

## CLIMATE CHANGE AND ITS ANTICIPATED IMPACTS WITH SPECIAL REFERENCE TO INDIAN AGRICULTURE

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### *Abstract*

*The present paper is an attempt to summarize the nature, magnitude and causes of climate change, and its anticipated consequences for human society especially for agriculture. Agriculture is itself responsible for an estimated one third of global warming and climate change. It is generally agreed that about 25 per cent of the main greenhouse gas, carbon dioxide, is produced by agricultural sources. Our daily lives activities adversely contribute to the change in the climate. Climate change is having impact on agriculture, tourism industries, ecosystems, health etc. Climate change also affects the insurance and credit market for agriculture. Major risks in Indian agriculture arising from climate change are decline in yields, increased farm expenditure, reduced farm incomes and increased threat of food, drought, insecurity and malnutrition. Significant negative impacts of climate change over time on Indian agriculture are reduction of agriculture yields and fall in GDP growth up to 2% per annum.*

**Keywords:** *Climate change, agriculture, India, global warming, crop-insurance.*

### **INTRODUCTION**

Climate is the pattern of weather conditions over time for a given area. Weather is the condition of the atmosphere at a particular place and time. It is characterized by parameters such as rain, wind, temperature and humidity. Climate change refers to change in the state of the climate system over time such as changes in global temperatures whether due to natural variability or as a result of human activity. Climate change may be limited to a specific region or part of a country and/or may occur across the whole Earth. The present paper is an attempt to summarize the nature, magnitude and causes of climate change, and its anticipated consequences for humane society especially for agriculture.

### **NATURE, MAGNITUDE AND CAUSES OF CLIMATE CHANGE**

The Inter-governmental Panel on Climate Change (IPCC) defines climate change as: “a change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcing or to persistent anthropogenic changes in the composition of the atmosphere or in land use”. The United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as “a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global

atmosphere and which is in addition to natural climate variability observed over comparable time periods". Climate change is a long-term change in the Earth's climate, or of a region on Earth (NASA).

Climate change is occurring due to increase in the level of greenhouse gases (GHG). In greenhouse gases, carbon dioxide, methane, nitrous oxide and fluorinated gases are the main contributors. GHG emissions have had a significant impact on the climate. Human activities are changing the natural greenhouse. According to IPCC, the three main causes of the increase in greenhouse gases observed over the past 250 years have been fossil fuels, land use, urbanization, industry, transportation and agriculture. Agriculture is itself responsible for an estimated one third of global warming and climate change. It is generally agreed that about 25 per cent of the main greenhouse gas, carbon dioxide, is produced by agricultural sources, mainly deforestation and burning of biomass. Fertilizer used in agriculture account for 60 per cent of the nitrous oxides. The Food and Agriculture Organization (FAO) has estimated that meat production accounts for nearly a fifth of global greenhouse gas emissions. These are generated during the production of animal feeds.

In its Fourth Assessment Report, the Intergovernmental Panel on Climate Change, a group of 1,300 independent scientific experts from countries all over the world under the auspices of the United Nations, concluded that there's a more than 90 percent probability that human activities over the past 50 years have warmed our planet. The industrial activities that our modern civilization depends upon have raised atmospheric carbon dioxide levels from 280 parts per million to 400 parts per million in the last 150 years.

The Industrial Revolution in the 19th century saw the large-scale use of fossil fuels for industrial activities. These industries created jobs and over the years, people moved from rural areas to the urban areas. Natural resources are being used extensively for construction, industries, transport, and consumption. Also, population has increased day by day which results increasing use of land for production and more used of fertilizers in agriculture. And more fertilizer means more emissions of nitrous oxide, both from the field into which it is put and the fertilizer industry that makes it. Pollution also results from the run-off of fertilizer into water bodies. Some people migrate to environmentally fragile areas and they forced on the exploitation of the natural resources. Hence the forest covers declines; it has adverse impact on the climate including rainfall, floods, droughts, land slide etc. Wastes, which originates from production and consumption process also increased day by day. Our daily lives activities adversely contribute to the change in the climate. Electricity that we use in our daily life is generated mainly from thermal power plants. These thermal power plants are run on fossil fuels (mostly coal) and are responsible for the emission of huge amounts of greenhouse gases and other pollutants. Means of transportation such as cars, buses, and trucks are run mainly on petrol or diesel, both fossil fuels. Gases extensively used in refrigerators, air-conditioners, freezers and aerosol cans are also responsible for climate change. Also, widespread destruction of trees could significantly increase the amount of CO<sub>2</sub> in the atmosphere. All this has contributed to a rise in greenhouse gases in the atmosphere

## **ANTICIPATED CONSEQUENCES OF CLIMATE CHAMNGE**

The consequences of climate change are difficult to predict. But certain effects seem likely such as on average, earth temperatures increase. Warmer conditions will vary depends on the different parts of the world. Some regions may become wetter and others dryer. Some regions may welcome warmer temperatures, but others may not. However, some crops and other plants may respond favorably to increase atmospheric CO<sub>2</sub>, growing more vigorously and using water more efficiently. At the same time, higher temperatures and shifting climate patterns may change the areas where crops grow best and affect the makeup of natural plant communities. Another serious consequence of climate change is that the sea level increased day by day. Some other consequences of climate change are heavy downpours followed by floods, droughts, storms, heat and cold waves and wild fires, those often destroy lives, property and ecosystems. Climate changes also disrupt the recreation and tourism industries which also depend on weather patterns. Climate change is also having an impact on health. In some regions heat related illnesses increases, whether in other regions there are increases in cold related illnesses.

