Transforming UK agriculture: modelling the impact of regenerative farming in Yorkshire under a changing climate

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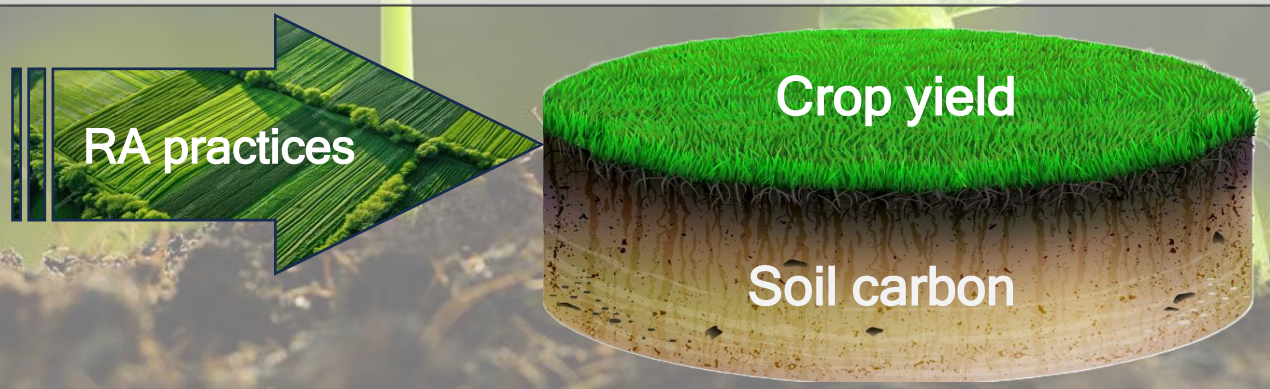
Aim

To model how individual and combined regenerative agricultural (RA) practices influence **long-term (30-year) crop yield and SOC accrual** under historical and future climates.



Methods

Used a **commercial farm** located at the University of Leeds, Tadcaster in North Yorkshire.

Adopted representative **clay loam soil** characteristics for the Tadcaster region.

