ClimatePig: Smart Systems Approaches for Climate Resilient Livestock Production

Prof Lisa Collins

2nd December 2020

UK CLIMATE RESILIENCE PROGRAMME

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Introduction

- Summary of project
- Detailed analysis of each WP
- Outputs and results
- Conclusion & Key Messages
- Stakeholder Response

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Introduction

Resilient, sustainable livestock production is a major gap in the future food system.

In the UK, outdoor pig production represents 40% of the breeding herd, but production efficiency and environmental impact are particularly vulnerable to changing climate and extreme weather events.

Aim: To provide critical improvements to on-farm climate services and technology integration and enable important first steps to be taken towards ensuring future outdoor pig production is sustainable and resilient to climate variability and change.

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New ways of working

- Brought together a multi- and inter-disciplinary UK climate resilience group
  - Climate science
  - Statistics
  - Modelling
  - Soil science
  - Animal science
  - Computer science/artificial intelligence
- Project designed from the outset with end-users.
- Results discussed with wider group of stakeholders

What are the barriers to strengthening our understanding of weather-associated risks?

What are the drivers for behaviour change?

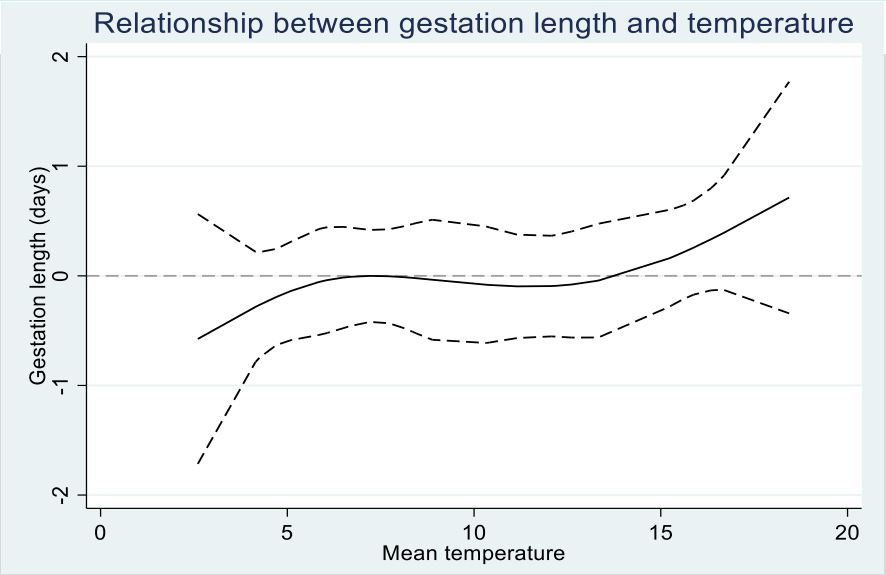
What are the implications for communication and decision-making?

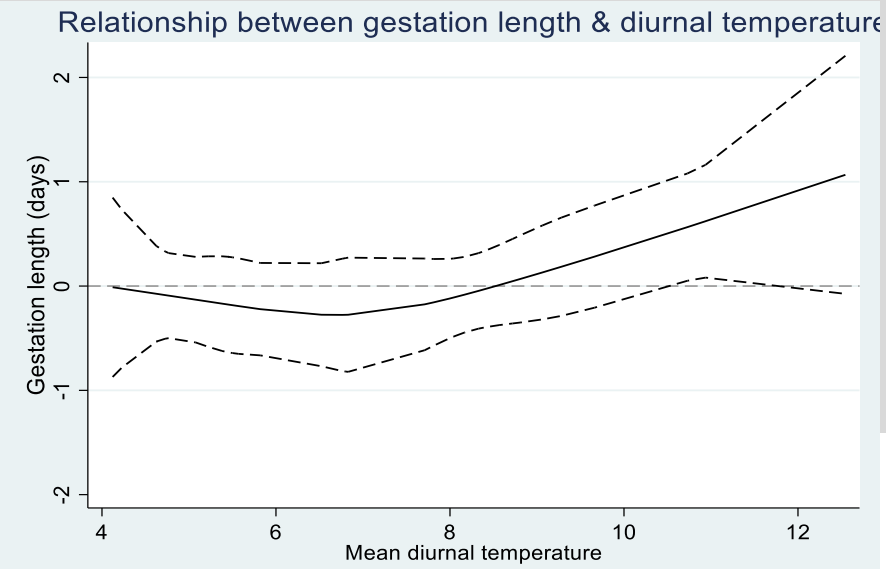
WP1: Analysis of climate and production data

Objective: To characterise and quantify short-term associations between climate factors and production performance variables

Shakoor Hajat, HyunJu Lee

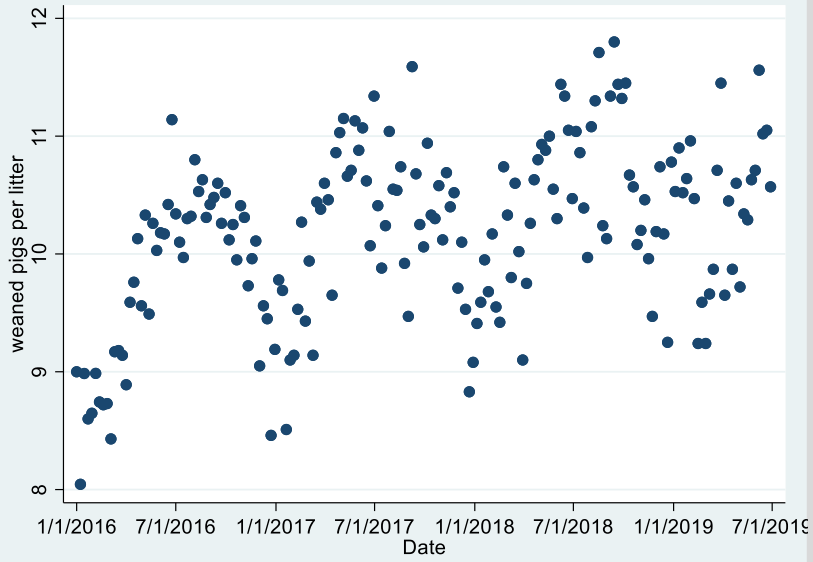
WP1 - Analysis of climate and production data



