

UK National Climate Crop Modelling Capability (UKNCCC)

Crop predictions and Assessment tools

A suite of modelling tools and remote sensing techniques used to forecast crop yields and assess climate impacts on UK agriculture across seasonal to long-term timescales

Call to action:

We need active collaboration between researchers, data providers, and end-users. This capability outlines the foundations for integrating advanced modelling systems, remote sensing, and scenario analysis into practical decision-making.

Why we need crop predictions and assessment tools in UKNCCC:

- The UKNCCC needs modelling tools, metrics, and indicators for climate impact assessments across both short- and long-term timescales. There is currently no national forecasting system for wheat, the UK's most common cereal crop. Remote sensing and machine learning tools like the General Large Area Model for annual crops using Satellite remote sensing data (GLAM-Sat) can help predict [UK winter wheat yields](#) in the near term
- Understanding the long-term impacts of climate change on a broader range of UK crops - including barley, oilseed rape, and potato - is equally important. These crops are underrepresented in global modelling efforts but are vital to UK food security
- The integration of The Agricultural Production Systems sIMulator (APSIM) and Long Ashton Research Station Weather Generator (LARS-WG) enables robust, site-specific simulations of climate variability and agroecosystem resilience. This supports the evaluation of future risks, adaptation strategies, and land management options such as Environmental Land Management schemes
- Agro-climate indicators and metrics can support decision-making in agriculture and inform crop breeding for climate resilience, and help to illustrate when, and where the most impactful changes could occur

These tools enhance the UKNCCC's ability to conduct coordinated climate impact assessments in agriculture, connecting science, policy, and industry. They also enable the UK to participate in international modelling while maintaining national relevance.



Benefits:

Improved Forecasting: Enables accurate, UK-specific crop yield forecasts across both short- and long-term timescales, supporting food security. Forecast skill can be improved by explicitly modelling compound events.

Climate Impact Assessment: Assesses the effects of climate change on a wide range of crops, helping to identify risks and adaptation strategies.

Decision Support: Provides actionable agro-climate indicators and metrics to inform agricultural decision-making and crop breeding for climate resilience.

Realising opportunities outside of current arable areas farmed in the UK.

Making changes to the farming systems and supply chains early to adapt.

Alignment with Policy:

This capability offers strong evidence for agricultural adaptation to climate change by delivering detailed crop yield forecasts, stress analysis, and scenario modelling. It enables targeted farming interventions, informs Defra's Land Management Schemes, aids risk-based planning for government climate responses, and supports future UK Climate Change Risk Assessments and Food Security Reports.

Priority Actions and Recommendations for UKNCCC:

This capability offers strong evidence for agricultural adaptation to climate change by delivering detailed crop yield forecasts, stress analysis, and scenario modelling. It enables targeted farming interventions, informs Department for Environment, Food and Rural Affairs (Defra's) Land Management Schemes, aids risk-based planning for government climate responses, and supports future UK Climate Change Risk Assessments (CCRA) and Food Security Reports.

- Efforts to compare national scale projections would help to harmonise outputs and provide clearer ways forward in terms of understanding uncertainties and knowledge gaps across modelling groups in the UK
- Making the outputs of crop models, agroclimatic indicators and metrics available in forms that can be used by industry stakeholders could support adaptation decision-making

We need to include more crops in the commonly used modelling tools to improve our understanding of food security implications. We also need better understanding of the impacts of climate extremes in our models, including direct climate impacts as well as indirect impacts from crop pests and diseases.

What are Crop predictions and Assessment tools?:

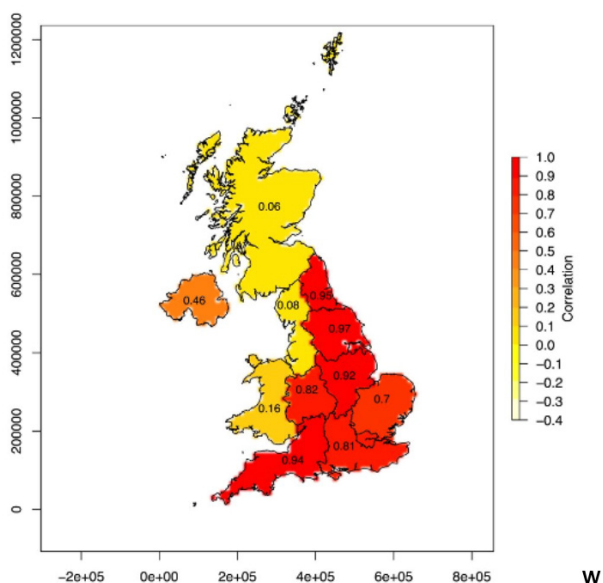
Tools used range from crop-climate models that are process-based to statistical models that rely primarily on the relationships between observed yield data and weather / climate data (e.g. European Centre for Medium-Range Weather Forecasts Reanalysis V5 (ERA5) or UK Climate Projections UKCP). These models are used at a range of time scales, from seasonal forecasting to multi-decadal climate change projections. Agro-climatic indicators and metrics generally do not model crop growth or yields, but take weather and climate data and use them to focus on sensitive times and variables in agricultural activities.