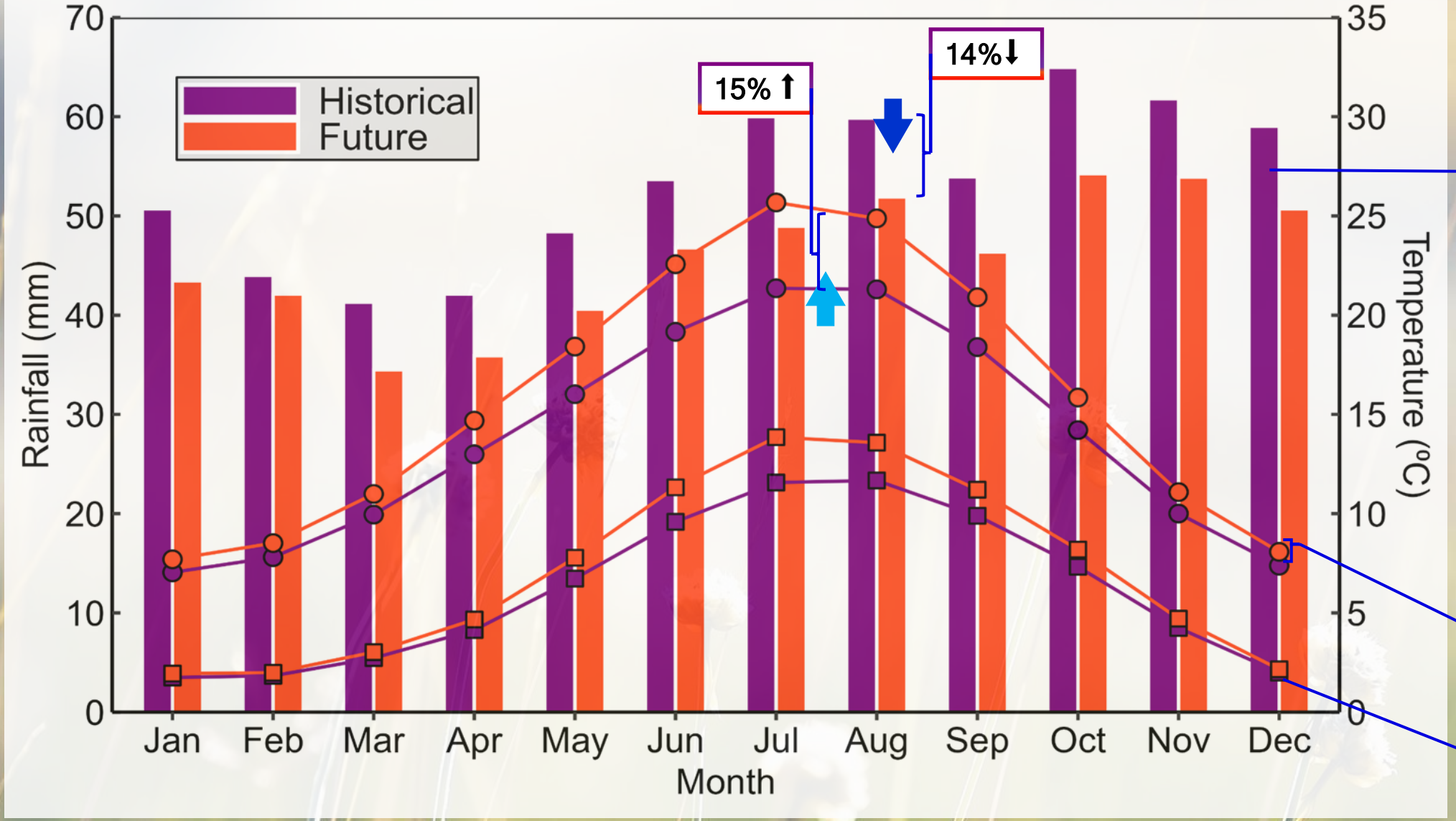
We compared **5 individual** and **3 combined** regenerative agriculture (RA) practices with ***Baseline*** rotations (winter and spring).

Individual RA practices included: (1) Crop diversity (2) Livestock integration (3) Reduced synthetic fertiliser use (4) Herbal leys and (5) Simple cover crop.

Combined RA scenarios comprised of (1) Ideal farming system (2) Most and (3) Least productive RA combinations.

Used **APSIM Next Gen** to simulate **crop yield** & **soil carbon stocks** using **30 years** of historical (1993-2023) and future (2030-2060) daily climate data.