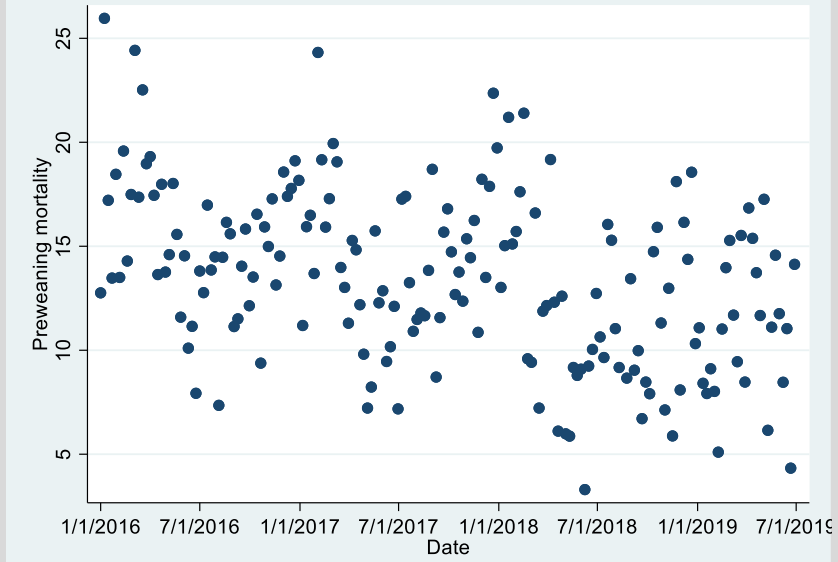


- University of Leeds farm production data (July 2016-May 2019)
- Linkage of ambient weather variables to farrow date
- Analysis at monthly level
- Little relationship between gestation time and mean temperature, diurnal temperature other temperature metrics
- No relationship between gestation length and rainfall
- No relationship between death rates and temperature or rainfall

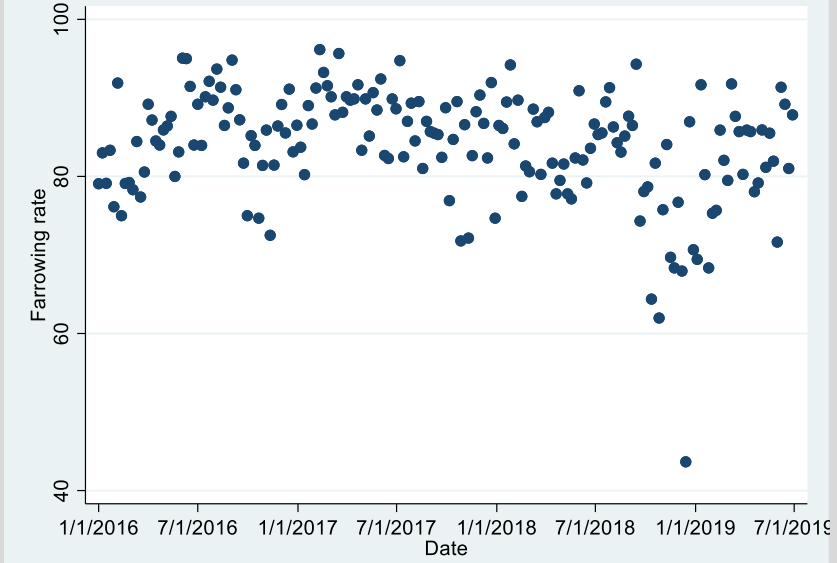
WP1 - Karro data: Seasonality in some outcomes (Results for Karro Farm B 2016-19)



