



Scenario
DOCTORAL TRAINING PARTNERSHIP

NERC
SCIENCE OF THE ENVIRONMENT

Climate change impacts on UK apple production and quality

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Future food and nutritional security requires sustainable food production systems in future, different climates. Perennial crops such as top fruit (apples, pears, plums, cherries, etc) are more sustainable than annual crops. Top fruit are also important to human nutrition and health. Frequent apple consumption has long been recognized as important to healthy, sustainable living in the UK. It is a comparatively cheap UK-produced fruit, easy to consume (requiring little or no preparation), stores well over winter, and is highly accessible because it is grown by amateur growers, including community orchards, as well as commercially.

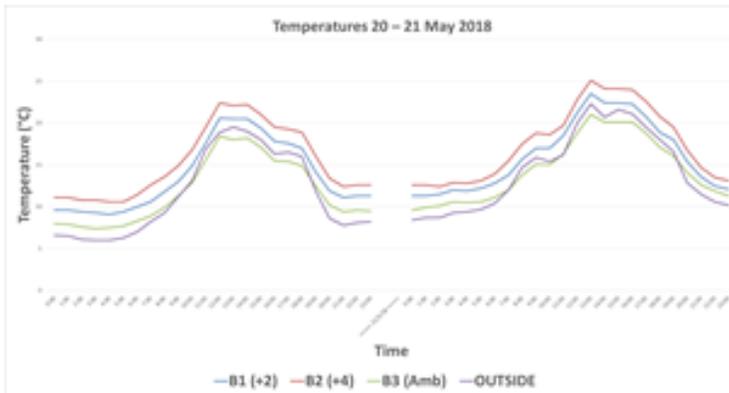
Climate change impacts research on crops tend to be limited to annual crops and are often short term (relative to the productive life of a perennial crop). Analysis of records from the National Fruit Collection (curated for the nation by the University of Reading) at Brogdale in Kent has shown that flowering dates of many different varieties are now 17 days earlier on average each spring than 60 years ago; and this is associated with warming of just over 1 °C over this period at Brogdale. Moreover, during the past 15 years inter-annual variation in flowering dates has increased, with swings of up to 3 weeks occurring from year to year. UK apple production has thus already been affected by climate change.

This project seeks to answer two questions. How will future apple production be affected by climate change? And how might future production systems be developed to mitigate this environmental challenge – simultaneously with the food and nutritional security challenges? This includes not only variety selection by growers, but also the identification of key traits for the future in plant breeding.

To this end, the National Fruit Collections Trust (NFCT) has funded the creation (by Fruit Advisory Services Team [FAST] and University of Reading [UoR] staff) of a 0.6 ha research platform comprising orchard trees under modified field environments in order to remedy the dearth to date of empirical long-term investigations of climate change impacts on perennial crop production.

This unique experimental facility at Brogdale is now operational, providing considerable resources for this studentship to investigate climate change impacts on apple production. It comprises a factorial combination of >15 diverse apple varieties, three temperature regimes, and three rainfall regimes, within three triple-span tunnels (each span 8m wide x 85m long x 5m high), covered with Lumisol diffuse plastic. The experimental temperature regimes track the ambient and comprise ambient; ambient +2 °C; ambient +4 °C (one per triple-span tunnel). These regimes are computer-controlled with automatic roof-venting, supported seasonally and when required by manual opening or closing of tunnel ends. The simulated rainfall regimes are ambient; ambient +20%; ambient -20%, with rainfall collected from tunnel roofs and redistributed by irrigation through 65 drippers designed to mimic rainfall within each tunnel.

The research platform showing the three triple-span tunnels (right)



Diurnal variation in temperature over two days in the three triple-span tunnels (left)

The effects of these regimes, and the previous year's tree performance (because apple is perennial), on the phenology, vegetative growth, fruit yield, and quality of each variety will be investigated by the student. In addition, the student will investigate physiological responses, including photosynthetic rate, water use, canopy structure, and light interception. The results will be applicable at regional (NW Europe) to local (SE England) scales.

The student will spend substantial periods undertaking fieldwork (c. 18 months over 3 years, principally every late spring, summer, early-autumn) at this site. Parallel laboratory studies will investigate changes in fruit quality (temporal and environmental). The project is highly quantitative, with data collection/ collation/ archiving/ analysis of environmental observations (from data loggers, etc) as well as crop data (vegetative and reproductive growth/yield, phenology, plus "explanatory" variables such as leaf photosynthetic rate) – together with the mathematical modelling and statistical analyses to understand and project from the responses obtained.

The student will also use a process-based approach to determine canopy size, light interception, vegetative growth, reproductive growth, and so radiation use efficiency. This would make the research outputs suitable for quantitative approaches to investigations at the regional level through mathematical modelling. As well as interaction with project stakeholders (NFCT, FAST, UoR) and links with the industry, the student will have the opportunity to develop skills in public engagement in science.

Training opportunities:

This project includes substantial placement in industry at the National Fruit Collection (NFC), Kent. In addition to the frequent interaction with fruit industry advisors from specialists in the Fruit Advisory Services Team in the fieldwork, NFC is also open to the general public with good opportunities to develop skills in the public engagement in the sciences.

Student profile:

This project would be suitable for graduates from a wide range of applied biology or environmental science degrees with good quantitative skills, or applied mathematics and statistics degrees with a strong background in food security. High resilience, adaptability, stamina, good interpersonal and communication skills, and a "can do" attitude are essential qualities for success in this collaborative multi-partner investigation with a high proportion of fieldwork.

Funding particulars:

This PhD research studentship has CASE sponsorship from the National Fruit Collections Trust in addition to NERC studentship funding. NFCT has also funded the unique research platform for this project.

<http://www.reading.ac.uk/nercdtp>