Using stable water isotopes to trace cereal water use in agricultural co-cropping systems under contrasting hydro-climatological conditions

Oludare Durodola

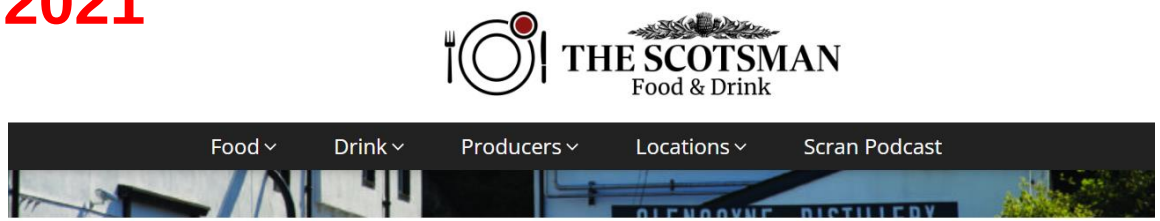
PhD in Geosciences

Supervisors: Youri Rothfuss, Cathy Hawes, Jo Smith, Tracy Valentine, and Josie Geris

Hydro Nation Scholars Programme

Background of the study

2021

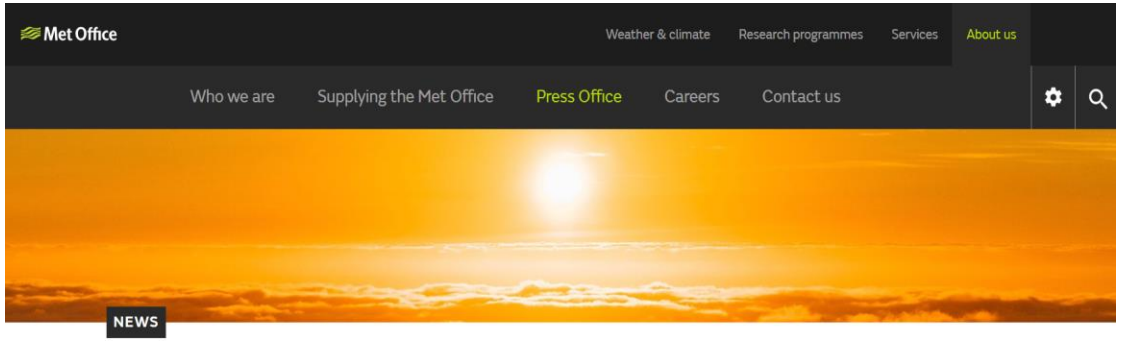


October 24, 2021

Barley and water shortages linked to climate change could limit future whisky production, new study finds

A new study shows the potential impact of climate change on the Scotch whisky industry.

2023



Climate change impacts June temperature records

Author: Press Office
14:00 (UTC+1) on Mon 3 Jul 2023

Introduction/Aims & objectives

Co-cropping systems benefits

- higher yields,
- increased land productivity,
- improved soil health and biodiversity.

Potential measure against drought by improving water use efficiency (FAO, 2022)

Aim: to determine water uptake patterns of different plant species in co-cropping and their respective monocultures.

Objectives are to:

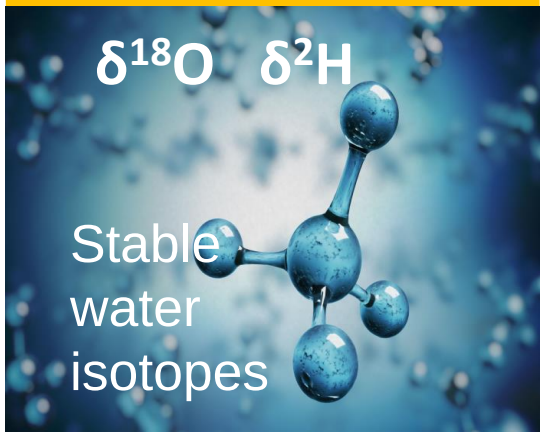
1. Examine the dynamics of precipitation.
2. Determine the sources of plant water uptake of monocultures.
3. Assess changes in co-cropping under contrasting environmental conditions.

Knowledge gaps

Water use patterns of co-cropping systems are largely unknown

What crop combinations can provide climate resilience?

Stable water isotopes not fully explored in temperate agroecosystems.



