co-cropping maintained soil carbon levels (Fig. 4).
- Soil carbon temporally corresponds to changes in bulk density in topsoil.
- Soil carbon unaffected temporally in the deep soil.

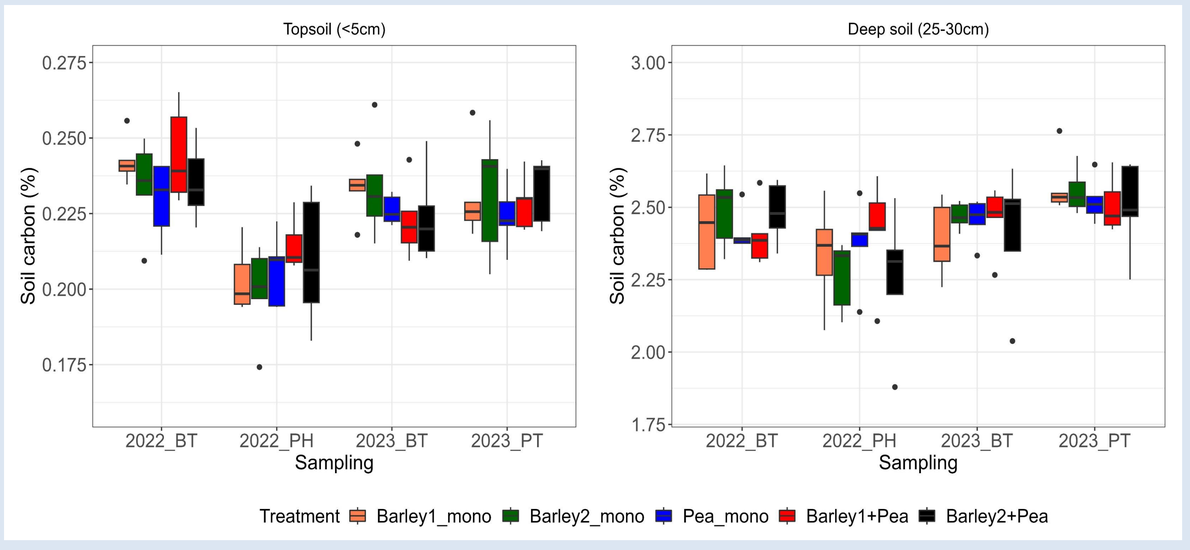

Fig. 4: Temporal variability of soil carbon (%) at topsoil (<5cm) and deep soil (25- 30cm); n = 10 for each treatment. BT= Before treatment; PH = Post harvest; PT = Post tillage.

Summary

- This study is among the first few studies to examine temporal variability of co-cropping productivity, and carbon cycling under natural conditions in a temperate climate.
- Co-cropped barley consistently maintained productivity and soil health.
- Co-cropping barley with legumes can provide insurance against complete crop failure for barley.
- Co-cropping is a viable practice of growing more food with limited water and land resources.

Future

- Modelling of carbon and water interlinkages in co-cropping systems under climate change.
- Develop a theoretical framework and engage with stakeholders.

References

1. Scottish Government (2023). Cereal and oilseed rape harvest report https://www.gov.scot/publications/cereal-oilseed-rape-harvest-2023-first-estimates/pages/key-findings/
2. FAO (2021). The State of the World's Land and Water Resources for Food and Agriculture (SOLAW) Report. https://www.fao.org/3/cb7654en/cb7654en.pdf
3. George, T. et. al. (2022). Harnessing Ecological Principles and Physiologic Mechanisms in Diversifying Agricultural Systems for Sustainability: Experience from Studies Deploying Nature-Based Solutions in Scotland https://journal.hep.com.cn/fase/EN/10.15302/J-FASE-2021437

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