### **IMPLICATIONS FOR AGRICULTURE**

The rise in global temperature on account of climate change would affect agriculture. The frequent climate change, particularly low rainfall and warming has posed serious threat to Indian agriculture. Major risks in Indian agriculture arising from climate change are decline in yields, increased farm expenditure, reduced farm incomes and increased threat of food, drought, insecurity and malnutrition. High temperatures also affect the quality of product. Increase in temperature causes distress to dairy animals affecting milk production. While in temperate latitudes a rise in temperature would help some countries to increase food productivity, it will have adverse effects in India and countries in the tropics. Significant negative impacts of climate change over time on Indian agriculture are reduction of agriculture yields and fall in GDP growth up to 2% per annum.

In India Climate changes shorten the Rabi season and decrease yield. The June-September monsoon is critical for the country as two-thirds of Indians depend on agriculture. The monsoon accounting for 75% of India's rainfall significantly impacts country's agriculture and livelihood of tens of millions of small farmers. Climate change is likely to intensify the variability of monsoon dynamics, leading to a rise in extreme seasonal aberrations, such as increased precipitation and devastating floods in some parts of the country as well as reduced rainfall and prolonged droughts in other areas. Such uncertainties of the monsoon have an adverse impact on Indian agriculture. Last year, the farm economy was hammered by a severe drought which affected agriculture production and results the tragedy of Indian farmers suicide. It is generally believed that extreme temperatures and heat spells could alter patterns of monsoon rains. There have been reports by scientists that India will experience a decline in summer rainfall by the year 2050 or even earlier. This has been corroborated by G. Nelson of the Washington-based International Food Research Institute (IFRI) as he felt that the situation may worsen by 2050 with "higher temperatures, less precipitation, depending on where in South Asia you are". Reports reveal that climate change is likely to increase the number of people at risk of hunger compared with reference scenarios with no climate change (Schmidhuber & Tubiello, 2007). Due to climate change, reductions in cereal production of up to 22 per cent are likely in South Asia (Tubiello & Fischer 2007). Prices of cereals more than doubled in 2008 and further increased in 2013 compared to 2000 as consumption has

been consistently higher than production and that has reduced stocks steadily. According to the World Development Report 2010, India's post-1980 deceleration in the increase of rice productivity is attributable not only to deteriorating irrigation infrastructure and also partly to stagnant rice prices but also to climate phenomena from local pollution and global warming. Extrapolating from year-to-year variations in climate and agricultural outcomes, yields of major crops in the country are projected to decline by 4.5 to 9 percent within the next three decades, even allowing for short-term adaptations. The implications of such climate change for poverty and GDP could be enormous given projected population growth and that one percentage point of agricultural GDP growth in developing countries, including India increases the consumption of the population by 4 to 6 percentage points. After 2050, temperature in India is expected to rise by 3-4°C over current levels and rainfall would become heavier, more intense and erratic and less regular, posing a threat to Indian agriculture, according to the Indian Institute of Tropical Meteorology, Pune.

Climate change also affect the health, growth and productivity of crops, livestock, fish, forest and pasture in different ways. It will, also, have an impact on the incidence of pests and diseases, biodiversity and ecosystems. Frequent changes in weather parameters, more importantly temperature and precipitation would not only threaten food production but also access, stability and utilization of food resources. Low rainfall and high warming have affected the yield of rice and wheat. According to Sinha and Swaminathan (1991) increase of 2-degree centigrade temperature could decrease the rice yield by about 0.75 ton/ha in the high yielding areas and a 0.5-degree centigrade increase in winter temperature would reduce wheat yield by 0.45 ton/ha. Moreover, an increase in winter temperature would there by translate into a 10 per cent reduction in wheat production in the high-yield states of North India. Kumar & Parikh (1998) showed that even with adaptation by Indian farmers of their cropping pattern and inputs, in response to climate change, the losses would remain significant. The loss in farm level net revenue is estimated to range between 9 and 25 per cent for a temperature rise of 2° C to 3.5° C. Later in 2001 they projected that with 2° C increase in temperature and 7 percent increase in precipitation, the net revenue of India will decline by 8.4 per cent. Assamese tea, Himachal's apples, Maharashtra's grapes, Goa's mangoes and cashew nuts and Kerala's paddy crops and Haryana's wheat are seen to be affected by climate change. Climate change is also likely to have significant effect on the quality of plantation and cash crops such as cotton, fruits, vegetables, tea, coffee, aromatic & medicinal plants, etc.

