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The Impact of Climate Change on Indian Agriculture

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Abstract

Agriculture is arguably the most important sector of the economy that is highly dependent on climate. A large body of scientific data and models has been developed to predict the impacts of the contemporary and future climate. The resulting advances in our understanding of climate impacts have come from the collection of better data, the development of new methods and models, and the observation of actual changes in climate and its impacts.

This article briefly summarizes some of the key findings from the research on agricultural impacts of climate change, based on the recent IPCC Assessment Reports published in 2001 and 2007 .I discuss the substantial uncertainties about actual and potential impacts of climate change on agriculture and its economic consequences. Early research on agricultural impacts led to some rather predictions of adverse impacts of climate change on food production, and the public perception that climate change may lead to global food shortages continues today.

As the scientific consensus grows that significant climate change, in particular increased temperatures, is very likely to occur over the 21st century (Christensen and Hewitson, 2007), economic research has attempted to quantify the possible impacts of climate change on society. Since climate is a direct input into the agricultural production process, the agricultural sector has been a natural focus for research. The focus of most previous studies has been on the study of climate change which may be greater in the developing world, where agriculture plays a larger economic role. This paper provides evidence on the impact of climate change on agriculture in India, where poverty and agriculture are both salient. I find that climate change is likely to

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reduce agricultural yields significantly, and that this damage could be severe due to rapidly change in climate scenario.

Most previous studies has the economic effect of climate change that have followed one of two methodologies, commonly known as the production function approach and the Ricardian approach.

The production function approach (also known as crop modeling) is based on controlled agricultural experiments, where specific crops are exposed to varying climates in laboratory-type settings such as greenhouses, and yields are then compared across climates. This approach has the advantage of careful control and randomized application of environmental conditions.

The Ricardian approach, pioneered by Mendelsohn et al. (1994), attempts to allow for the full range of compensatory or mitigating behaviors by performing cross-sectional regressions of land prices on county-level climate variables, plus other controls. If markets are functioning well, land prices will reflect the expected present discounted value of profit. this approach can account for both the direct impact of climate on specific crops as well farmers adjustment of production techniques, substitutions of different crops and even exit from agriculture.

Agriculture typically plays a larger role in developing economies than in the developed world. For example, agriculture in India makes up roughly 20% of GDP and provides nearly 52% of employment (as compared to 1% of GDP and 2% of employment for the US), with the majority of agricultural workers drawn from poorer segments of the population

This paper applies the panel data approach to agriculture in India, using a panel of over 200 districts covering 1970 to 2000. The basic estimation strategy implies yearly district-level agricultural outcomes (in this case, yields) on yearly climate measures (temperature) and its effect. The resulting weather parameter estimates, then, are identified from district-specific deviations in yearly weather from the district mean climate.

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This negative impact of climate change on agriculture is likely to have a serious impact on poverty: recent estimates from across developing countries suggest that one percentage point of agricultural GDP growth increases the consumption of the three poorest deciles by four to six percentage points (Ligon and Sadoulet, 2007). The implication is that climate change could significantly slow the pace of poverty reduction in India.

Introduction:

Climate is the most important determinant of crop productivity, particularly in country like India, where about 2/3rd of the cultivated area is rainfed. Climate change, therefore, is of serious concern having large-scale impacts, directly and indirectly, on agriculture. It is manifested with increase in global temperature, increased intensity of rainfall, rising sea level, melting of glaciers, shifting of crop growing season and frequent occurrences of extreme events such as drought and flood. To address the long-term negative impacts of climate change and short- and medium-term impacts of climatic variability on agriculture, there is a need for sustained research on increased adaptation and mitigation, capacity building, development activities, and bringing necessary changes in policies. These actions have to be accompanied by long-term sustained actions towards generation and strengthening of strategic knowledge system in key impact sectors like water, agriculture, energy, health, etc. by building human and institutional capacity. The National Mission on Strategic Knowledge for Climate Change (NMSKCC) was initiated with this very objective.

SHORT-RUN WEATHER FLUCTUATION VERSUS LONG-TERM CLIMATE CHANGE

A representative farmer s production function is f (T; L; K), where T represents temperature, L represents an input that can be varied in the short run, which we shall call labor, and K represents an input that can only be varied in the long run, which we call capital.. The point is that some inputs, such as fertilizer application or labor effort are relatively easy to adjust, while other inputs, such as crop choice or irrigation infrastructure, may be more difficult to adjust or may be

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effectively fixed at the start of the growing season. The farmer, taking price and temperature as given, solves the following program:

Max {p.f(T,L,K)-wL-rk)

Data Sources and Summary Statistics

The analysis is performed on a detailed 40-year panel of agricultural outcomes and weather realizations covering over 100 districts. Although Indian districts are generally somewhat larger than US counties, the district is the finest administrative unit for which reliable data are available. This section describes the data and provides some summary statistics.

Agricultural outcomes

Detailed district-level data from the Indian Ministry of Agriculture and other official sources on yearly agricultural production, output prices and acreage planted and cultivated for 100 districts over the period 1970-2020 have been collected into the Indian Agriculture and Climate Data set by a World Bank research group, allowing computation of yield and total output . This dataset covers the major agricultural states with the exceptions of Kerala and Assam. Also absent, but less important agriculturally, are the minor states and Union Territories in northeastern India, and the northern states of Himachal Pradesh and Jammu-Kashmir

Weather data

Recent research in economics and agricultural has pointed to the importance of daily fluctuation in temperature for plant growth (Schlenker and Roberts, 2009). Commonly Available data, such as mean monthly temperature, will mask these daily fluctuation, so it is important to obtain daily temperature records.

Conclusion

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A suitable action plan can be prepared with the participation of farmers so that agriculture which is backbone of the country as well as of farmers may be helpful in enhancement of production and thereby poverty alleviation. Climate change effects on agriculture are likely to be ubiquitous, both in terms of direct and indirect impacts. Maintaining plant health across the planet, in turn, is a key requirement for climate change mitigation, as well as the conservation of biodiversity and the provision of ecosystem service sunder global change. Information gathered so far has been fragmented and a comprehensive analysis of climate change impacts on agriculture is required. Experimental research on a diverse range of crop and biotic and abiotic systems is necessary to improve comprehension of climate change impacts on agriculture s. To maintain ecosystem health and services under variable, unpredictable conditions, we need more resilient systems, decentralization, participatory research and breeding networks. At the same time, increased involvement of the many stakeholders and scientists from outside plant pathology shows the

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