Historical (1993-2023) and future (2030-2060) climates for the case study region



The Regenerative Agriculture (RA) strategies

Regenerative agriculture

RA Rotations

Baseline → wheat - barley - oilseed rape

Individual RA

1. Crop diversity → **Baseline** + Field beans

2. Simple cover crop → **Baseline** + White clover

3. Fertilizer reduction (10%) → **Baseline** + ⬇10%UreaN

4. Fertilizer reduction (30%) → **Baseline** + ⬇30%UreaN

5. Fertilizer reduction (50%) → **Baseline** + ⬇50%UreaN

6. Herbal leys → **Baseline** + Red clover - Pryegrass - Chicory

7. Integrate livestock → **Baseline** + Pryegrass-Lucerne-Silage-Merino ewes (35 kg)

Combined RA

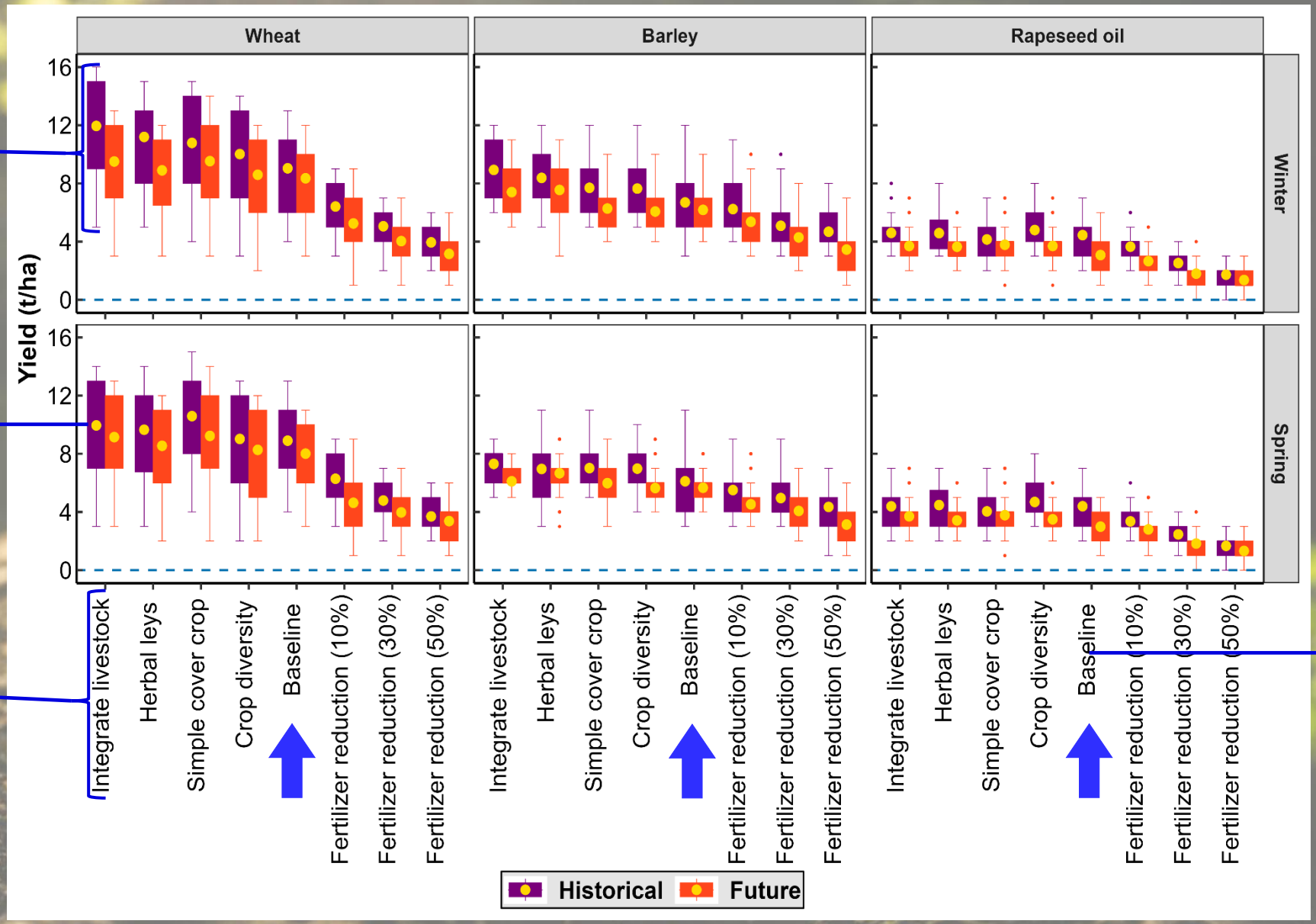
1. **Ideal farming system** → **Baseline** + Crop diversity + Simple cover crop + Herbal leys + livestock
2. **Most productive** → **Baseline** + Crop diversity + Herbal leys + merino ewes
3. **Least productive** → **Baseline** + Simple cover crop + ⬇50%Fertilizer

Results – Predicted impact of individual regenerative agriculture practices on crop yield