Study location and experimental design

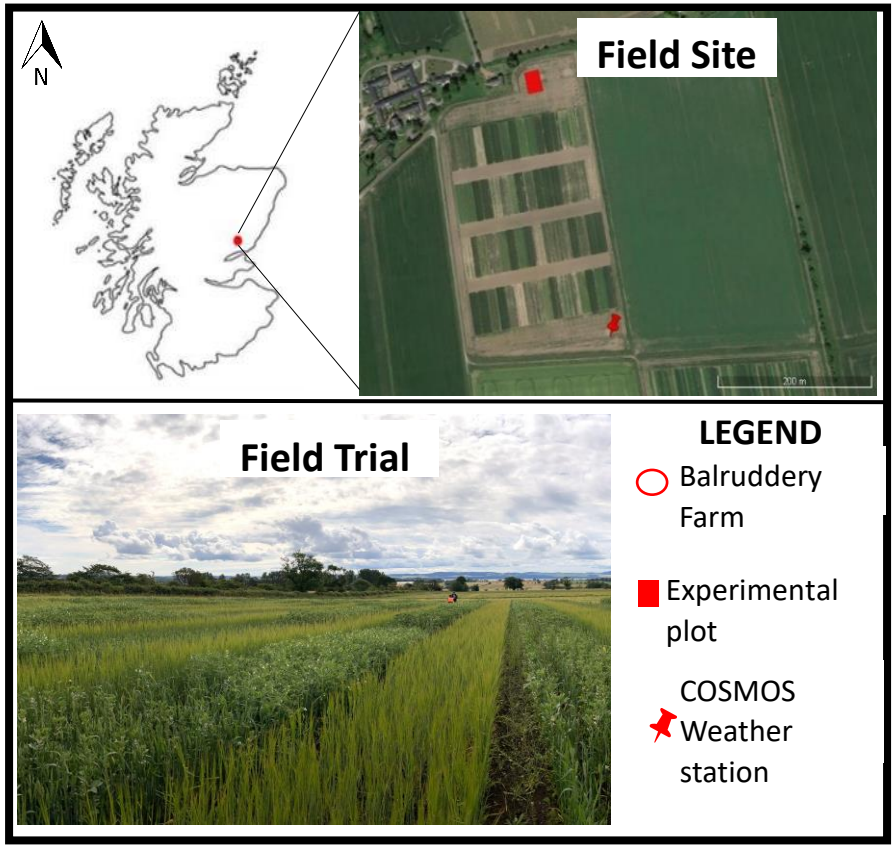


Figure 1: Study location within Scotland

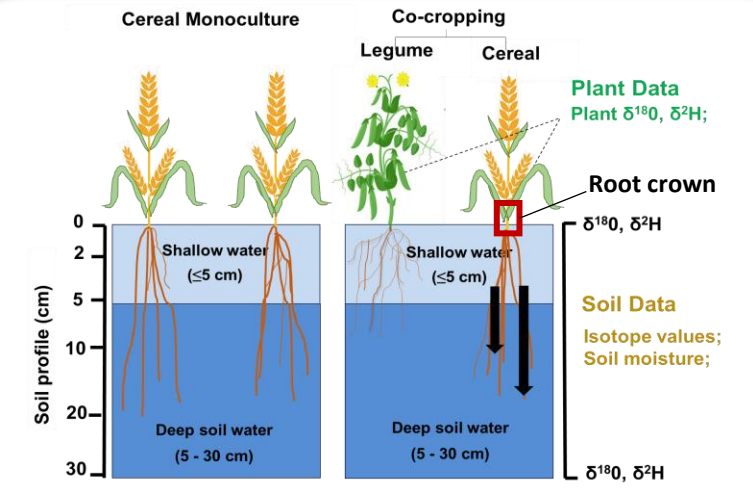
- Study in **2022 and 2023** at Balruddery Farm, Scotland, UK.
- Experimental design: **4** monocultures & **5** Co-crops:

Monocultures	Co-cropping
Barley (3 genotypes)	Barley and Pea (***B&P***) Barley and Bean (***B&F***)
Wheat (1 genotype)	Wheat and Faba bean (***W&F***) Wheat and Pea (***W&P***)

