CLIMATE CHANGE AND AGRICULTURE: PERSPECTIVES FROM INDIA

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ABSTRACT

Climate change is no more an environmental concern. It has emerged as the biggest developmental challenge for the planet. During the recent decade, with the growing recognition of the possibility of climate change and clear evidence of observed changes in climate during 20th century, an increasing emphasis on food security and its regional impacts has come to forefront of the scientific community. In recent times, the crop simulation models have been used extensively to study the impact of climate change on agricultural production and food security. Adaptation in agriculture to climate change is important for impact and vulnerability assessment and for the development of climate change policy. A wide variety of adaptation options has been proposed as having the potential to reduce vulnerability of agricultural systems to risks related to climate change, often in an *ad hoc* fashion. This paper develops a typology of adaptation to systematically classify and characterize agricultural adaptation options to climate change, drawing primarily on the Indian situation. It is expected that in the coming decades with the increased use of computers, the use of simulation models by farmers and professionals as well as policy and decision makers will increase. In India, substantial work has been done in last decade aimed at understanding the nature and magnitude of change in yield of different crops due to projected climate change. This paper presents an overview of the state of the knowledge of possible effect of the climate variability and change on food grain production in India.

Keywords: Climate change, Environment, Agriculture.

Introduction

Climate change and agriculture are interrelated processes, both of which take place on a global scale. Climate change affects agriculture in a number of ways, including through changes in average temperatures, rainfall, and climate extremes (e.g., heat waves); changes in pests and diseases; changes in atmospheric carbon dioxide and ground-level ozone concentrations; changes in the nutritional quality of some foods; and changes in sea level(Hofmann, 2013).

Climate change is already affecting agriculture, with effects unevenly distributed across the world. Future climate change will likely negatively affect crop production in low latitude countries, while effects in northern latitudes may be positive or negative. Climate change will probably increase the risk of food insecurity for some vulnerable groups, such as the poor (Porter, 2014).

Study Area:

Indian agriculture remains vulnerable to the vagaries of weather, and the looming threat of climate change may expose this vulnerability further. This article presents findings from a study that uses new data to analyse the impact of weather shocks on agricultural productivity in the short run, and that of

climate change in the long run. It shows that climate change could reduce farm incomes by 15-18%, and by 20-25% in unirrigated areas. So, this paper presents the impact of climate change on Indian agriculture.

Objectives:

1. To know the relationship in between Climate change and Indian agriculture.
2. To find out the impacts of climate change and Indian Agriculture.

Data Base and Methodology:

Secondary data will be used to find out the results of the impact of climate change on the crops, soil health and water resources in India.

One of the major challenges facing humankind is to provide an equitable standard of living for present and future generations: adequate food, water, energy, safe shelter and a healthy environment. But, global environmental issues such as land degradation, loss of biodiversity, stratospheric ozone depletion along with human-induced climate change, threatens our ability to meet the basic human needs.

The Third Assessment Report (TAR) of the Intergovernmental Panel on Climate Change (IPCC) reaffirms that the climate is changing in ways that cannot be accounted for by natural variability and that 'global warming' is happening. Global mean temperatures have risen (0.6oC in the last century), with the last decade being the warmest on record. Climate change will, in many parts of the world, adversely affect socio-economic sectors, including water resources, agriculture, forestry, fisheries and human settlements, ecological systems and human health, especially in developing countries due to their vulnerability.

Vulnerability to climate change is closely related to poverty, as the poor have fewer financial and technical resources. They are heavily dependent on climate-sensitive sectors such as agriculture and forestry; they often live on marginal land and their economic structures are fragile. This is true for a developing country like India where agriculture remains the mainstay of the economy, contributing nearly 27% of the total Gross Domestic Product (GDP) and employing nearly two-thirds of the country's population. Agriculture exports account for 13 to 18% of total annual exports of the country. However, given that 62% of the cropped area is still dependent on rainfall; Indian agriculture continues to be fundamentally dependent on the weather.

Climate change will have an economic impact on agriculture, including changes in farm profitability, prices, supply, demand and trade. The magnitude and geographical distribution of such climate-induced changes may affect our ability to expand the food production as required to feed the populace. Climate change could thus have far reaching effects on the patterns of trade among nations, development and food security.

Agriculture is sensitive to short-term changes in weather and to seasonal, annual and long term variations in climate. Crop yield is the culmination of a diversified range of factors. Parameters like soil, seed, pest and diseases, fertilizers and agronomic practices exert significant influence on crop yield. The burgeoning population, along with human-induced climate change and environmental problems is increasingly proving to be a limiting factor for enhancing farm productivity and ensuring food security for the rural poor.

Agricultural productivity can be affected by climate change in two ways: first, directly, due to changes in temperature, precipitation and/or CO2 levels and second, indirectly, through changes in soil,

distribution and frequency of infestation by pests, insects, diseases or weeds. Acute water shortage conditions, combined with thermal stress, could adversely affect wheat and, more severely, rice productivity in India even under the positive effects of elevated CO2 in the future. The mean temperature in India is projected to increase by 0.10 C to 0.30C in *kharif* (summer) and 0.30C to 0.70C in *rabi* (winter) by 2010 and to 0.40C to 2.00C in *kharif* and 1.10C to 4.50C in *rabi* by 2070 (IPCC, 1996). Mean rainfall is projected not to change by 2010 but may increase by 10% during *rabi* by 2070. At the same time, there is an increased possibility of climate extremes, such as the timing of onset of monsoon and intensities and frequencies of droughts and floods. The findings of several studies carried out in India are given in Table-1.