Longterm yield

Average yield

Individual RA practices



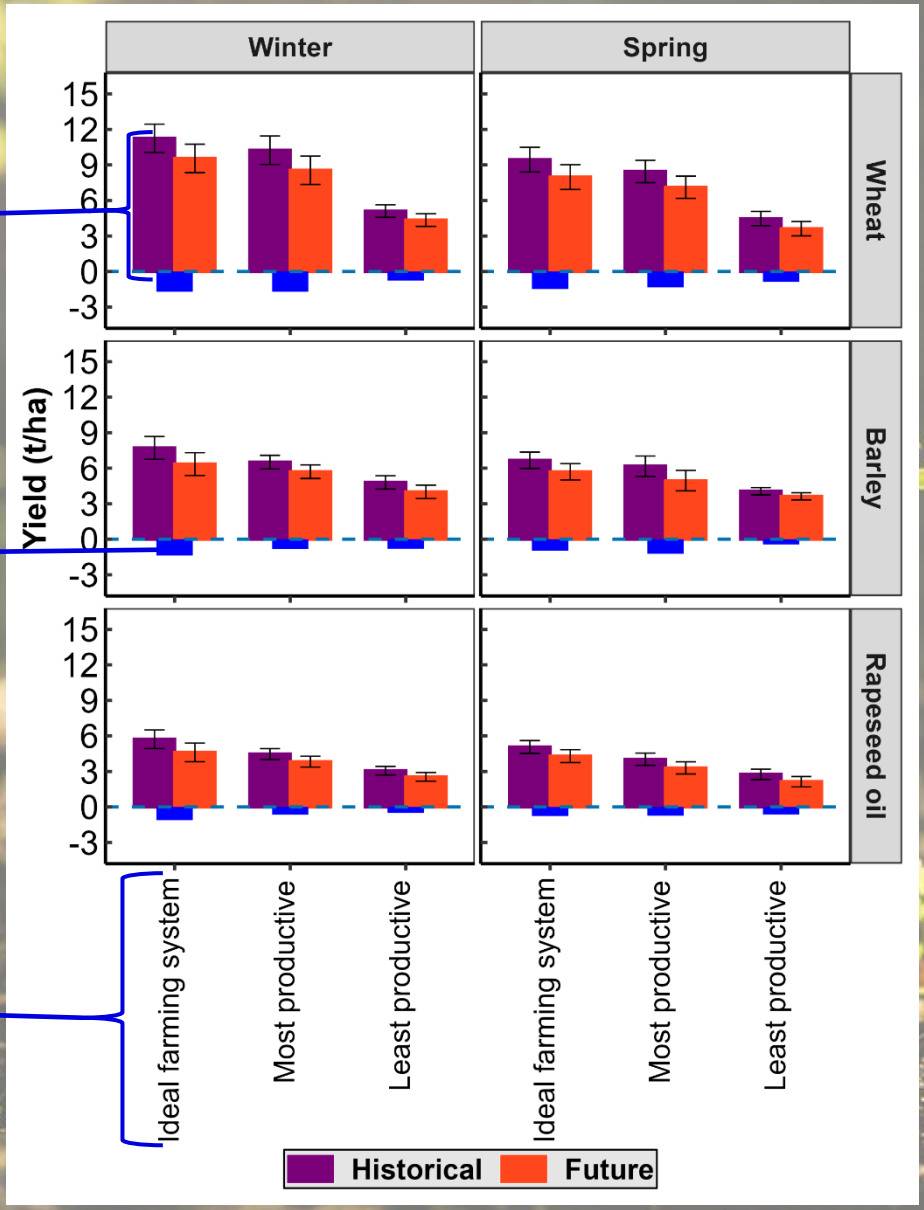
Baseline rotation (wheat-barley-oilseed rape)

Results – Predicted impact of combined regenerative agriculture practices on crop yield

