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Effect of Climate Variability and Change on Agriculture in India

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The challenges India faces in tackling malnutrition are complicated further by the vulnerability of its agriculture to climate variability and change. By improving our understanding of how the climate affects agriculture, we can better address maternal and child nutrition in India. This research seeks to shed light on these climate–agriculture–nutrition pathways. It shows that, while the climate does not affect agriculture in some of the ways we assume it does, we are not paying enough attention to other ways in which climate change can negatively affect agriculture.

A delayed rainy season does not necessarily mean less agricultural production

The onset of the monsoon captures the Indian imagination every summer, with extensive news coverage given to the progression of the monsoon. It is widely assumed that a delayed start to the rainy season results in poor crop yields, yet no studies confirm this. Using production data for ten crops as well as rainfall and temperature data from the 1970s into the 2000s, we tested this assumption using statistical models. We found that it was the length of the rainy season, rather than its onset, that was important to crop yields. Thus a rainy season that is a few days late is not much cause for worry, but a much greater delay in onset that is likely to shorten the rainy season could reduce crop yields. We also found that rice and cotton farmers in districts with lower levels of irrigation (who are therefore more likely to be poorer) were likely to experience a decline in yields due to a shortened rainy season (Figure 1).

However, farmers in districts with greater access to irrigation and inputs were better able to smooth production.

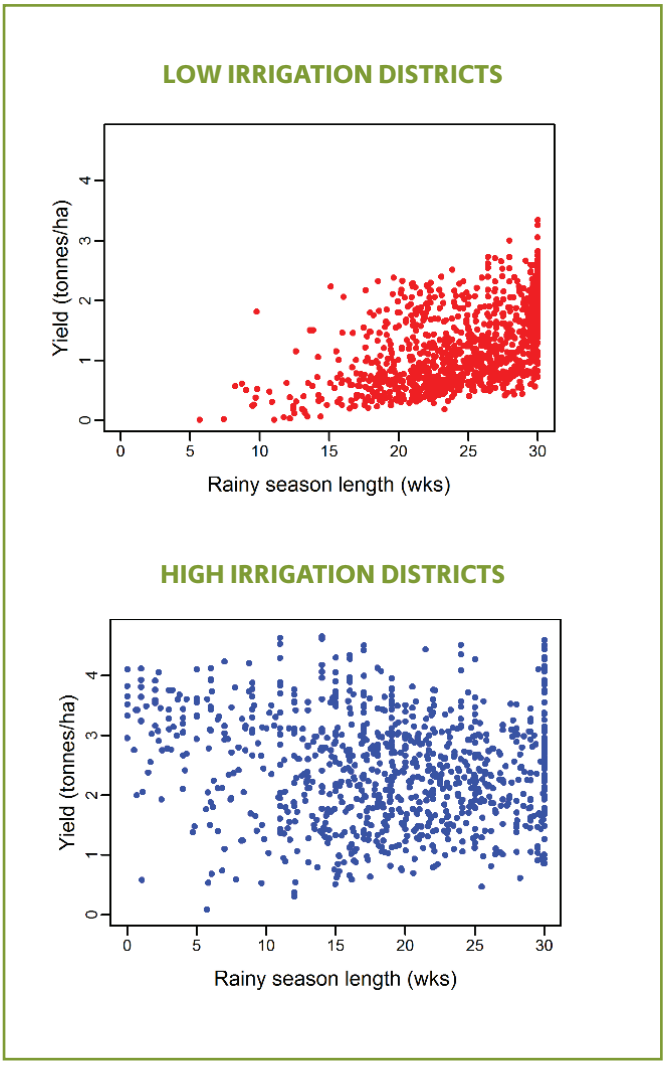

Figure 1. Response of rice yield to the length of the rainy season in districts with low (0–40% cultivated area irrigated) and high (80–100% cultivated area irrigated) levels of irrigation.

Some of the worst effects of climate change will be on crops important to nutrition

Rice and wheat account for half the calories consumed by Indians. The dominance of these crops in Indian diets is also reflected in their dominance in climate change impact studies. Unfortunately, this means that other crops, which together account for a large proportion of calories consumed as well as important nutrients and micronutrients, are largely ignored in climate change assessments. This should be all the more alarming because many of these crops, such as the coarse cereals sorghum and millets, are important to the diets of poorer Indians.

Using statistical models, we studied the projected impacts for the year 2050 in seventeen climate models on the seventeen major Indian crops for which there are long-term data. We found that under both moderate (Representative Concentration Pathway, or RCP 4.5) and high (RCP 8.5) greenhouse gas emissions scenarios, rice and wheat are relatively less severely affected than many other crops that are important for nutrition. The crops expected to be affected most severely by climate change included coarse cereals, legumes, and oilseeds (Table 1). Some of these crops are promoted as being more tolerant of harsher climates, so what is going on?

The source of the vulnerability is that the crops affected most severely are not necessarily the most sensitive to climate, but are grown in climatically marginal regions. Climate change only worsens the already hot and dry conditions in these regions. Combined with the fact that no part of India will experience an improved growing climate in the future, this implies that even if the crops currently grown in these regions are shifted elsewhere, there will be less climatically attractive land with which to feed more people. Moreover, alternative sources of livelihood will need to be found for those living on these marginal lands.

Regardless of the climate model considered, the effects will be negative for most crops. At the same time, the extent to which crops will be affected varies more widely depending on the climate models chosen than due to emissions scenarios.

This is sobering news because we do not know which climate models best represent the future climate for our regions of interest. However, it also means that policymakers can start planning climate adaptation strategies now without being overly concerned about wasted resources should the world go down a lower emissions pathway.

Large Decrease	Maize, high irrigation; Safflower*
Moderate Decrease	Rice, high irrigation; Pearl millet; Cotton, high irrigation; Wheat, low irrigation; Wheat, high irrigation; Barley, high irrigation; Sorghum*; Rapeseed/mustard, high irrigation; Maize, low irrigation*; Sesame*; Barley, low irrigation*; Chickpea*
Little Change	Cotton, low irrigation; Finger millet*; Soybean*
Moderate Increase	Rice, low irrigation; Castor; Pigeon pea*; Groundnut*; Linseed*; Rapeseed/mustard, low irrigation*
Large Increase	-

** Low statistical confidence*

Table 1. Future changes in yields (year 2050, "moderate" RCP of 4.5).

Implications

These studies together show that historical data can be very useful in helping us plan for future climate challenges. The maintenance and improvement of agricultural and climate data collection leads to long-term benefits that dwarf the costs. Researchers, extension workers, and policymakers must not ignore crops that are important to the nutrition of rural Indians, especially since it appears many of these crops may be among the most severely affected by climate change. Finally, we see hardly any benefit to Indian agriculture from climate change. While some crops may experience slight benefits, it seems clear that the majority will not. Thus, rather than bolstering merely rice and wheat, investments that increase the climate resilience of all crops ultimately will generate better returns for Indian livelihoods and nutrition.

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