Average no. piglets weaned per litter



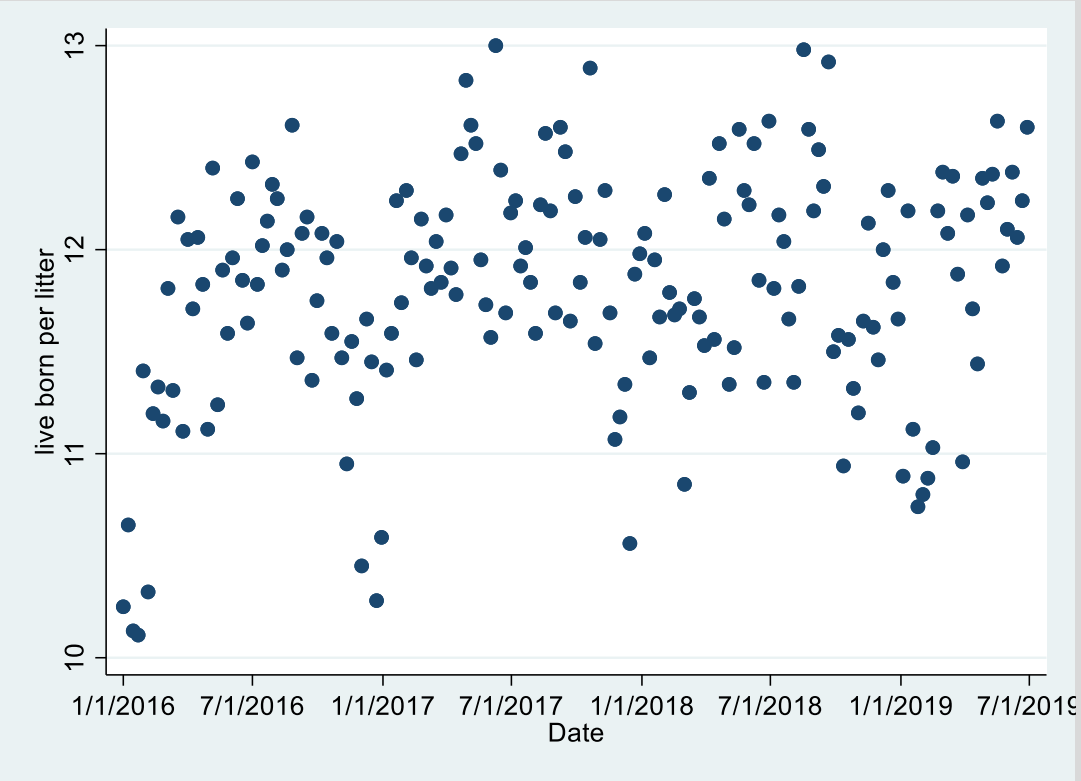
Percentage piglet preweaning mortality

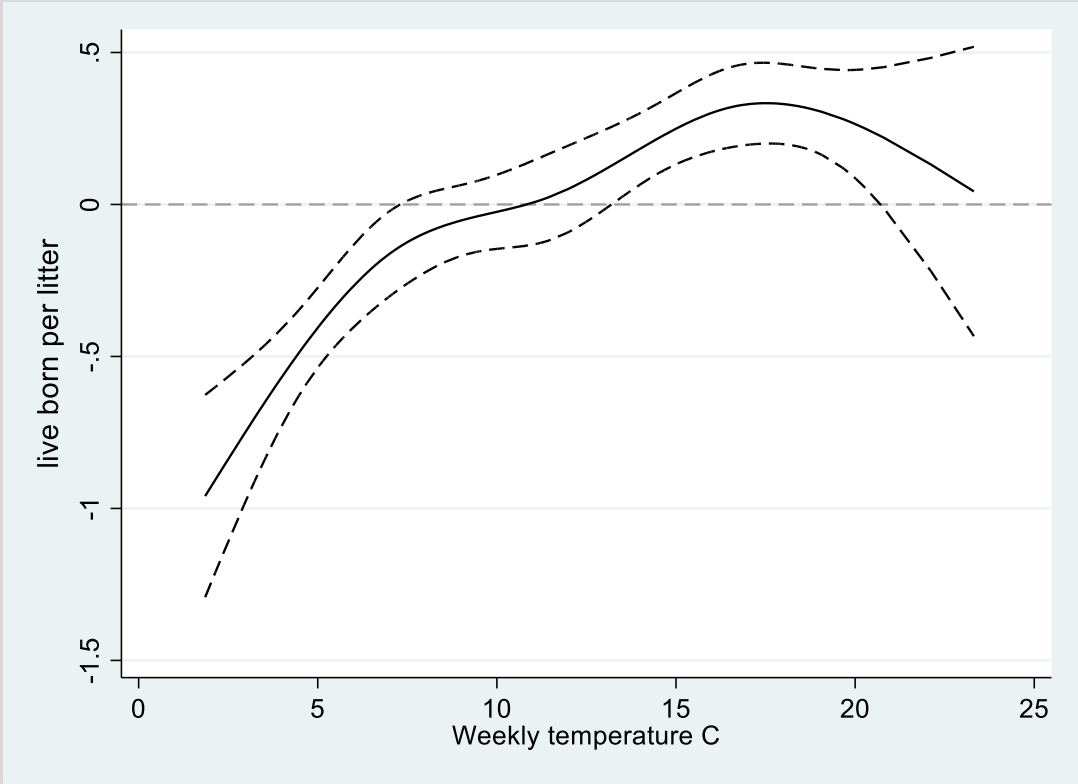


Percentage of sows farrowed

WP1 - Average number born alive per litter (Results for Karro Farm B 2016-19)

- Seasonality not present in all farms
- Temperature signal not present in most locations





Additional 0.041 (95% CI 0.009, 0.073) liveborns per 1°C increase in temp (p=0.01)

WP2: Dietary adaptation strategies to alleviate heat stress in sows

Objective: Conduct a preliminary field assessment of risk-informed adaptation options for diet to reduce environmental impact and increase climate resilience.

Katie McDermott, Steven Laird, George Sorensen, Helen Miller, Pippa Chapman

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WP2: Experimental design

Four experimental diets:

- Control (standard P, standard E)
- High Protein (high P, standard E)
- High Energy (standard P, high E)
- High Protein & Energy (high P, high E)

- Diets fed to 187 lactating gilts and sows over seven experimental batches.
- Farrowed April - August 2019
- Litter performance, faecal nutrient output and soil nutrient content examined

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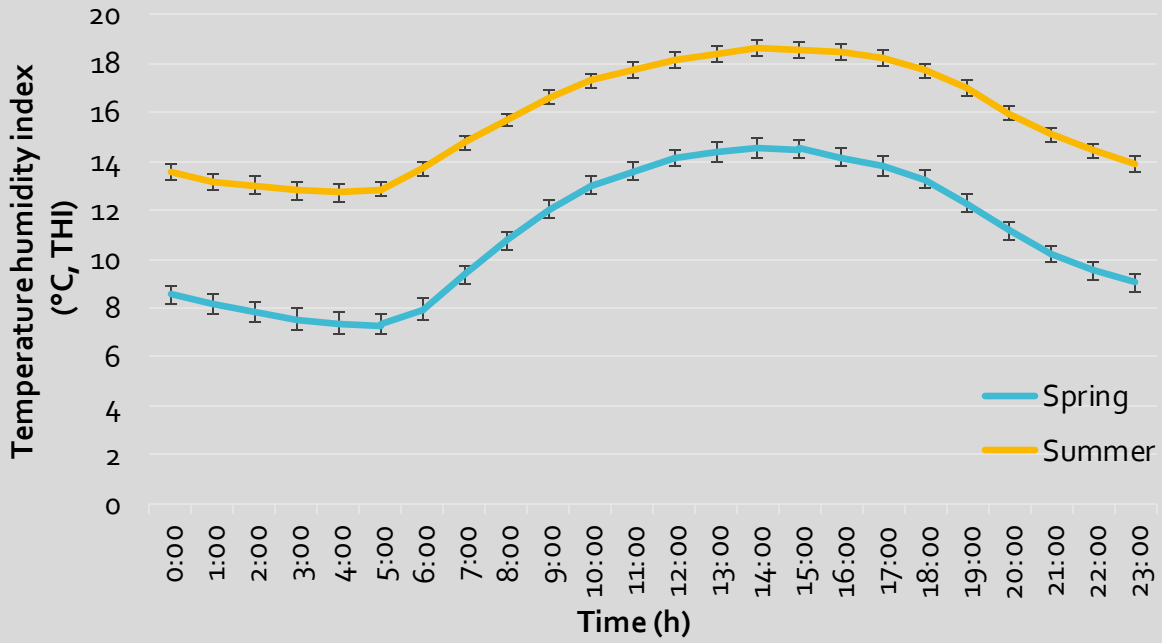
WP2 - Can diet mitigate against heat stress?

- Previous work in Yorkshire identified a critical upper limit of 20°C for Temperature Humidity Index (THI)[1] for outdoor breeding pigs[2]

Number of days over critical THI value in spring and summer 2019

	Days with THI over 20°C
Spring	0/73 (0%)
Summer	24/71 (34%; range 1-16h)

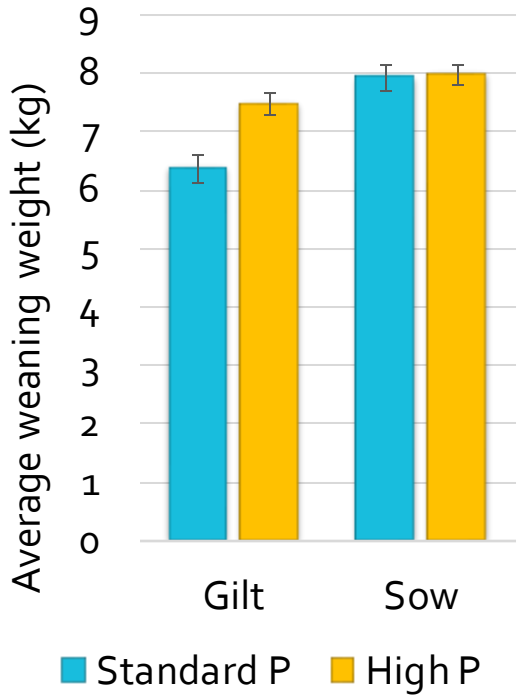


A typical 24 hour THI profile for spring and summer 2019

[1]Temperature humidity index = T-(0.55 – (0.0055*RH))*(T-14.5) where T = temperature (°C) and RH = relative humidity (%)

[2] LeMoine, A. 2013, Meteorological effects on seasonal infertility in pigs, PhD thesis, University of Leeds