- 4 sampling campaigns
- 150 soil and 140 plant samples analysed

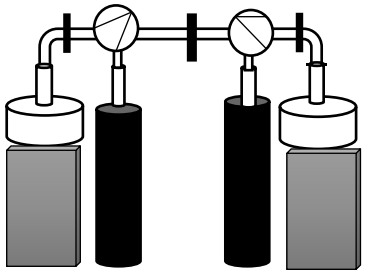
Methodology

Experiment



Stable Water Isotope Analysis

Cryogenic vacuum distillation



Temp >90 ℃
Efficiency >98%

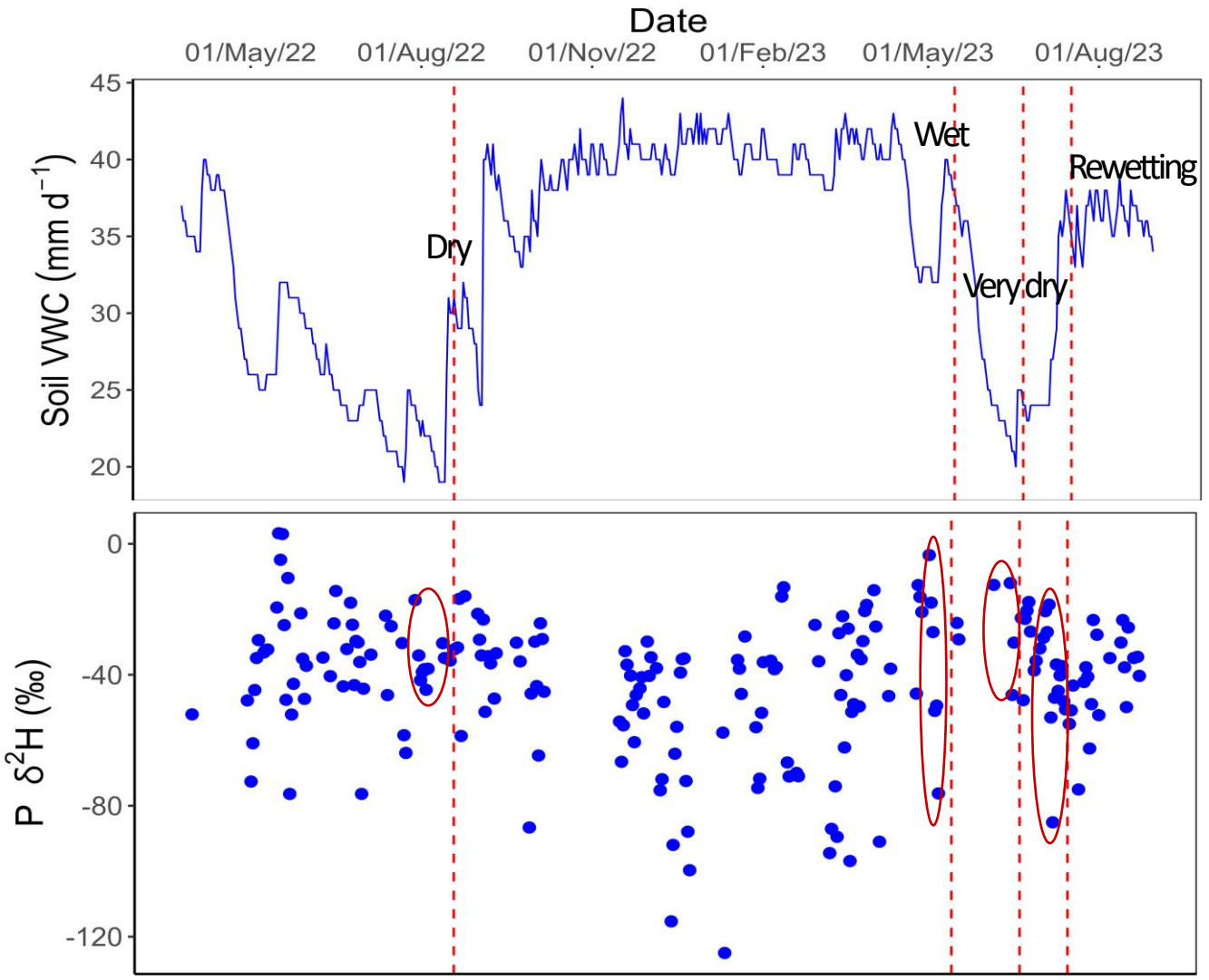
- Soil and plant: Picarro L2130-i laser spectroscope
- Precipitation: TWIA-45-EP (Los Gatos Research)

