

IMPACT OF CLIMATE CHANGE ON AGRICULTURE

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KEYWORDS: Climate Change, Agriculture, Food Supply, Vulnerability, Impact, Adaptation, Mitigation.

ABSTRACT:

This paper attempts to take an overview of the impacts of climate change on world agriculture. It focuses on the Indian scenario, i.e. on climate change impacts on Indian agriculture. It explores how agricultural growth and environmental sustainability has to be achieved while coping with the climate change phenomena. Agriculture sector reveals high sensitivity and resilience to climate change. Agriculture is an important driver of the wheels of the Indian economy. Therefore, agricultural sector needs to be improved steadily on sustainable basis. India needs to prepare in advance to face the consequences of climate change. FAO estimates that this year due to the shocks of the economic crisis combined with high national food prices, the number of hungry people is expected to grow overall by 11 per cent. Genetically modified crops are emerging as the major solution to increase productivity of crops in the future as drought and climate change have an impact on yields. Agricultural sector in developing countries is carried out by small-scale subsistence farmers who are poor. They are forced to extend their farming activities over the marginal rainfall areas and on degraded lands as well. Due to global warming, the frequency of droughts in several tropical countries has increased, which has impacted severely on agriculture, especially the small and marginal farmers. Food production in several countries is severely disrupted because of flooding. Approximately 20 to 30% of plant and animal species assessed so far are likely to be at increased risk of extinction if increases in global average temperature exceed 1.5 to 2.5°C. If global average temperature exceeding 1.5 to 2.5°C, with an increase in atmospheric CO₂ concentrations, major changes in ecosystem structure and function are projected. This will have negative consequences for biodiversity and ecosystem goods and services, mainly food supply. At lower latitudes, in dry and tropical regions, productivity of crops is likely to decrease with small local temperature increases (1 to 2°C). This would increase the risk of hunger. Therefore, agriculture sector needs to be given an all round push by adopting modern technologies especially by developing countries.

1. INTRODUCTION

Climate change is one of the most important global environmental challenges of the present century. Response to climate change in developed and developing countries varies greatly. Climate change impacts are not felt in isolation. The impacts of climate change vary across space and there are important yet complex interactions occurring at different spatial scales. The most visible impacts of climate change are the increased global mean surface temperature; increased frequency and severity of drought, variations in precipitation, and increased heavy precipitation events. All these manifestations have a significant impact on world agriculture. Of all the sectors of economic activities, agricultural sector is heavily dependent on weather and climate and highly influenced by global warming. Agriculture sector reveals high sensitivity and resilience to climate change. Due to global warming, the frequency of droughts in several tropical countries has increased, which has impacted severely on agriculture. Food production in several countries is severely disrupted because of flooding. This is also the consequence of climate change. Changes in global supply and demand for various crops provide new challenges to farmers worldwide. This paper attempts to take an overview of the impacts of climate change on world agriculture. It focuses on the Indian scenario, i.e. on climate change impacts on Indian agriculture. It explores how agricultural growth and environmental sustainability has to be achieved while coping with the climate change phenomena.

1.1 Vulnerability to Climate Change

There are large variations in vulnerability to climate change among regions, sectors and various groups. Vulnerability to climate change varies across regions, sectors, and social groups. Understanding the regional and local dimensions of vulnerability is essential to develop appropriate and targeted adaptation efforts. The private sector and civil society have key roles to play in supplementing government efforts to reduce vulnerability. Several countries in the tropical and sub tropical zones are more vulnerable to the potential impact of global warming, whereas some countries in the temperate zone may reap some benefits from climate change. Developing countries are located in areas which are within or bordering hot areas. In developing countries agricultural systems are much less capital and technology intensive. Therefore, they are more vulnerable to climate change. The predictions of future concentrations of greenhouse gas emissions and patterns of climate change and global warming are uncertain. So also is the vulnerability to climate change.

It has been observed in a global assessment of the potential impact of climate change on world food supply that if the atmospheric carbon dioxide concentration doubles, it will result in a small increase in global crop production. Depending on the projected climate, the extent of decreased production varies by countries. The production is expected to increase in developed countries. However, there will be disparities between crop production in developed and developing countries. Along with food production, livestock production is also influenced by climate change. Because of the impact of climate change on grazing lands and animal productivity, livestock production will be affected.

2. A REVIEW OF STUDIES

Several studies have been conducted to assess the likely impact of greenhouse gases on agriculture in developing countries. Climate sensitivity of agriculture has been measured by cross sectional analysis, agronomic analysis model and Agro-Ecological Zone (AEZ) modelling. Actual farm performance is measured in different climate zones in cross sectoral analysis. Agronomic experiments are carried out on major crops. Ecophysiological relations are established to predict plant performance in AEZ modeling. Agronomical studies suggest that warming may influence crop yields, and they are likely to reduce. The farmers may try to overcome this problem with the adaptation efforts like carbon fertilization.