WP2 - Litter performance, faecal output & effect on soil nutrient content



Average weaning weight of piglets in summer

- Overall performance better in spring than summer though no difference in feed intake
- Sows unaffected by diet
- In summer there may be a beneficial effect of protein supplementation to gilts
  - Improved litter growth (+43 g/d) & weaning weights (+ ~1kg) compared with standard P
- However, gilts on high P lost more condition and body fat *vs* standard P
  - Potential impact on later pregnancies and sow health?
- Animals on a high protein diet excreted more N in faecal matter
  - Potential environmental impact

Soil sampled Apr & Sep '19	Olsen P (mg/kg)	NO_3 (mg/L)	Available N (mg/L)
Normal	63.68	47.6	40.28
High P	42.58	26.8	19.81
High E	44.36	32.6	14.42
High P & E	55.44	46.2	32.24

- Olsen P and Available N (NH_4+NO_3) in soil increased in all treatments over time but no significant difference between diet treatments
- Could not link soil nutrient content to changes observed in N content of faecal material

WP3: Precision tools with Earth observation to track risks linked to weather

Objective: Develop precision tools combined with Earth Observation, machine learning and data analytics, to track the evolution of risk in outdoor pig production units, associated with weather and diet

Daniel Gilson, Lisa Collins, Jason Burgon, Lei Zhang, Nigel Allinson

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WP3 - Drone-mounted cameras

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WP3 - Object Tracking

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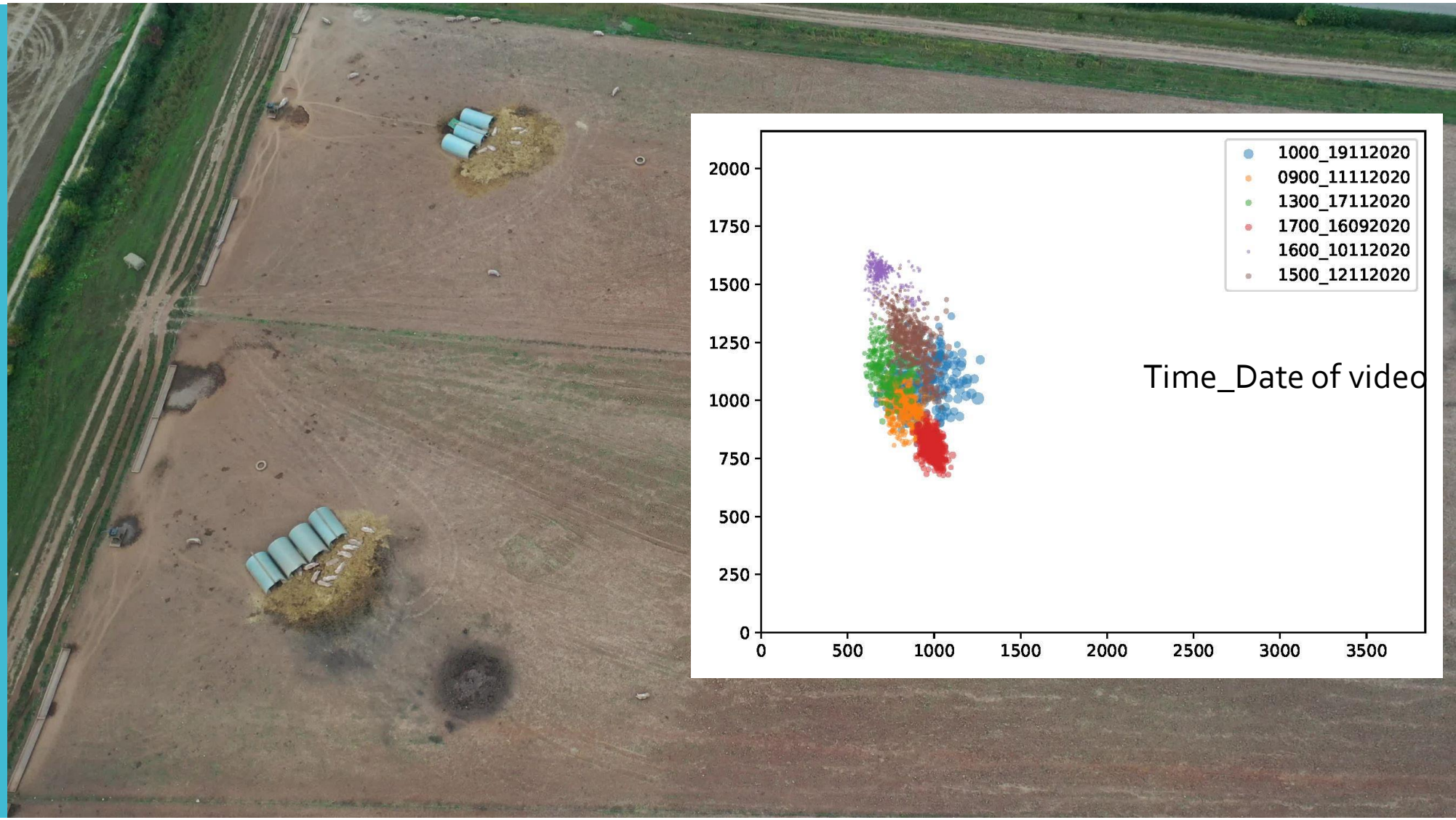
WP3 - Object Tracking



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WP3 - Applications

- System can track small objects continuously and using known locations can help to identify unnatural habits like not eating or drinking, or aid in security and disease control

- Using CCTV cameras mounted to poles would allow continuous tracking, as opposed to short flights with drones

- Can provide information on land usage:
  - Currently finalising analyses on soil roughness data to give accurate information on the health of the field.
  - Aid in determining grazing lengths and rotation schedules to avoid irreparable damage to fields.

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WP4: Measuring and modelling the impact of outdoor pigs on soil carbon and nutrient dynamics under a changing climate

Objective:

- Quantify the impact of outdoor pigs on soil properties
- Model the impact of management and climate change and on soil organic carbon and nitrogen using the DayCent model (Del Grosso et al., 2008)

Marcelo Galdos, Ishwar Pun, Pippa Chapman, Steve Dobbie, Steve Banwart, Lisa Collins

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WP4: Methods

- Sampled soil annually (three times) and analysed for a range of physical and chemical properties

- To model impact of outdoor pigs on soil organic carbon and nitrogen we used:
  - historical crop records (yield & fertiliser application rates)
  - future climate projection data (UKCP18 RCP 8.5)