Modelling

MixSIAR Bayesian end-member mixing model framework

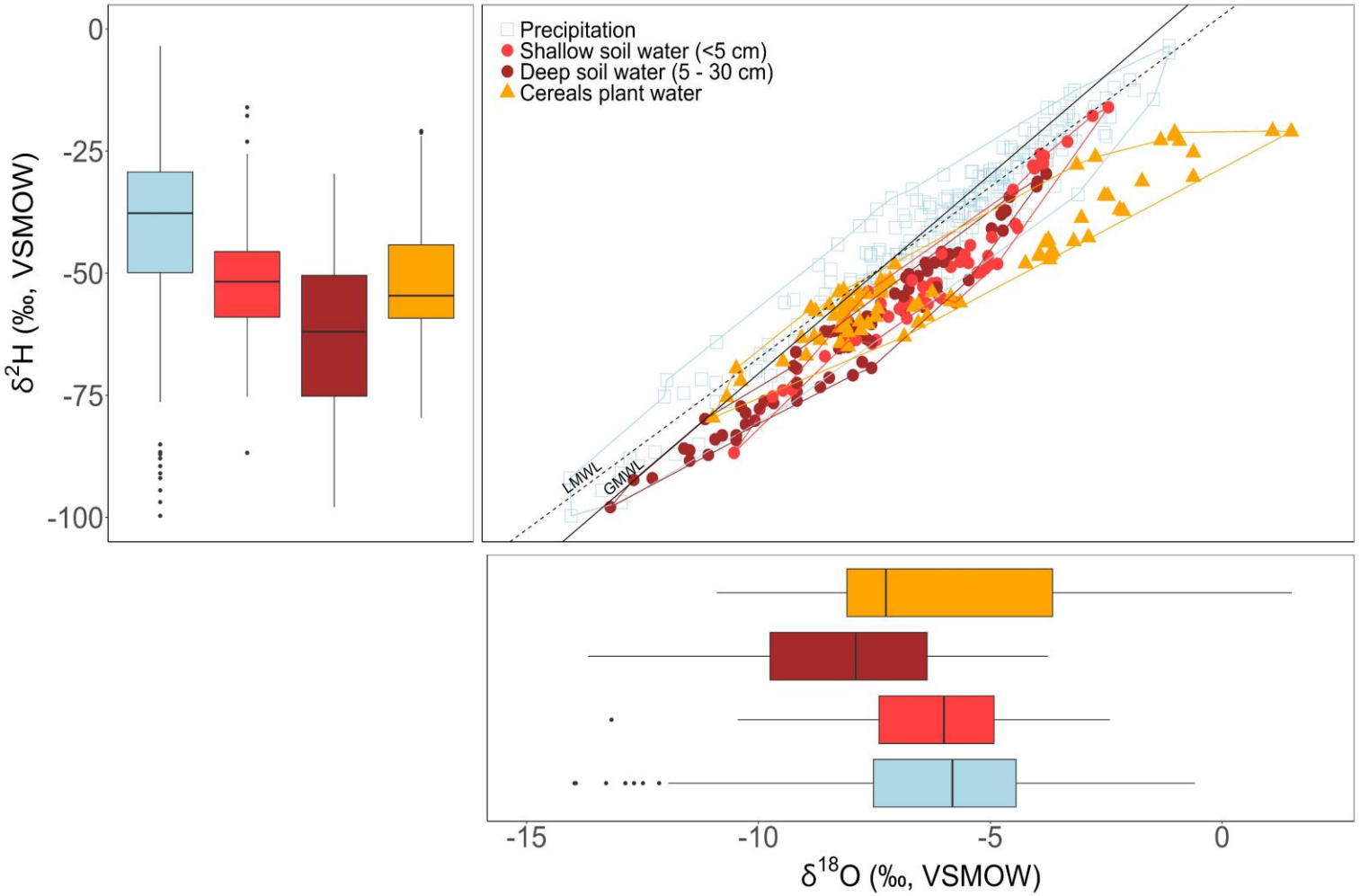
- Shallow soil water (<5 cm)
- Deep soil water (5 -30 cm)