Average crop yield

Yield loss due to climate change

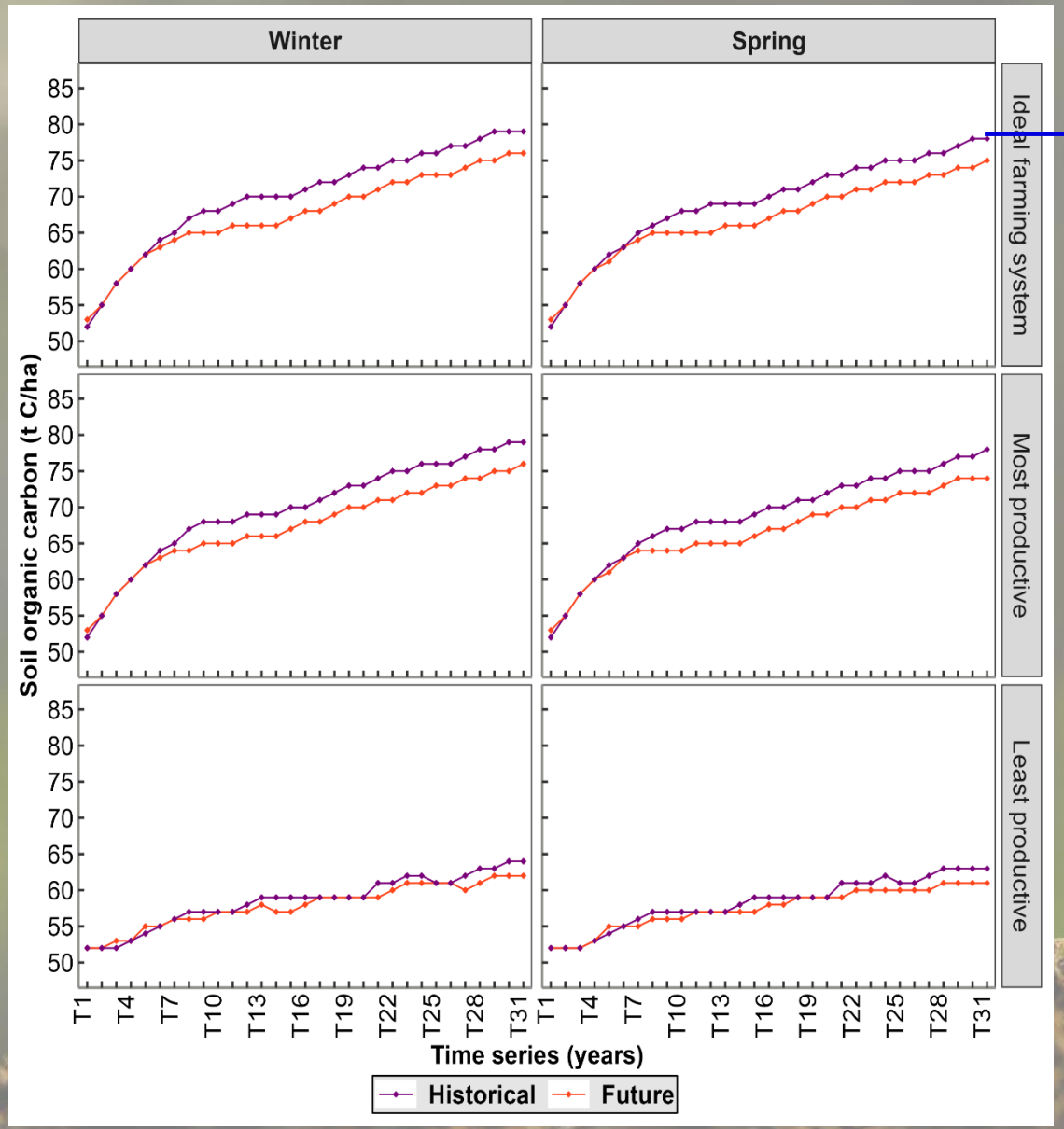
Combined RA practices



Results – Crop Productivity

- **Global warming** reduced crop yields by ~15% across regenerative strategies and cropping seasons.
- **Winter rotations** produced slightly higher yields than spring rotations.
- **Ideal farming system** combining high-performance RA practices had the highest yields relative to *baseline* across climates and rotations.
- Reductions in **synthetic fertiliser inputs** resulted in pronounced declines in crop productivity across RA systems and climates.