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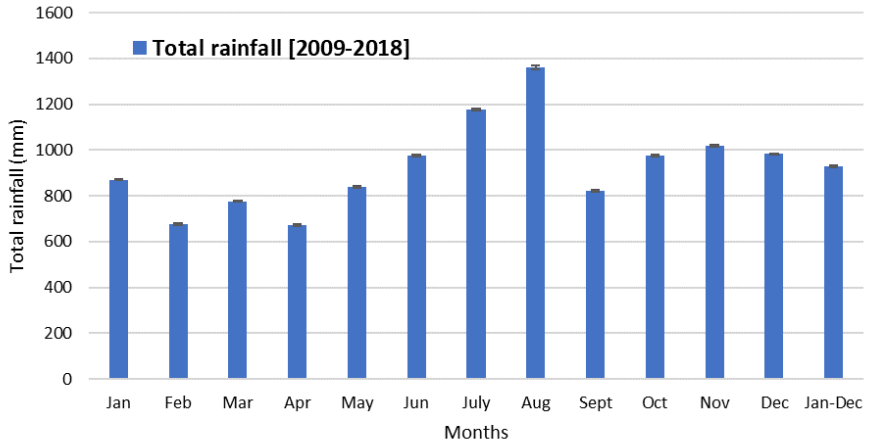
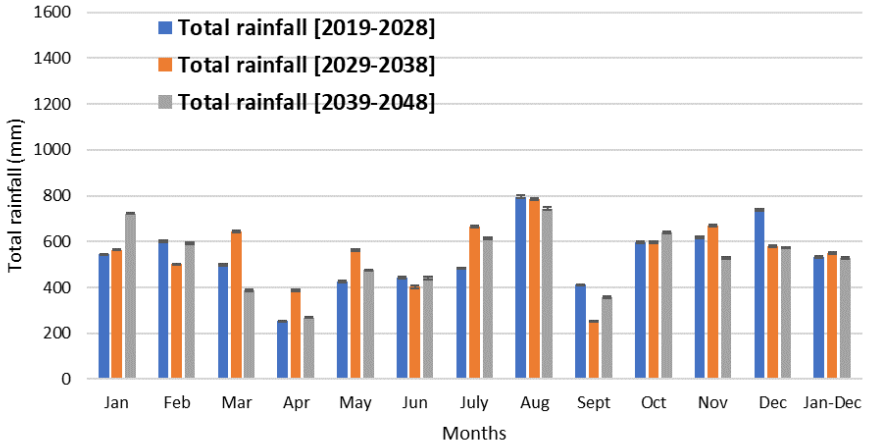
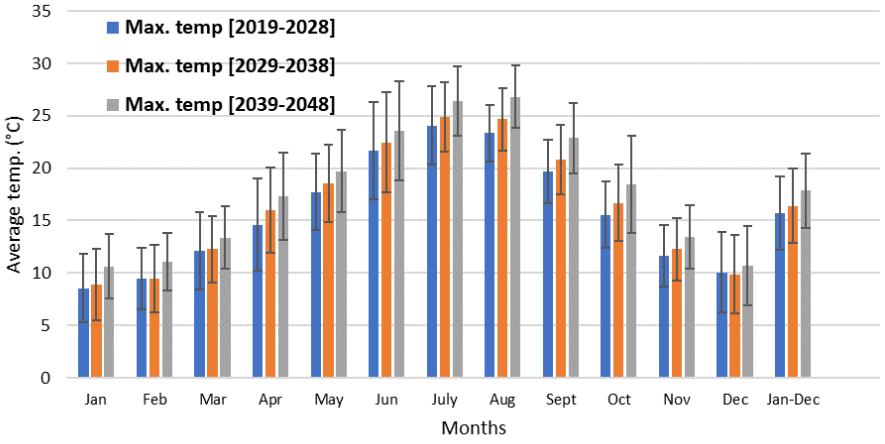
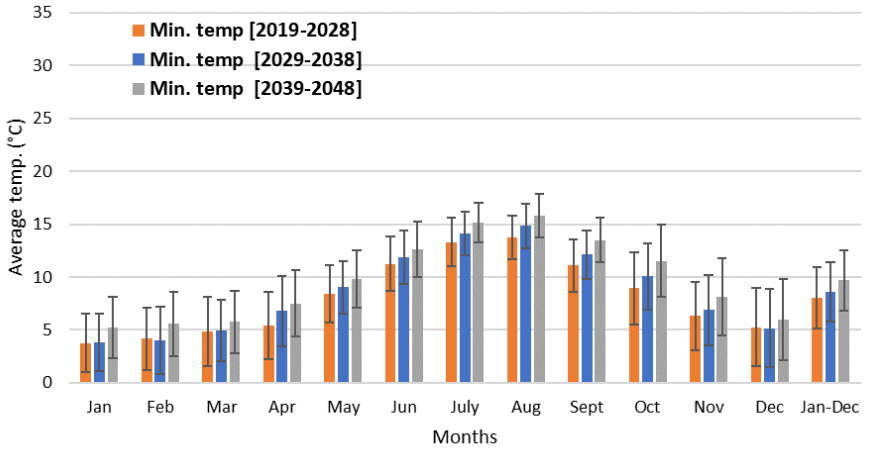
WP4 - Weather and Climate data (RCP 8.5)









- Average temperature will increase
- Rainfall will decrease

Source: weather data (Bramham station, Met Office 2012); climate data (UKCP18)

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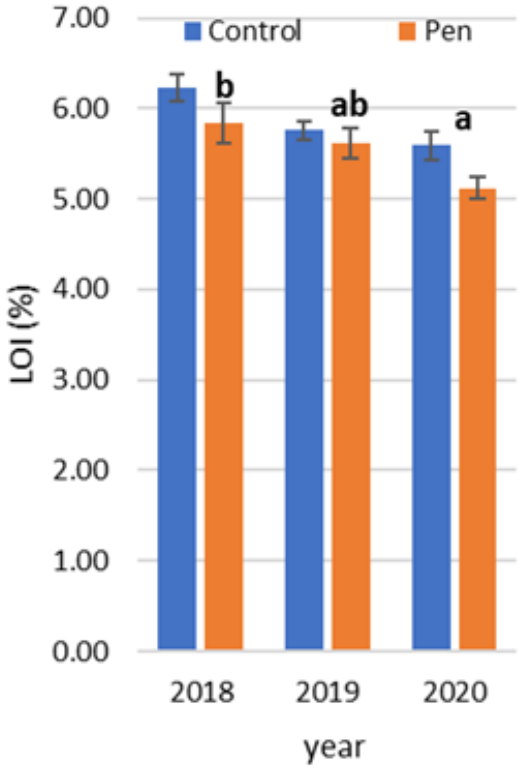
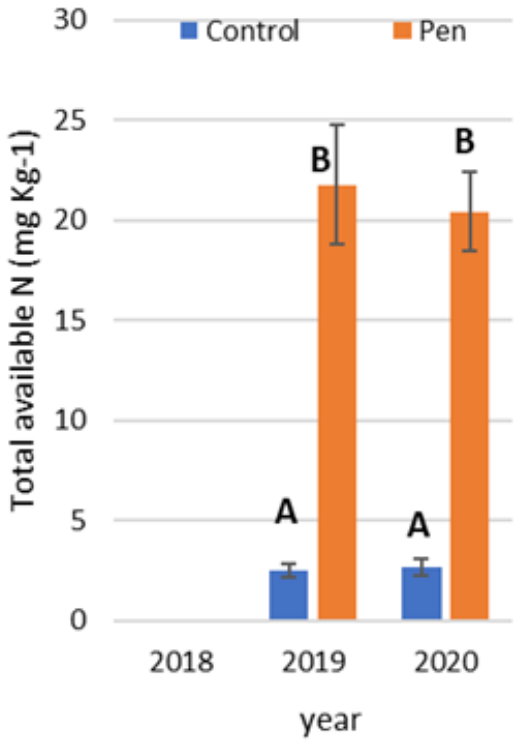
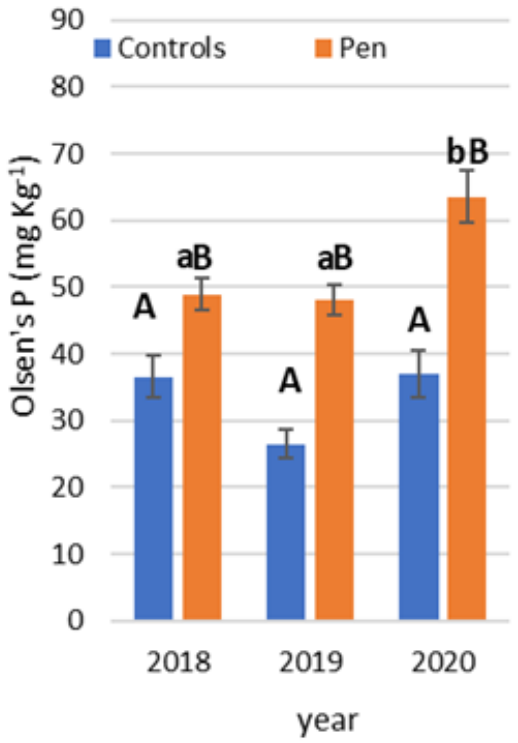
WP4 - Soil data: Physio-chemical properties