Results: Environmental conditions



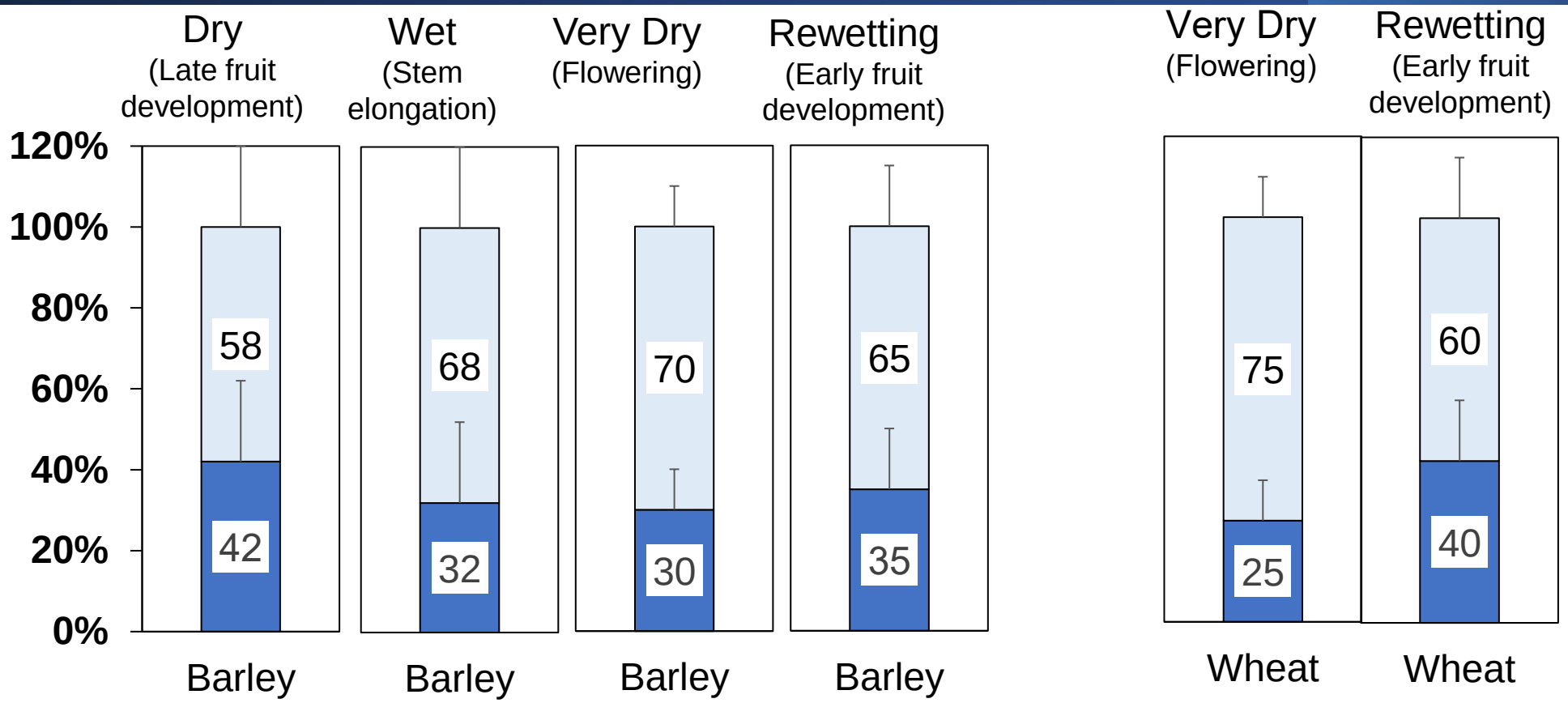
- Four (4) distinct hydro-climatological conditions.
- Water scarcity (low soil moisture content ~20%) prevailed in August 2022 and June 2023.
- Isotopic values of precipitation shows distinct environmental conditions.

Results: Isotopic composition of waters



- Cereal plant water, soil water and precipitation water overlapped.
- Cereal plant water depict mixtures of different soil water sources.
- Shallow soil water (<5 cm) distinct from deep soil water (5-30 cm).