Agencies like Inter-Governmental Panel on Climate Change (IPCC, 2007) and Universal Ecological Fund (2011) have indicated the effect of climate change on agriculture, globally. According to these reports, there will be 14 per cent deficit in global wheat production, 11 per cent in rice and 9 per cent in maize by 2020. Research findings coming from different parts of the world indicate that climate change will affect many crops. According to a report of the Central Government of India in the Parliament, the productivity of staple grain wheat could decline by up to 18 per cent by 2020 due to adverse impact of climate change. The yield of another major food crop, rice might also fall by up to 6 per cent by 2020. These findings are based on the research conducted under Indian Council of Agricultural Research (ICAR)'s *Network Project on Climate*

*Change* (NPCC). The report further indicates that the productivity of kharif maize and sorghum could also be affected by climate change.

Climate change also affects the insurance and credit market for agriculture. Agricultural insurance is an important mechanism by which risks to agricultural output and income can be addressed. Crop insurance incentivizes farmers to adopt innovative options by spreading the risks over space and time. But some new risks emerging from climate change which may results crop insurance riskier as well as costlier for the insurance company and may fail the insurance market for crop due to climate change.

To manage the additional risks arising from climate change, credit support to farmers is essential for sustaining farm productivity. Because of climate change cost of production of farmer's increases which required more credit and ultimately the demand for credit increases and the credit becomes costlier.

### **FINDINGS OF SOME OF THE STUDIES RELATED TO INDIA**

Climatic changes are believed to be accentuated by accumulation of greenhouse gasses in the earth's atmosphere, and anthropogenic activities over the last few centuries are said to have contributed significantly to the process. Despite debates and controversies surrounding the nature, magnitude and impact of the phenomenon, climate change issues have attracted growing attention of researchers and policymakers all over the world. Because climatic factors such as temperature and precipitation directly impact agronomical aspect of crops, changes in these variables are bound to have a significant impact on crop yield and its variability. Further, through their impact on water availability and the eco-system, climatic changes can have further influence on longer term agricultural prospect of a country or a region. Moreover, accentuated weather uncertainties can also have implications for credit delivery and insurance support to the farm sector.

Studies for India, such as Mall et al (2006), Kumar (2011) etc., mostly based on data for the last century, find that impact of climate change on agriculture has been varied across seasons and regions. Climate change implications will obviously render policy making for agriculture in India a more complex task in the coming years. One interesting finding from a study related to Andhra Pradesh is that "a monsoon-dependent crop is more sensitive to temperature and precipitation, whereas a winter crop remains largely resilient to changes in the levels of climate variables" (Barnwal and Kotani, 2013: 95). As composition of agricultural production in India has already started to shift away from southwest monsoon dependent kharif crops to winter crops, the country should be in course for gathering resilience against climate related uncertainties. The process can be further bolstered by stepping up public and private investments for expansion and fuller utilization of irrigation capacity. In other words, policy approach to address climate change concerns can have considerable convergence with the overall policy approach for strengthening agricultural sector of the economy. Lal et al. (1999) projected 50% increased yield for soybean for a doubling of CO<sub>2</sub> in central India. However, a 3<sup>o</sup> C rise in surface air temperature almost cancels out the positive effects of doubling of carbon dioxide concentration. A decline in daily rainfall amount by 10% restricts the grain yield to about 32%. Hundal and Kaur (1996) examined the climate change impact on productivity of wheat, rice, maize and groundnut crop in Punjab. If

all other climate variables were to remain constant, temperature increase of 1, 2 and 3 degree Centigrade from present day condition, would reduce the grain yield of wheat by 8.1, 18.7 and 25.7%, rice by 5.4, 7.4 and 25.1%, maize by 10.4, 14.6 and 21.4% and seed yield in groundnut by 8.7, 23.2 and 36.2%, respectively. Surface temperature variability also will play an important role in affecting agricultural production in the country (Kumar *et al.*, 2001). 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. Indian agricultural production and consequently, the country's Gross Domestic Product (GDP) show a strong link with Indian Summer Monsoon Rainfall (ISMR) (Gadgil and Gadgil 2006, Kumar *et al.*, 2004).

## CONCLUSION

Scientific evidence has by now confirmed that climate change has been taking place and that human activity has contributed to it. There is however still no unanimity regarding the exact nature and magnitude of the problem. But the effects of the phenomenon will not be limited to country boundaries. Hence no country in the globe should think that it is a problem of the others. Irrespective of which countries of the world are expected to be more adversely affected, the global community must collectively self-govern itself to adopt measures for mitigating the impending common problem. The economic impacts of climate change in agriculture is that some new risks emerging from climate change which may results crop insurance riskier as well as costlier for the insurance company and may fail the insurance market for crop due to climate change.

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