- Significant decline in soil organic matter over time in pig pens only (% loss on ignition -LOI)
- Available nitrogen significantly higher in pig pens than control
- Phosphorus significantly higher in pig pens than control and increased over time

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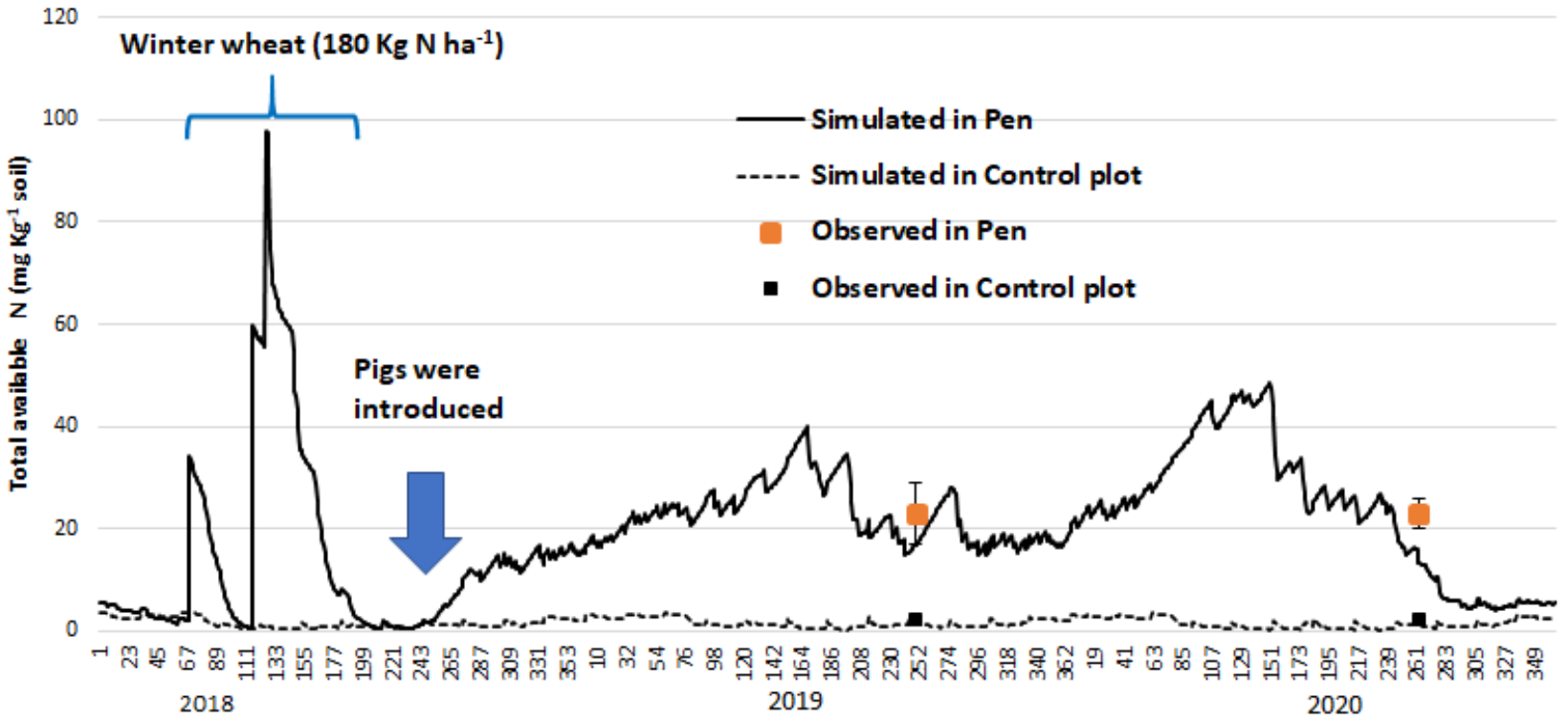
WP4 - Model validation: Soil available nitrogen (NH_4+NO_3)



- N accumulates during summer months from pig urine and faeces, and declines in autumn/winter as soil gets wetter

