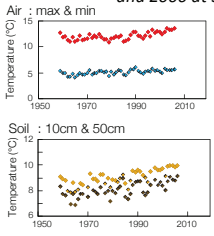
Adapting our crop and soil systems to climate change

Introduction

Over the next 75 years if gaseous emissions continue unabated, our climate will become:

- 3.5°C warmer in summer
- 50% drier in summer
- 40% wetter in winter
- 90% less snow
- 4 weeks earlier spring
- More extreme wind, temperature and rainfall events
- 90% higher CO_2 levels
- Higher UV-B and reduced ozone

Annual temperatures between 1959 and 2006 at SCRI



Effects:

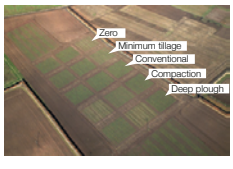
- Longer growing season
- Changed: Abiotic stresses
- Pest and disease pressures
- Efficiency of water, nutrient and irradiation use

Need:

- More resilient/adaptable crop genotypes, esp. durable resistance
- Functionally resilient soil and crop environments

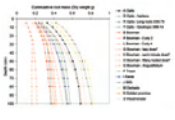
Mitigation

Plants can efficiently incorporate carbon in soils but it must be kept there by appropriate cultivation.



Long-term effects of different soil cultivation techniques on cropping, soil structure, and biodiversity.

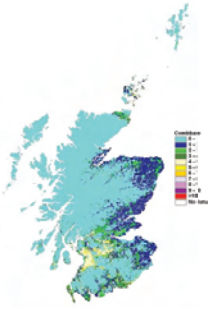
Rooting systems differ in their efficiency for incorporating carbon and scavenging water and nutrients.



Genotypic differences in root biomass distribution with depth (barley)

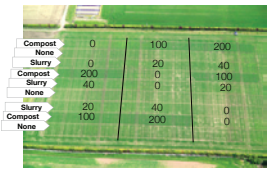
Different crops and even varieties add different amounts of carbon to soil

Scottish soil, weather and crop management data were used in the "Nitox model" to estimate the greenhouse gas N_2O emissions from soils under different land uses, identify regional emission patterns and producing estimated emissions from Scottish soils.



Estimates of soil N_2O emissions (kg N ha^{-1} yr^{-1}) from cultivated and uncultivated land across Scotland.

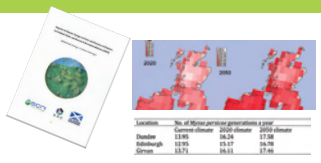
Carbon can be added to soils from sources such as municipal compost and this will affect on soil structure, nutrient and carbon cycling. Plants also vary in their nutrient use efficiency which may be improved to reduce gaseous and leaching losses.



Carbon and nutrient cycling in soils – effects of adding compost.

Adaptation

Many pests and pathogens will increase in severity with climate change.

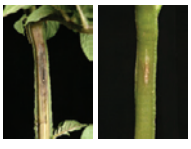


Number of Myzus persicae generations a year predicted using the CLIMEX software package

Plant resources are being characterised genetically and phenotypically for useful characteristics such as drought resistance, pest and pathogen resistance and yield under more variable and stressed environments.

Barley being characterised under drought-stressed conditions in field plots

We target resistance mechanisms likely to be robust and broad range to combat likely known pests and pathogens and new threats.

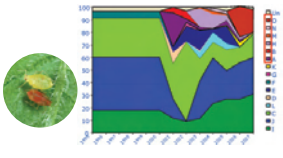


Basic gene showing broad-spectrum, durable bacterial disease resistance

We investigate the developmental processes which rely on environmental triggers which may change, for example reduced chilling requirement for black currants to maintain synchronous bud break and therefore successful harvesting.

Solving the problem of uneven bud-break in black currant due to lack of winter chill.

We study pest and pathogen populations to understand how they respond to climate change, which helps target control methods.

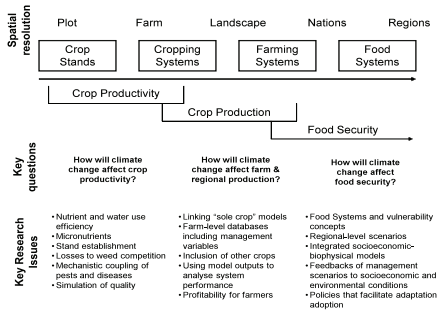


Changes in aphid populations and the viruses they carry in response to climate change

The result of this research and exploitation of our genetic resources is new crops

Genetic resources and breeding new crops: New potato, resistant to problematic diseases - late blight and potato cyst nematode

Food security



Effects of scale on elements of food systems contributing to food security and the various questions and research issues appropriate to different scales.

Conclusions

Understanding the complex biological mechanisms operating in crops and soils enables strategies to be devised for increasing their resilience to climate change. Co-ordinated inter-disciplinary research is key to achieving beneficial outcomes.

Acknowledgements

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