Food crops in India in a changing climate

Walker Institute research

Food production and our changing climate

Food crop production in tropical and temperate regions is sensitive to changes in climate.

Most of the world's supply of staple food – crops such as rice and maize - is produced in the tropics where climate can vary dramatically from year-to-year.

Reliable seasonal forecasts of crop yield would be of real benefit to government planners, agri-business and farmers. Further ahead, the impacts of climate change also pose a serious threat to food security and need to be much better understood.

Therefore, developing models that will be able to produce crop forecasts a season to decades ahead is crucial for future food security, especially in very vulnerable regions.

Under climate change, crops in many regions will be prone to environmental stresses not observed in today's climate. For example, by the end of this century short periods of hot temperatures that are found in some regions in the current climate will be found over a wider area. If these occur at flowering time, then the harvest of annual crops, such as groundnut and wheat, can be seriously reduced.

"Climate change is emerging as a major threat to food security, and governments need to find "creative solutions" and "alternative approaches" in order to deal with the challenge."
UN Food and Agriculture Organisation, September 2007.

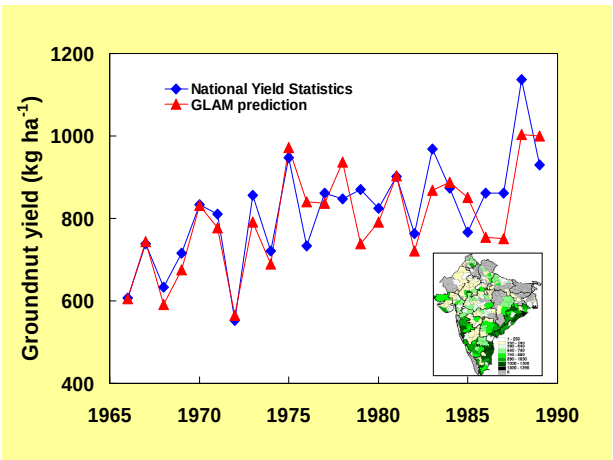
Developing a new kind of crop model

Models that simulate crop production are traditionally designed to run at field scales. However, predicting the impacts of climate on food supplies requires crop models that capture the effects of climate at country and global scales.

We have developed a new crop model for large areas based on analyses of the large-scale observed relationships between crop yield and climate.

This new model simulates biological and physical processes on the same scale as climate models. It provides a tool to understand and predict the impacts of climate on crops at the district and country scale.

The crop model is being extended to study the impact of different crop varieties, improved irrigation, and the effects of increased CO_2 on crop yield.



Our large area crop model (GLAM) simulates well the current year to year changes in Indian groundnut (peanut) yield.

The effect of crops on local and regional climate

As well as being influenced by weather and climate, crops and other vegetation can themselves exert an influence on regional and local climate. Current impact studies do not consider these feedbacks between crops and climate.

We have incorporated the growth and development routines of our crop model into the land surface scheme of the UK Met Office climate model, creating a coupled crop-climate model. Both the crop and the atmosphere evolve dynamically within the model and can respond to, and influence, each other.

Using this model to forecast future climate has revealed that growing crops and land use changes can alter the magnitude of regional climate variability and change. For example, with our model, future warming over West Africa is greater when the feedback from crops is incorporated.

We are investigating:

- the impacts of climate change on food production
- forecasts of crop yields a season or more ahead
- water use by agriculture under climate change
- the feedbacks between crops and climate

The effect of climate variability on crop productivity

Crop productivity in India is very sensitive to variability in monsoon rainfall and temperature within a season. For example, large reductions in crop yield occur when there is break in the monsoon or unseasonal storms.

Many grain crops are particularly vulnerable to brief episodes of high temperatures (>32-36ºC) when these coincide with the time of flowering. We have quantified this response and so defined temperature thresholds for wheat, rice and groundnut crops.

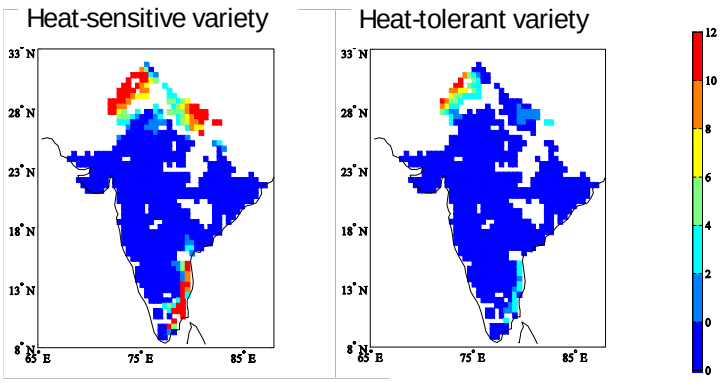
Many annual crops – such as wheat, soybean and rice – have a threshold temperature above which seeds do not form properly. A brief episode of hot temperatures (>32-36ºC) can devastate crop yields.

Climate change—impacts and adaptation

We have used our crop model for seasonal to decadal forecasts of crop yield at a large scale.

In one study, we examined the impacts of scenarios of climate change on the productivity of the groundnut crop across India using the UK Met Office regional climate model.

We defined the areas in which groundnut will be particularly vulnerable to heat stress, and we also examined the extent to which planting a more heat-tolerant crop variety provides adaptation to climate change.



The red/ orange/ yellow boxes show areas where heat stress could substantially reduce groundnut yield by the end of this century.

www.walker-institute.ac.uk
Tel: +44 (0)118 378 7380
Email: walker_info@reading.ac.uk
Director: Prof Nigel Arnell