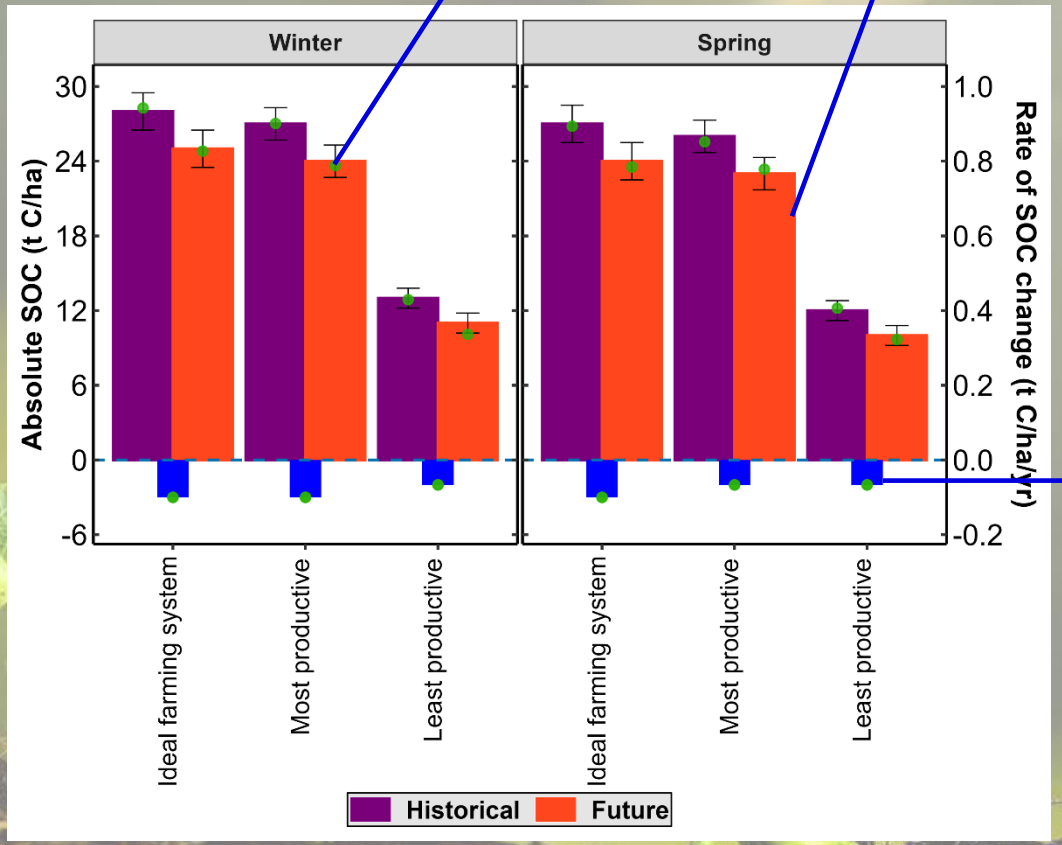
Results – Predicted effects of Combined RA practices and Climate on SOC Storage



