Keysheet
6

Climate Change Impacts on

Agriculture in **India**

Agriculture represents a core part of the Indian economy and provides food and livelihood activities to much of the Indian population. While the magnitude of impact varies greatly by region, climate change is expected to impact on agricultural productivity and shifting crop patterns. The policy implications are wide-reaching, as changes in agriculture could affect food security, trade policy, livelihood activities and water conservation issues, impacting large portions of the population.

Agriculture and climate change

The agricultural sector represents 35% of India's Gross National Product (GNP) and as such plays a crucial role in the country's development. Food grain production quadrupled during the post-independence era; this growth is projected to continue.

The impact of climate change on agriculture could result in problems with food security and may threaten the livelihood activities upon which much of the population depends. Climate change can affect crop yields (both positively and negatively), as well as the types of crops that can be grown in certain areas, by impacting agricultural inputs such as water for irrigation, amounts of solar radiation that affect plant growth, as well as the prevalence of pests.

The Indian Agricultural Research Institute (IARI) examined the vulnerability of agricultural production to climate change, with the objective of determining differences in climate change impacts on agriculture by region and by crop.

The Indian Agricultural Research Institute

The Indian Agricultural Research Institute (IARI), New Delhi is a research organisation under the Indian Council for Agricultural Research (ICAR). It conducts various professional courses in agricultural sciences and allied fields. The research area of the institute covers the entire range of agricultural science. www.iari.res.in

Description of methodology

Scientists at IARI used a variety of crop growth models to evaluate potential climate change impacts on wheat and rice (India's primary crops), and other crops such as sorghum and maize. Specific variables used in the models included changes in temperature, CO2 levels, precipitation, and solar radiation. (See Box 6.1 for a full description of models used). Importantly, these variables can both increaseand decrease crop yields with changes in climate, and therefore the interaction of these effects was also studied (for example, while increased temperatures can reduce yields, this can be offset by increased yields due to increased solar radiation) (Figure 6.2). The study also examined impacts on rain-fed versus irrigated crops.

The models were developed using historic weather datasets as a baseline, correlated with growth and yield of crops to characterise inter-seasonal climatic variability at various locations.

Box 6.1

Models used to predict climate change impacts on agriculture

The following models were developed to evaluate the impacts of changes in temperature and carbon dioxide on crops:

- INFOCROP, a generic growth model for various crops, was developed by IARI for optimal resource and agronomic management options.
- INFOCANE, a simple sugarcane growth model, was developed by IARI to measure effects on cane yield.
- Simple tea and coconut models were developed for tropical India and Sri Lanka.
- Pest damage mechanisms were coupled with INFOCROP for simulating the effect of pests. The use of this model meant that assessments could be made of the impact of climate change and its variability on incidence of pests for various crops.
- Interaction effects of climate changes (temperature rise, rainfall and radiation changes), with irrigation and nitrogen amounts, and agronomic management practices were established for various agro-ecologies. These were used to calculate the actual impact of climate change on agricultural production as well for suggesting agro- and resource management options for sustaining production in India.

Predicted climate change impacts on agriculture

The predicted changes to agriculture vary greatly by region and crop. Findings for wheat and rice are reported here:

Wheat Production

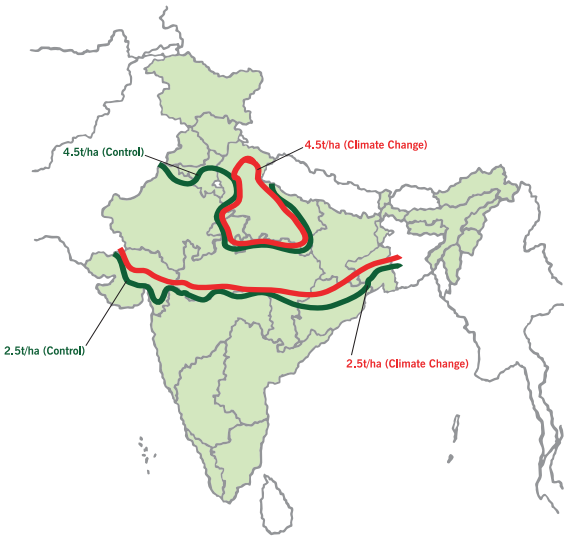
- The study found that increases in temperature (by about 2ºC) reduced potential grain yields in most places. Regions with higher potential productivity (such as northern India) were relatively less impacted by climate change than areas with lower potential productivity (the reduction in yields was much smaller);
- Climate change is also predicted to lead to boundary changes in areas suitable for growing certain crops. These are shown for wheat in Figure 6.1;
- Reductions in yields as a result of climate change are predicted to be more pronounced for rain fed crops (as opposed to irrigated crops)and under limited water supply situations because there are no coping mechanisms for rainfall variability.
- The difference in yield is influenced by baseline climate. In sub tropical environments the decrease in potential wheat

yields ranged from 1.5 to 5.8%, while in tropical areas the decrease was relatively higher, suggesting that warmer regions can expect greater crop losses.