Some studies have pointed out that because of higher temperatures during the growing season, the harvests of maize, rice and other staple crops could drop by up to 40 per cent by the end of the century. Due to projected temperature rise, crop yields could reduce by as much as 20–30 per cent in the tropical and subtropical areas. As there is an urgent need for investment in infrastructure, scientists have highlighted the necessity of massive investments to develop crops that are tolerant to heat. Warming leads to water stress and increases the necessity of irrigation. In order to develop irrigation massive investment is required. International Rice Research Institute estimates that between 15 to 20 million hectares of irrigated rice would be hit by some degree of water scarcity by 2025. (The Times of India, 24-07-09)

Studies were carried out in selected regions identified as vulnerable to climate change and also economically backward. At the village level, case studies were conducted focusing on the social and economic implications of climate change impacts on inland and coastal agriculture. The impacts of climate variability and economic changes on lives of the villagers were studied. The studies included the strategies used by the villagers in coping with these changes, and the impacts of government policy on the coping strategies. At each site, surveys and interviews were conducted with farmers and local officials. The results of the surveys will help to design policy recommendations regarding adaptation to climate change. The studies revealed that the farmers have the ability to adapt to climate variability. Their ability also depends on government policies. In all the case studies economic status, agricultural practices, coping mechanism and access to facilities and services were taken into consideration. Certain other issues specific to each district were also considered. Case studies attempted to study the implications of differential access to irrigation facilities. A study focused on the opportunities offered by crop diversification and contract farming. Villages prone to river flooding and storm surges offered insights into these two dimensions of coastal vulnerability. Some information was also collected through questionnaires. Certain themes common to all the case studies were the economic status, agricultural practices, coping mechanisms, and access to facilities and services. Certain other issues specific to each district were also reflected in the selection of villages. For instance, the implications of differential access to irrigation facilities, the opportunities offered by crop diversification and contract farming. The choice of two villages

prone to river flooding and storm surges respectively offered insights into these two dimensions of coastal vulnerability.

3. IMPACT OF CLIMATE CHANGE ON INDIAN AGRICULTURE

Agriculture is an important driver of the wheels of the Indian economy. About 700 million of its rural population (over 60% of our labour force) depends directly on climate-sensitive sectors such as agriculture, forests and fisheries, and natural resources for their subsistence and livelihoods. Climate change is impacting all the natural ecosystems as well as socio-economic systems of the country. Climate change will have major impact on Indian agriculture. Climate change in agriculture sector is posing the toughest challenge for India's 11th plan objective of making growth inclusive. "Simulations using dynamic crop models indicate a decrease in yield of crops as temperature increases in different parts of India. However, this is offset by an increase in CO₂ at moderate rise in temperature and at higher warming. Negative impact on crop productivity is projected due to reduced crop durations" (Pascheem, 2009) Therefore, agricultural sector in India needs to be improved steadily on sustainable basis. India needs to prepare in advance to face the consequences of climate change. Farmers have to assure food security for the country. A second green revolution is urgently needed to raise the growth rate of agricultural GDP to around 4%. Agricultural sector in India is dominated by small-scale subsistence farmers who are poor. They are forced to extend their farming activities over the marginal rainfall areas and on degraded lands as well. Agriculture in India is closely linked with forestry sector. The impact of projected climate change on forest ecosystems, carbon stocks and mitigation capacity of forests in India is under study. Water resources form the basis for India's agriculture and power needs. They will be adversely impacted due to global warming. A project is going on to study climate change and persistent droughts-impact, vulnerability and adaptation in rice growing sub divisions of India. The Norwegian Institute of Environmental and Agricultural Research is taking part in a programme on integrated adaptation strategies to sustain rice productivity under different climate change scenarios in India.

Though agriculture's share in the total green house gas (GHG) emissions of India is relatively small, it will be a big loser as a consequence of climate change. Agricultural sector contributes 28% of the country's GHG emissions as per the sources of Environment and Forest Ministry (Sud, 2008). As per the findings of the study conducted by the Indian Agricultural Research Institute (IARI) New Delhi, with every 1 degree C. increase in temperature throughout the growing period of the crop, the overall wheat production may be lost by 4 to 5 million tones. In this study it is assumed that the availability of irrigation water would remain the same. But with retreating Himalayan glaciers, and increasing uses of water for industrial and other purposes, it is bound to decrease. The possible adverse bearing of global warming on the output of other crops has still not been assessed. But it is likely to be relatively less. The kharif (summer) crops may have a comparatively smaller impact.