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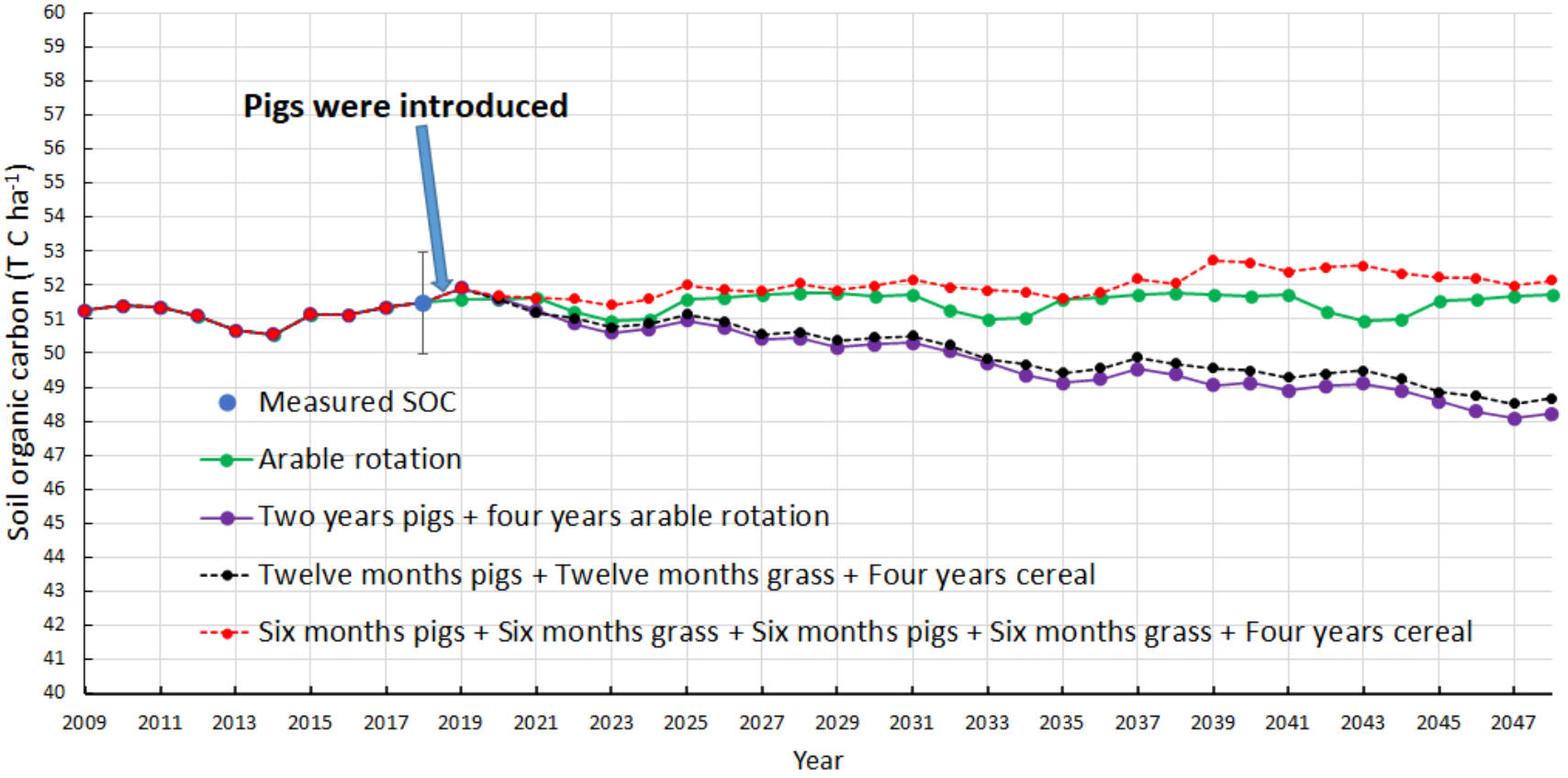
WP4 - Soil organic carbon stock with future climate data



- Pig/arable rotation w/ current management leads to a decline in SOC stocks
- Reducing length of time pigs are on field and intercalating with other land uses can potentially mitigate those losses

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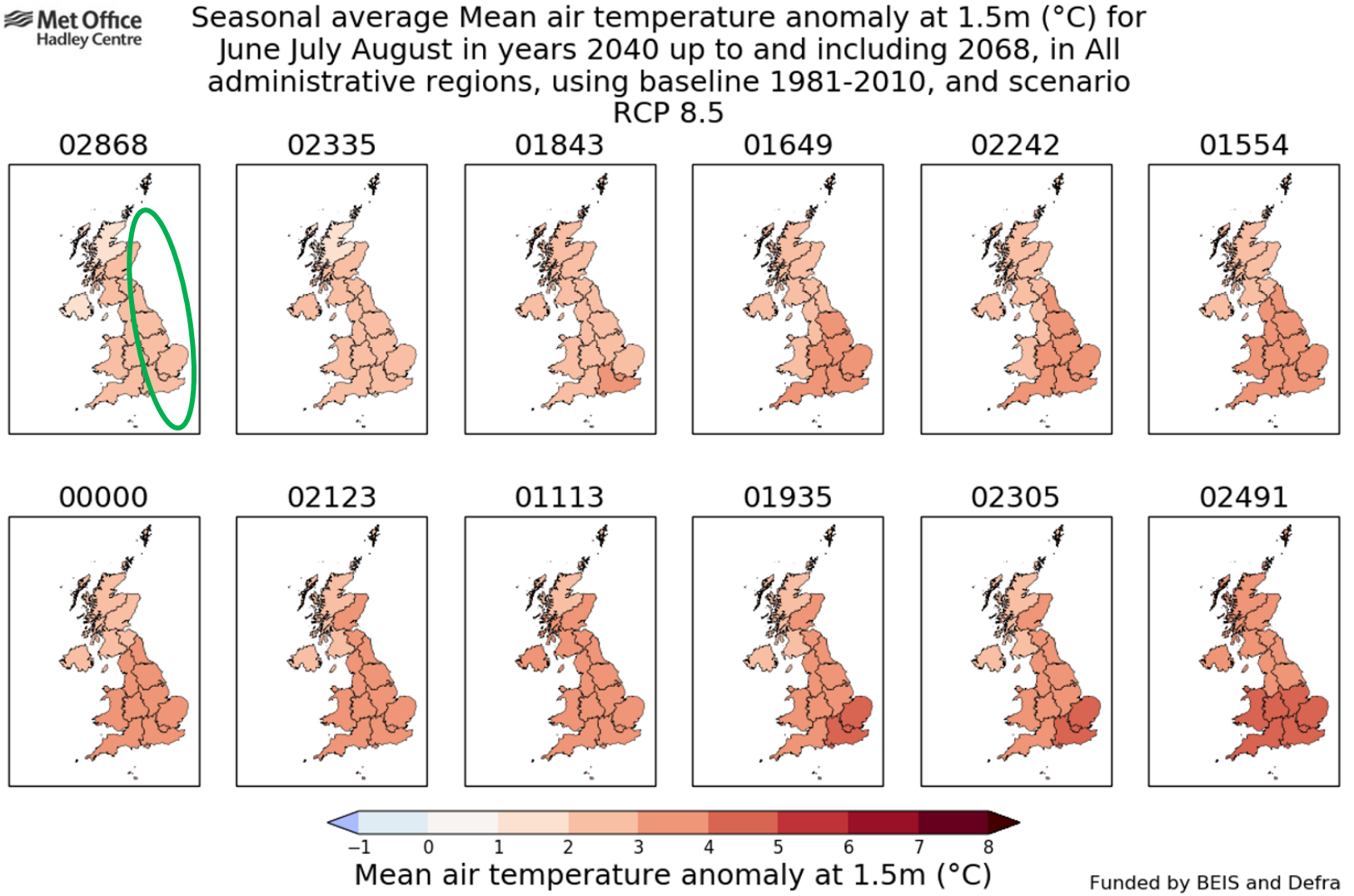
Projected climate change (RCP 8.5)