Figure 6.1

Boundary Changes for Productivity of Irrigated Wheat

Impact under 425ppm CO_2 concentration and 2ºC temperature rise



Rice Production

- Overall, temperature increases are predicted to reduce rice yields. An increase of 2-4ºC is predicted to result in a reduction in yields.
- Eastern regions are predicted to be most impacted by increased temperatures and decreased radiation, resulting in relatively fewer grains and shorter grain filling durations.
- By contrast, potential reductions in yields due to increased temperatures in Northern India are predicted to be offset by higher radiation, lessening the impacts of climate change.
- Although additional CO2 can benefit crops, this effect was nullified by an increase of temperature.

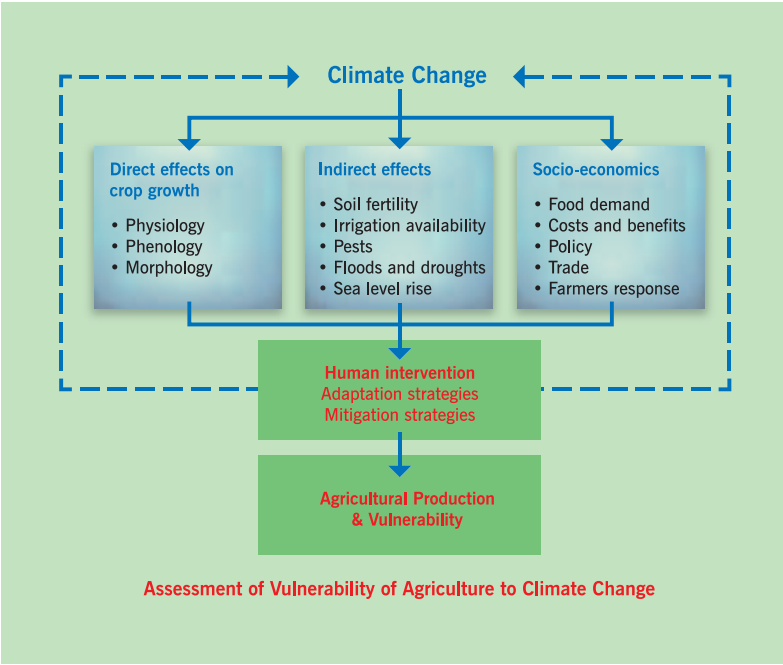
What are the policy implications of these predictions?

The policy implications for climate change impacts in agriculture are multi-disciplinary, and include possible adaptations to:

- Food security policy: to account for changing crop yields (increasing in some areas and decreasing in others) as well as shifting boundaries for crops, and the impact that this can have on food supply.
- Trade policy: changes in certain crops can affect imports/exports, depending on the crop (this is particularly relevant for cash crops such as chillies).
- Livelihoods: With agriculture contributing significantly to GNP, it is critical that policy addresses issues of loss of livelihood with changes in crops, as well as the need to shift some regions to new crops, and the associated skills training required.
- Water policy: Because impacts vary significantly according to whether crops are rain fed or irrigated, water policy will need to consider the implications for water demand of agricultural change due to climate change.
- Adaptive measures: Policy-makers will also need to consider adaptive measures to cope with changing agricultural patterns. Measures may include the introduction of the use of alternative crops, changes to cropping patterns, and promotion of water conservation and irrigation techniques.

Figure 6.2

Impact of Climate Change on Agriculture



Needs for further research

Due to the complex interaction of climate impacts, combined with varying irrigation techniques, regional factors, and differences in crops, the detailed impacts of these factors need to be investigated further.

Specific recommendations for further research include:

- Precision in climate change prediction with higher resolution on spatial and temporal scales;
- Linking of predictions with agricultural production systems to suggest suitable options for sustaining agricultural production;
- Preparation of a database on climate change impacts on agriculture;
- Evaluation of the impacts of climate change in selected locations; and
- Development of models for pest population dynamics.

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