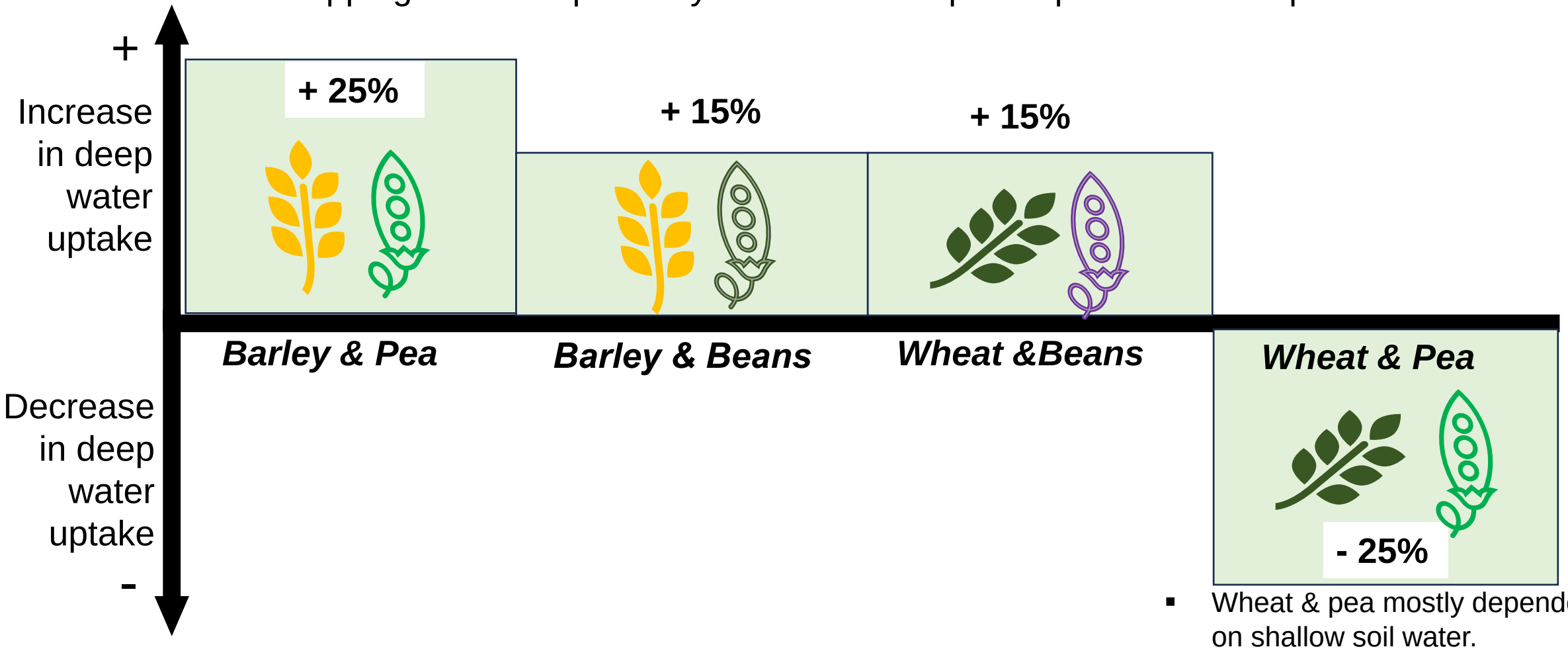
Results: Sources of water uptake in monocultures



- Cereals in all the monocultures mostly uptake > 60% water from the shallow soil layer.
- Differences based on hydro-climatological conditions and growth stages.

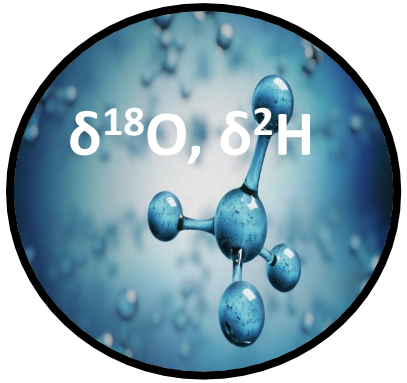
Results: Changes in water uptake in co-cropping

- Cereals in co-cropping exhibited plasticity and increased plant uptake from deep soil water



- Wheat & pea mostly dependent on shallow soil water.