3.1 Adjustments at Farm Level

In order to reduce or overcome the adverse impacts of climate change on agriculture, adaptive actions need to be taken at various levels. Some of the adjustments at farm level are:

- Introduction of later- maturing crop varieties or species, heat and drought resistant crop varieties by utilizing genetic resources better adapted to new climatic conditions. Better compatibility to new agricultural technologies
- Switching cropping sequences, Sowing earlier, adjusting timing of field operations,
- Conserving soil moisture through appropriate tillage methods, and improving irrigation efficiency.

Genetically modified crops are emerging as the major solution to increase productivity of crops in the future as drought and climate change have an impact on yields. Some measures such as switching crop varieties are simple, easier, effective and inexpensive. Introducing irrigation or efficient water-conserving technologies need huge investments. Economic adjustments are also necessary. They involve shifting and adjustments of various capital inputs necessary for agriculture. Studies combining biophysical and economic impacts have revealed that market adjustments can moderate the impacts of reduced yields. Over the period of time, crop yields are likely to increase with advances in technology. But the historical trends reveal that the increase may be at a slower rate.

3.2 Adaptation and Mitigation in Agricultural Sector in India

India has initiated certain steps that the developing countries can adopt. They include 'climate proofing' of public infrastructure investments, food security and water resources. India's Green House Gas emissions are among the lowest in per capita terms. The adverse impact of global warming on agriculture can be mitigated to an extent by suitably adapting to the changed climatic and ecological conditions. Some of the measures suggested for adaptation and mitigation in agricultural sector in India are:

1. Identification of the present vulnerabilities of agricultural systems.
2. Agricultural research to develop new crop varieties.
3. Improved training and general education of populations dependent on agriculture.
4. Food programs and other social security programs to provide insurance against supply changes.
5. Transportation, distribution, and market integration to provide the infrastructure to supply food during crop shortfalls.
6. Removal of subsidies, as it controls the changes in prices, which overshadow the climate change signal in the marketplace.

4. ADAPTIVE RESPONSE WORLD OVER

World economic crisis has resulted in lower incomes and increased unemployment. FAO estimates that this year due to the shocks of the economic crisis combined with high national food prices, the

number of hungry people is expected to grow overall by 11 per cent. Changes in global supply and demand for various crops provide new challenges to farmers worldwide. Food insecurity is emerging as a major problem. On this backdrop, it is pertinent to study the adaptive actions taken world over to tackle the impact of climate change in the agricultural sector.

As a major adaptive response, it is suggested that breeding of heat and drought resistant crop varieties be introduced. They will utilize genetic resources that may be better adapted to new climatic and atmospheric conditions. Collections of such genetic resources are maintained in germ-plasm banks. These may be screened to find sources of resistance to changing diseases and insects, as well as tolerances to heat and water stress and better compatibility to new agricultural technologies. Crop varieties with a higher harvest index (the fraction of total plant matter that is marketable) will help to keep irrigated production efficient under conditions of reduced water supplies or enhanced demands. Genetic manipulation may also help to exploit the beneficial effects of CO₂ enhancement on crop growth and water use.

The International Food Policy Research Institute (IFPRI) conducted a survey of 1,000 Ethiopian cereal crop farmers in the Nile River basin, in Ethiopia. The main finding of the study was that poor access to technology and weak informal network adversely affect farmers' ability to adapt to climate change. Several farmers do not adapt to changes in temperature and rainfall. They have to face the problems like shortages of labour, land and money. Sometimes they do not get proper information. Scientists have observed that national and regional climate change research institutions are not interacting well with each other. Therefore, the speed and quality of information sharing is also affected. Farmers need to adapt their farming practices to new conditions. Therefore, they need to be informed on the use of climate information to maximize agricultural production.

CONCLUSION

Approximately 20 to 30% of plant and animal species assessed so far are likely to be at increased risk of extinction if increases in global average temperature exceed 1.5 to 2.5°C. If global average temperature exceeding 1.5 to 2.5°C, with an increase in atmospheric CO₂ concentrations, major changes in ecosystem structure and function are projected. This will have negative consequences for biodiversity and ecosystem goods and services, mainly food supply. At lower latitudes, in dry and tropical regions, productivity of crops is likely to decrease with small local temperature increases (1 to 2°C). This would increase the risk of hunger. Therefore, agriculture sector needs to be given an all round push by adopting modern technologies especially by developing countries. The international community should help developing countries to study various impacts, identify adaptation strategies, and prepare programs for various locations to help the rural poor most vulnerable to climate change.

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