Source: Met Office climate data (UKCP18)

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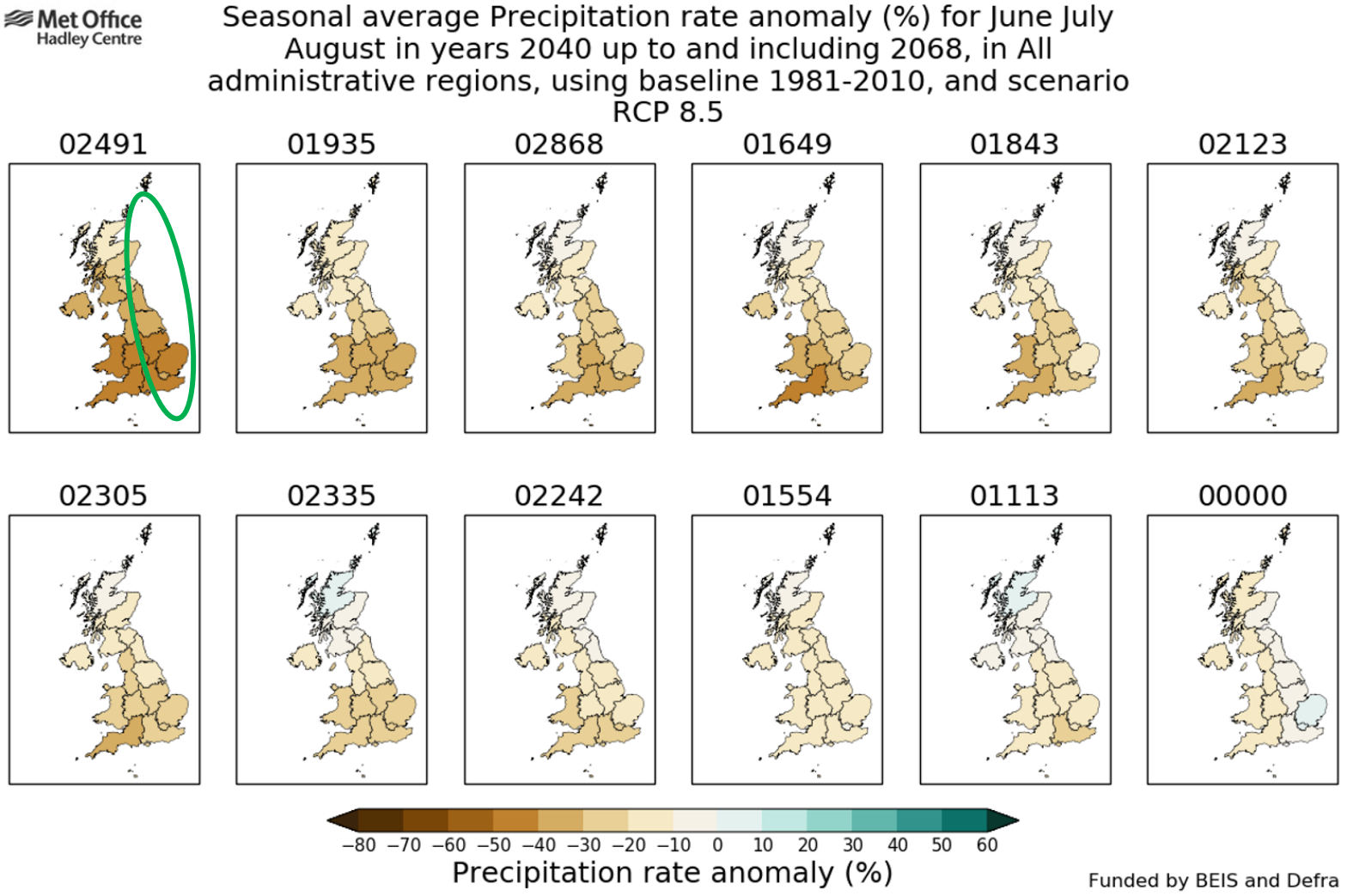
Projected climate change (RCP 8.5)



Source: Met Office climate data (UKCP18)

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Key Messages

- Many interacting variables to consider in outdoor production e.g.:
  - Individual pig requirements
  - Presence/absence of extreme weather during trial period
  - Sampling resolution to enable full integration with weather data
  - Challenges with soil sampling e.g. distribution of faecal material and straw in pen; should have sampled after each batch
- SOC decreases when outdoor pigs are introduced into an arable rotation in the current management system.
- Nutrient build-up in soils without crops can lead to losses to the environment.
- OPPORTUNITY to explore a range of management options to mitigate.

ClimatePig: Stakeholder Response

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Speaker: Steve Urwin

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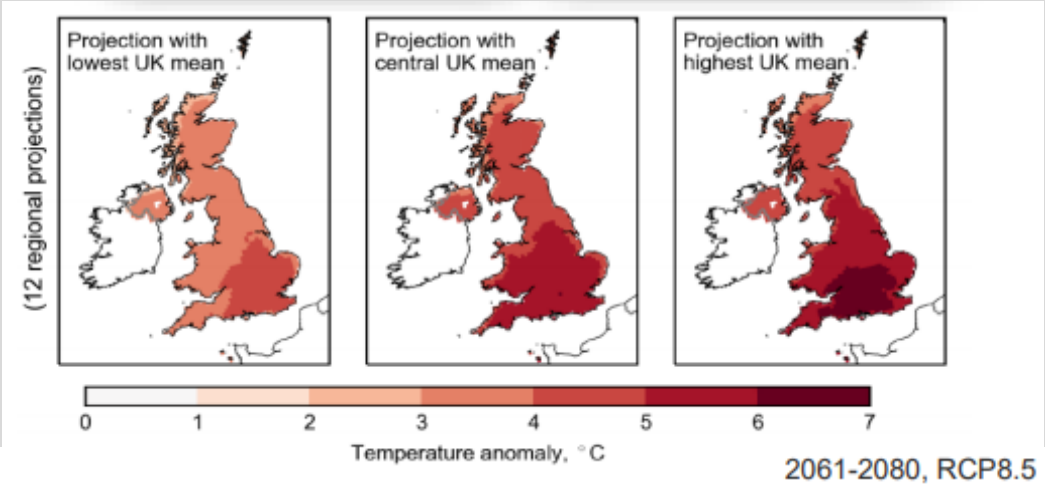

2061-2080, RCP8.5

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Q&A and Discussion

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With thanks to:

Karro Food Group

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Spen Farm and staff

UKRI for funding

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Contact details

Website: www.ukclimateresilience.org

Twitter: @UKCRP_SPF

YouTube: UK Climate Resilience programme

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The UK Climate Resilience programme is supported by the UKRI Strategic Priorities Fund.
The programme is co-delivered by the Met Office and NERC on behalf of UKRI partners AHRC, EPSRC, ESRC.