Key take away messages



Successful study of water dynamics in Scottish agroecosystems using water isotopes.

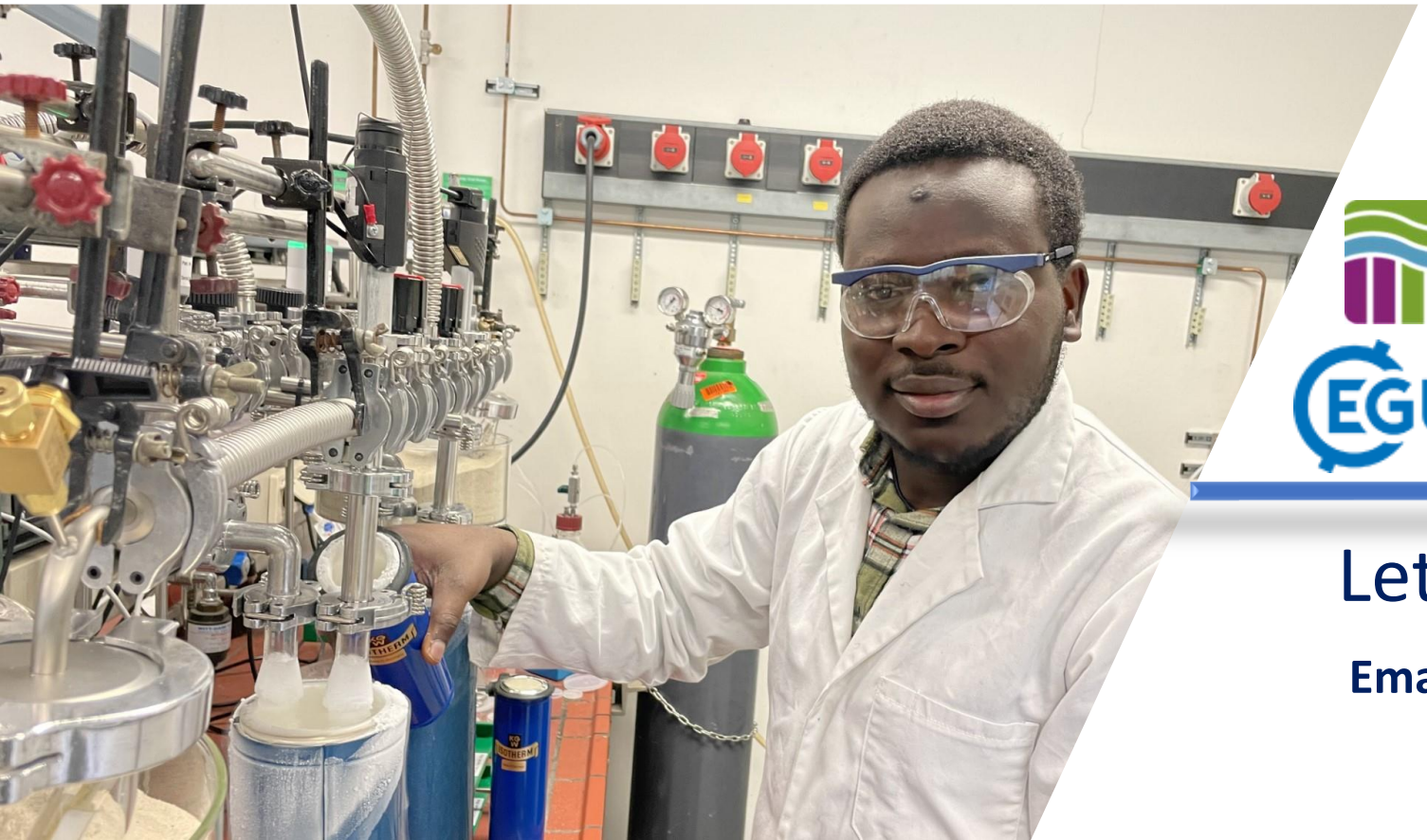
Cereal plants in Scotland **mostly use shallow soil water (≤ 5 cm depth)** during growth.

Co-cropping showed optimisation of soil water use during dry conditions.

Co-cropping could provide climate resilience for cereals and improve productivity.







Thank you

Let's connect please....

Email: o.durodola.21@abdn.ac.uk

Twitter: @DurodolaOludare