

Climate Change and its Impact on Agriculture

Abstract

Climate change is a change in the space and time distribution of weather patterns or conditions or properties of a region or some regions or the entire earth. It is caused by natural processes like biotic processes, variation in Earth orbit, variation in albedo or reflexivity of ocean and continents, continental drift and mountain building, variation in solar radiation on earth, glacier melting, floods, volcanic eruptions and plate tectonics or anthropogenic activities like deforestation, burning of crop residues, use of fossil fuel and high energy consumption through electronics gadget (use of air conditioners, aeroplanes, refrigerators, vacuum cleaners etc). While the term "global warming" means specific increase in surface temperature due to human activities, the term "Climate change" is very comprehensive and includes global warming as well as other changes in weather pattern / condition resulting into more emissions of greenhouse gases due to both human activities and natural processes.

Keywords: Climate Change, Global Warming, Pollution, Ecosystem.

Introduction

The 2007 IPCC Fourth Assessment Report (AR4) summarizes the magnitude of impact of various degrees of warming. According to IPCC AR4, 1.5°C surface warming above pre-industrial temperature will lead to widespread coral mortality, hundreds of millions of people at risk of increased water stress, more damages from droughts and heat waves and floods and increased species extinction rates. Once we surpass 2°C the impact listed above are exacerbated, and some new impacts will occur, coastal flooding will impact millions of people, coral bleaching will be widespread, global food crop production will decline and sea level will rise by close to 1 meter by 2100. Up to 30% of global species will be at risk of extinction.

At 3-4°C warming, widespread coral mortality will occur and 40-70% of global species are at risk. Glacial retreats will threaten water supplies in central Asia and South America, sea level rise of 1 meter or more would be expected by 2100, with the possibility of destabilization of the Greenland and west Antarctic ice sheets which would cause much more sea level rise and flooding of coastal communities.

Aim of the Study

The effects of climate change on the agriculture and ecology of organisms are receiving considerable attention in the scientific literature. This research focuses on the majority of threats which include global warming, sea surface temperature, expanding sea water acidification etc.

Indian Scenario of Climate Change

The areas of special concern to us in India, where agriculture is the predominant source of livelihood, are unfavorable changes in mean temperature, excess or deficit in rainfall, more uncertain weather behaviour including extreme weather events, sea level rise, and more frequent and severe coastal storms and tsunamis.

The rise in mean temperature of 2 to 3.2°C will lead to a reduction in the duration of the wheat crop in North India, resulting in a loss of 6 to 7 million tones of wheat every year.

The World Bank group, through their publication entitled "Managing Climate Risk: Integrating Adaptation into World Bank Group Operations" observed in 2006, the consequences of environmental changes in India especially affecting poor people include:

1. Decreased water availability and water quality in many arid and semi arid region;
2. An increased risk of floods and droughts in many regions, the north-western India, Jharkhand, Orissa and Chhatisgarh are highly prone to

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3. drought. The incidence of Flood expected to occur far more frequently in Plains and Coastal region.
4. Reduction in water regulation in mountain habitats;
5. Decrease in reliability of hydropower and biomass production;
6. Increased incidence of water borne diseases such as malaria, dengue and cholera;
7. Increased damages and deaths caused by extreme weather events, unusual and unprecedented spells of hot weather are expected to occur far more frequently and cover much larger area.
8. Decreased agriculture production and productivity, adverse impacts on fisheries.
9. Adverse effects on many ecological systems specially mountain ecosystem.

Impact of Climate Change on World Agriculture

Despite development in the field of technology, application of science and technology in the field of agriculture to reduce impact of climate change, agriculture productivity appear to be stagnant or declining across the world. The weather still play a key factor in agricultural productivity, The variability in local climates have more impact on agriculture rather than global climate patterns. The Earth's average surface temperature has increased by 1.5⁰ F (0.83⁰ C) since 1880. A 2008 study published in science suggest that , due to climate change , southern Africa could lose more than 30% of main crop maize by 2030. In South Asia lasses of many regional staples, such as rice, millet and maize could loss 10%, the pattern most appear to impacting the developing and poor countries who have less resources to cope with climate change.

The Intergovernmental Panel on climate change (IPCC) Third Assessment Report, published in 2001, concluded that decreased water availability will hardest hit the Tropical and Sub-Tropical countries, it will led to reduced crop yield and exposing crop to new disease.

The increased in the mean seasonal temperature can reduce the duration of many crops and hence reduce crop yield. In area where temperature are already closed to physiological maxima of crops, warming will impacts more immediately (IPCC 2007).

**Impact of Climate Change on India's Agriculture
Temporal and spatial patterns of temperature and precipitation in India.**

1. The average increase in temperature between the most recent decade and the 1970s is about 0.45 degrees and 0.63 degrees in the kharif and rabi seasons respectively.
 - i. Temperature increases have been particularly felt in the North-East, Kerala, Tamil Nadu, Kerala, Rajasthan and Gujarat. On the other hand, Punjab, Odisha Na Uttar Pradesh have been the least affected.
2. During the same period, rainfall for kharif and Rabi season has declined on average by 26 millimeters and 33 millimeters respectively.

- Annual average rainfall has on average declined by about 86 millimeters.
- ii. Rainfall deficiencies are more concentrated in Uttar Pradesh, North-East, and Kerala, chattisgarh and Jharkhand. While, there has actually been an increase in precipitation in Gujarat, Odisha and Andhra Pradesh.
 3. The imprint of climate change is also manifested in the increasing frequency of extreme weather outcomes-
 - i. Proportion of dry day (rainfall less than 0.1 mm per day), as well as wet days (rainfall greater than 80 mm per day) has increased steadily over time
 - ii. Rise in the number of day with extremely high temperatures, and a corresponding decline in the number of days with low temperatures.