Table 1

Crop	Scenario	Projection	References
Rice	2^{0C} rise 1.5^0C rise + 2 mm rainfall rise + 460 ppm CO_2	-0.06 - 0.075 ton / hec +12% in South India	Aggarwal & Kalra (1994)
Wheat	2^0C rise + 425 ppm CO_2	-1.5 - 5.8% in sub tropical India -17-18% in tropical India -10% in Punjab, Haryana	Kumar & Parikh (1998)
Maize	2^0C rise + 425 ppm CO_2	-7-12% in North India	Chatterjee (1998)

From Table-1, it is clear that most of the staple food crops in India are going to be adversely affected. For sugarcane, it was observed that for every 1°C rise in temperature, there would be a marked reduction in its yield.

Impact of climate change on soil

The soil system responds to the short-term events such as episodic infiltration of rainfall and also undergoes long-term changes such as physical and chemical weathering due to climatic change. The potential changes in the soil forming factors directly resulting from global climate change would be in the organic matter supply, temperature regimes, hydrology and changes in the potential evapotranspiration. Both the organic matter and carbon to nitrogen ratio(C: N ratio) will diminish in a warmer soil temperature regime. Drier soil conditions will suppress both root growth and decomposition of organic matter and will increase vulnerability to erosion. Increased evaporation from the soil and accelerated transpiration from the plants themselves will cause soil moisture stress.

Impact on pests, diseases and weeds

Incidence of pest and diseases would be most severe in tropical regions due to favourable climate/weather conditions, multiple cropping and availability of alternate pests throughout the year. Climate change is likely to cause a spread of tropical and subtropical weed species into temperate areas and

to increase the numbers of many temperate weed species currently limited by the low temperature at high latitudes.

- For short-season crops such as wheat, rice, barley, oats, and many vegetable crops, extension of the growing season may allow more crops in a year.
- Longer-season cultivars can be sown to provide a steadier yield under more variable conditions.
- Late maturing varieties and alteration of time of sowing to take advantage of the longer growing seasons needs to be adopted.
- Changes in cropping pattern (shift from rice–wheat cropping system to other favourable crop mix) may be adopted. Crop diversification in Canada and in China has been identified as an adaptive response.
- Heat and drought tolerant, pest resistant, salt tolerant varieties would be beneficial. Genetic engineering and gene mapping offer the potential for introducing a wider range of traits.
- Minimum, reduced or conservation tillage technologies, in combination with planting of cover crops and green manure crops, offer substantial possibilities to reverse existing soil organic matter, soil moisture, soil erosion, and nutrient loss to combat further losses due to climate change.
- Water resources in the semi-arid regions are expected to decrease due to climate change. Increased evaporation (resulting from higher temperature), combined with changes in precipitation characteristics (amount, variability and frequency), has the potential to affect agriculture - the predominant user of water. Better water management is required for enhancing crop productivity and ensuring food security. Generally, irrigated agriculture is less adversely affected than dry land agriculture but adding irrigation is a costly affair as it is dependent upon the availability of water supplies.
- Added nitrogen and other fertilizers would likely be necessary to take full advantage of the CO2 effect but may have deleterious effects on humans and aquatic ecosystems.

The above facts demand urgent measures, from the scientific community and the government. Some of the adaptation measures at the farmers' level could be:

Water and nutrient management thus, have to be redefined in various agro-ecologies to meet the future demands.

Strategies for facing the challenge

Specific measures can only provide a successful adaptive response if they are adopted in appropriate situations. A variety of issues need to be considered, including land-use planning, watershed management, disaster vulnerability assessment, consideration of port and rail adequacy, trade policy, and the various programmes countries use to encourage or control production, limit food prices, and manage resource inputs to agriculture.

Important strategies for improving the ability of agriculture to respond to diverse demands and pressures include:

- Improved training and general education of populations dependent on agriculture.
- Research on new variety development, incorporating various traits such as heat and drought tolerant, salt and pest resistant should be given prime importance.
- Food programmes and other social security programmes, to provide insurance against local supply changes.

- ❖ Infrastructure facilities like transportation, distribution and market need to be improved.
- ❖ Existing policies may limit efficient response to climate change. Changes in policies such as crop subsidy schemes, land tenure systems, water pricing and allocation, and international trade barriers could increase the adaptive capability of agriculture.

Conclusion

Climate change is widely agreed to be already a reality, and its adverse impacts on the vulnerability of poor communities are superimposed on existing vulnerabilities. Climate change will further reduce access to drinking water, negatively affect the health of poor people, and will pose a real threat to food security in many countries in Africa, Asia and Latin America. Consequently, the World Bank is moving towards mainstreaming climate risk in all its work, and integrating climate-change adaptation, where appropriate, in projects, strategies and policies. We believe this is necessary to ensure the effectiveness of our investments in poverty eradication and sustainable development. Signals of climatic change are already visible. Global climate change is going to affect major crops like rice, wheat, maize in India. Climate is the least manageable of all resources. Hence, to avert the ill effects of climate change, more attention has to be paid to other resources and technologies viz. soil, irrigation water, nutrients, crops and their management practices, to sustain the productivity and to ensure food and environmental security to the country. Adaptive measures are to be taken in a timely fashion, both at the farmers' level (backed by strong agriculture/climate research and application oriented outputs) as well as at the policy makers' level to enable the small and marginal farmers to cope with the adversities of climate change.

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