The General Large-Area Model (GLAM) family of crop models is used at Leeds, which includes process-based models as well as forecasting tools that rely on remote sensing data to make within-season predictions of crop production, with associated management benefits. Other examples of commonly used models include JULES-Crop, DSSAT and APSIM.

- JULES-Crop: Part of the UK's Joint UK Land Environment Simulator (JULES), which includes a crop module
- DSSAT (Decision Support System for Agrotechnology Transfer): A widely used international crop modelling framework that includes many crop models
- APSIM (Agricultural Production Systems sIMulator): A detailed simulation model that represents agricultural systems, including crop growth, soil processes, and management practices
- Long Ashton Research Station Weather Generator (LARS-WG) is a stochastic weather generator, a tool that simulates long-term climate data. It uses information from global climate models (GCMs) and future climate scenarios (like SSP2-4.5 and SSP5-8.5) to produce realistic weather patterns. With LARS-WG, up to 1000 years of simulated climate data for both current (baseline) and future conditions can be generated. This includes natural climate variability and can be applied to multiple locations with different soil types. The simulations are based on outputs from five selected GCMs, helping to explore how climate might change under different socioeconomic pathways

Together, they form a powerful modelling framework that enables national-scale assessment of how climate change and variability impact crop production and ecosystem services across diverse soils, climates, and management strategies, supporting evaluations of systems resilience in UK agriculture.

Various agro-climatic indicators and metrics are used in the UK and globally, differing in scale, climate variables, and thresholds. The [UK Climate Risk portal](#) provides several metrics based on UKCP18 projections relevant to agriculture and food security, such as start of growing season, growing season length, growing degree days, crop growth duration, start of field operations, accumulated frost, frost days, dairy cattle heat stress, wheat heat stress, potential soil moisture deficit, days above field capacity, and drought indicators. Additional climate indicators can be found on the [Met Office Climate Data Portal](#), and recent reports (e.g. on [livestock heat stress](#), and crop production in [Spain](#) and papers (e.g. Arnell et al. 2021a,b, Arnell & Freeman [2021](#)).



Preliminary result from the **Remote Sensing version of the GLAM crop model** show skill in predicting yields from nowcasting (see figure) out to 4-5 months in advance of the harvest.



AgZeroPlus is advancing UK-wide crop yield modelling network by integrating satellite-based observations with process-driven models. Using Sentinel-2 data, the initiative maps crop development and health at field and sub-field scales, enabling accurate yield predictions for major crops such as winter wheat. Historic yield mapping helps identify management practices and environmental factors that influence productivity, while precision yield datasets from modern harvesting machinery provide granular insights and validation for these models. This approach supports targeted interventions, improved resource efficiency, and pathways toward NetZero farming without compromising productivity.

Relevant studies:

National Horizon Scanning for Future Crops Under a Changing UK Climate

Presenting a horizon scan approach based on simplified modelling approaches (EcoCrop data), producing mapped changes in suitability under +2°C and +4°C warming scenarios (above pre-industrial), for over 160 crops across the United Kingdom. Which highlights these opportunities will require a change to the current farming system and supply chains.

- For the United Kingdom, climate change is likely to bring opportunities to diversify cropping systems.
- Many current and potential new crops show widespread increases in suitability under a +2°C warming scenario.
- Under a +4°C scenario, several current crops (e.g. onions, strawberries, oats, wheat) begin to show declines in suitability in the region of the United Kingdom where most arable crops are currently grown.
- Whilst some new crops with increasing suitability may offer viable alternatives (e.g. soy, chickpea, grapes), the greatest average increases in suitability across crops occur outside the UK's current areas of greatest agricultural production.

Resilience of UK crop yields to compound climate change

- Severe impacts of extreme weather on UK crop yields.
- Using UKCP 2.2km Local – high resolution.
- Increasing volatility in UK wheat yields since the 1990s.
- The role of compound weather extremes (frost + heavy rainfall).
- Projected climate changes during growth stages (warmer/wetter winters, warmer/drier summers).
- Potential benefits for yield growth alongside heightened risk from unprecedented extremes.



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