SOC accrual

Rate of SOC change

Absolute SOC



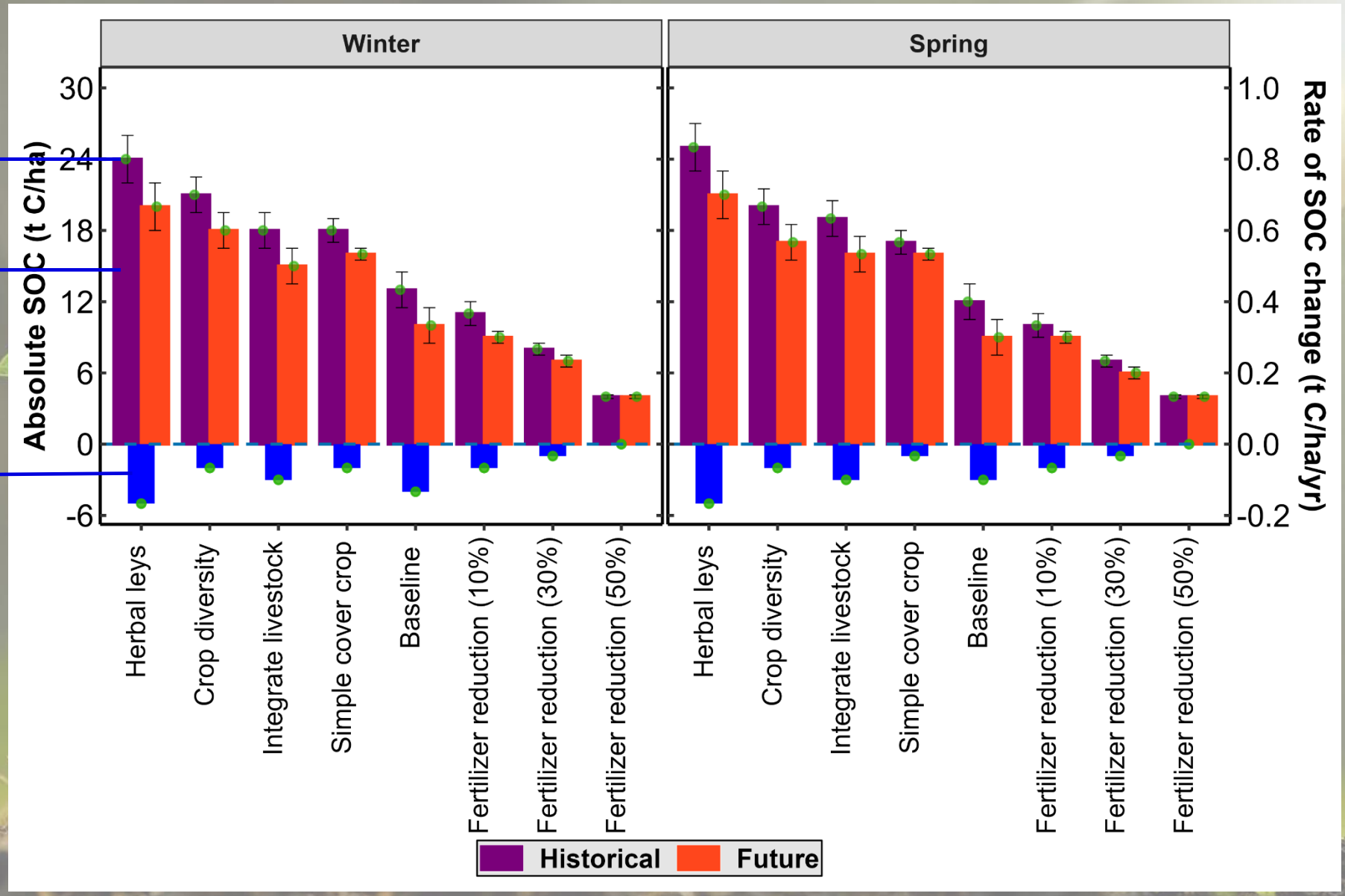
SOC loss

Results – Predicted effects of Individual RA practices and Climate on SOC storage