**Impact of weather on agricultural productivity
the two key findings are:**

1. Marginal change in weather have little or no impact and the impact is felt almost only when temperature increases and rainfall shortfalls are extreme.
 - i. These findings have important implications for the impact of climate change on agriculture, since most climate change models predict an increase in extreme weather events.
2. Extreme shocks have highly divergent effects between unirrigated (defined as districts where less than 50 percent of cropped area is irrigated) and irrigated areas almost twice as high in the former compared with the latter.
 - i. Crop impacts-crops grown in rainfed areas-pulses in both kharif and rabi-are vulnerable to weather shocks while the cereals-both rice and wheat-are relatively more immune.

Impact of weather shocks on Agricultural Yields

(percentage decline in response to temperature increase and rainfall decrease)

	Extreme temperature shocks	Extreme Rainfall Shocks
Average Kharif	4.0%	12.8%
Kharif, Irrigated	2.7%	6.20%
Kharif, Unirrigated	7.0%	14.7%
Average Rabi	4.7%	6.7%
Rabi, Irrigated	3.0%	4.1%
Rabi, Unirrigated	7.6%	8.6%

Source: Economy survey of India 2017-18

Impact on farm revenue

Table 2 Show the impact of extreme shocks on famer income, measured by value of production.

1. Here again, the largest adverse effects of weather shocks are being felt in unirrigated areas.
2. Also, these figures indicate that even though lower supply should increase local prices, here the "supply shock" dominates, with reductions in yields leading to reduced revenues.

Impact of weather shocks on Farm Revenue

	Extreme temperature shocks	Extreme Rainfall Shocks
Average Kharif	4.3%	13.7%
Kharif, Irrigated	7.0%	7.0%
Kharif, Unirrigated	5.1%	14.3%
Average Rabi	4.1%	5.5%
Rabi, Irrigated	3.2%	4.0%
Rabi, Unirrigated	5.9%	6.6%

Source: Economy survey calculation from IMD & ICRIAT data.

Implication on Agriculture Performance in the Long Run

1. Climate change models predict that temperature in India are likely to rise by 3-4 degree Celsius by the end of the 21st century. These imply that in the absence of any adaptation by farmers and any changes in policy (such as irrigation), farm income will be lower by around 12 percent on an average in the coming years. Unirrigated areas will be the most severely affected, with potential losses amounting to 18 percent of annual revenue.
2. Based on the observed decline in precipitation over the last three decades, it is found that in unirrigated areas, farm income will decline by 12 percent for kharif crops and 5.4 percent for rabi crops.
3. Models of climate change also predict on increase in the variability of rainfall in the long-run, with a simultaneous increase in both the number of dry-days as well as days of very high rainfall. This channel along would imply a decrease in farm incomes by 1.2 percent.
4. These three channels through with climate change would impact farm incomes are likely to be correlated. Taking these correlations into account, farmer income losses from climate change could be between 15 percent and 18 percent on average, rising to anywhere between 20 percent and 25 percent in unirrigated areas. These are stark findings, given the already low levels of incomes in agriculture in India.

Climate Change Mitigation and Adaptation in Agriculture

1. There is need to embrace agricultural science and technology, it will not only be vital in increasing yields but also in increasing reliance to all pathologies that climate change threatens to bring in it's wake.
2. Assist farmers in coping with current climatic risks by providing value added weather service to farmers. Farmers can adapt to climate changes to some degree by shifting planting dates, choosing varieties with different growth duration or changing crop rotations.
3. An Early warning system should be put in place to monitor changes in pest and disease outbreaks. The overall pest control strategy should be based on integrated pest management because it takes care of multiple pests in a given climatic scenario.

4. Participatory and formal plant breeding to develop climatic-resilient crop varieties that can mature before the peak heat phase set in.
5. Developing short duration crop varieties that can mature before the peak heat phase set in.
6. Selecting genotype in crops that have a higher per day yield potential to counter yield loss from heat-induced reduction in growing periods.
7. Preventive measures for drought that include on-farm reservoirs in medium lands, growing of pulses and oilseeds instead of rice in uplands, ridges and furrow system in cotton crops, growing of intercrops in place of pure crops in uplands, land grading and leveling, stabilization of field bunds by stone and grasses, graded line bunds, counter trenching for runoff collection, conservation furrows, mulching and more application of Farm yard manure.
8. Efficient water use such as frequent but shallow irrigation, drip irrigation and sprinkler irrigation for high value crops, irrigation at critical stages.
9. Efficient fertilizer use such as optimum fertilizer dose, split application of nitrogenous and potassium fertilizers, deep placement, use of neem, karanja products and other such nitrification inhibitors, liming acid soils, use of micronutrients, integrated nutrient management.
10. Seasonal weather forecasts could be used as a supportive measure to optimize planting and irrigation pattern.
11. India needs bottom-up planning along with benevolent and strategic top-down planning and reforms.

Conclusion

Climate change can be a mega catastrophe if we do not take action now, both in area of adaptation and mitigation. Anticipatory preparation to potential changes in temperature precipitation and sea level can help to introduce new technologies in farming. The technological transformation of small scale agriculture and fisheries can be a beneficial outcome. Climate change has already increased the volatility of prices of agricultural commodities. In the future it will be difficult to import food grains at an affordable price. Therefore, the future will belong to nations with grains and not guns. An uncommon opportunity now exists for converting a potential calamity like climate change into a tool for achieving the goal of sustainable agriculture.

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