Rate of SOC change

Absolute SOC

SOC loss

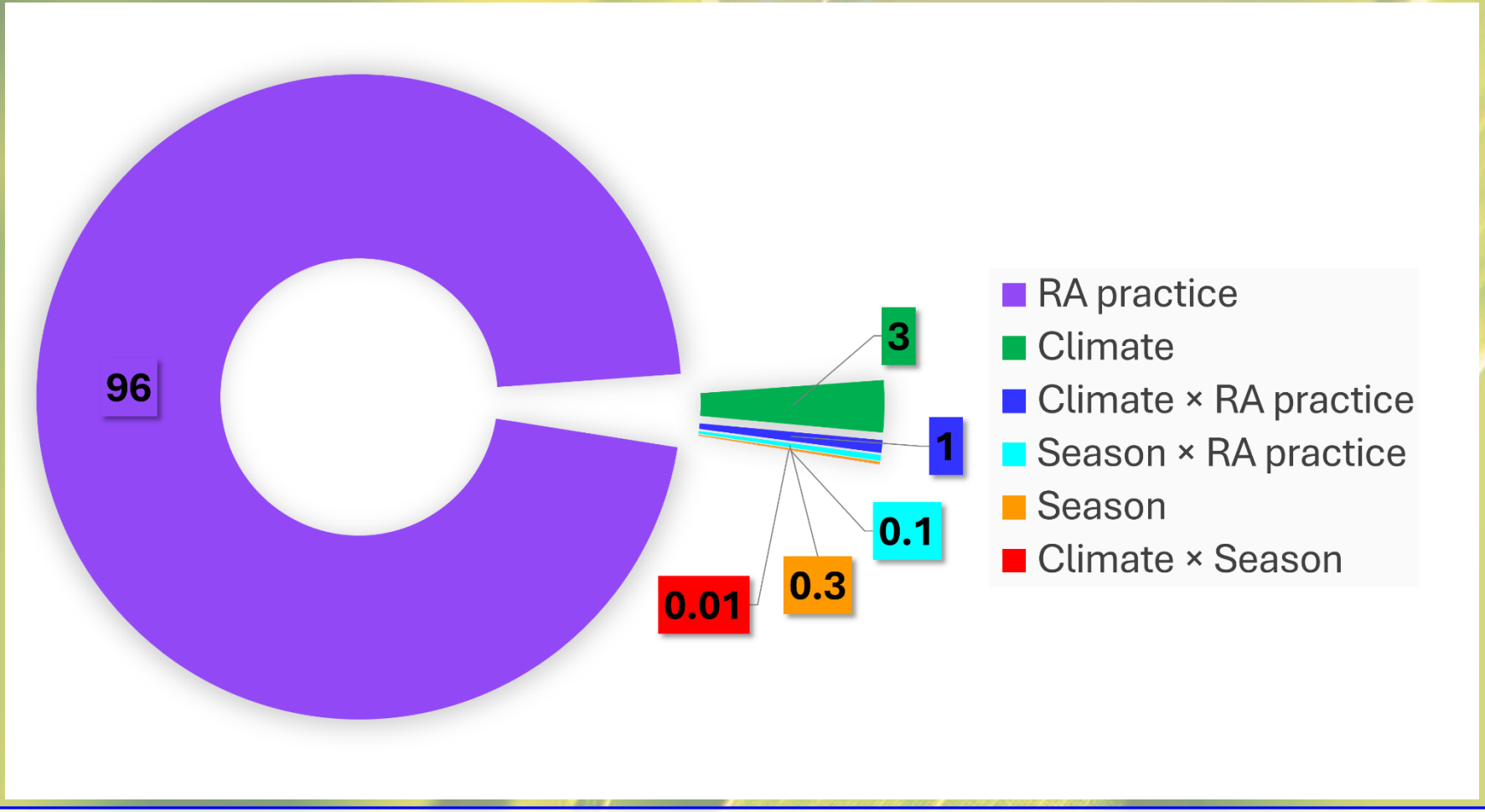


Results – Soil organic carbon responses

1. **Ideal farming system** incorporating resilient RA practices (e.g., herbal leys and crop diversity) were most conducive for SOC accrual (28 tC/ha) while sustaining productivity across climates and seasons.

2. **Future climates** reduced SOC accumulation by approx.10-20% across RA systems and cropping seasons.

Relative impact of RA practice, Climate and Season on yield and SOC



- Yield and SOC were strongly governed by RA practice (96%) in comparison to climate (3%) and season (<1%).

Summary: Keynotes

1. **High performing RA practices were predicted** to produce strong yield and SOC synergies when implemented in combination.

2. **Climate change** reduce both crop productivity and SOC accumulation, highlighting need for innovative climate adaptation strategies.

3. RA management decisions exert a **stronger influence** **(96%)** on system outcomes relative to climate variability **(3%)**.

4. **Implication:** RA practices alone cannot offset impacts of climate change and must be supported by other interventions.

Thank you!

Any Questions?

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