

Effect of Climatic Change on Agriculture: A Review

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Abstract

India is predominately a land of Agriculture major portion of our population is dependent upon Agriculture. The climate change and global warming poses major challenge on Agriculture with changing weather cycle crop production is decreasing causing great loss to farmer and economy as a whole. The solution lies in research there are many researches which are done on these two issues. The paper is an attempt to reviews and assesses the current literature on Effect of Climatic Change on Agriculture. The paper proves effective in knowing about what are the various affect of climate change on agriculture. The paper will help researcher and academicians in knowing the current literature on Effect of Climatic Change on Agriculture.

Key Words: Global Warming, Climate Change, Crop Production, Bio Diversity, Sustainable development.

Introduction

Climate Change an Overview:

Intergovernmental panel on climate change defines Climate change as any change in climate over time that is attributed directly or indirectly due to human activity that alters the composition of the global atmosphere in addition to natural climate variability observed over comparable time periods (IPCC, 2007). Climate change is any significant long-term change in the expected patterns of average weather of region (or the whole Earth) over a significant period of time. It is about non-normal variations to the climate, and the effects of these variations on other parts of the Earth. These changes may take tens, hundreds or perhaps millions of year. But increased in anthropogenic activities such as industrialization, urbanization, deforestation, agriculture, change in land use pattern etc. leads to emission of green house gases due to which the rate of climate change is much faster now. Climate change is caused by the release of 'greenhouse' gases into the atmosphere. These gases (CO), methane (CH) and nitrous oxide (NO) gas accumulate in the atmosphere, which result global warming. The changes in global climate related parameters such as temperature, precipitation, soil moisture and sea level. Some other effects of climatic change is frequent occurrence of E-Nino effects, El Niño is the name given to a periodic heating-up of the surface of the tropical Pacific Ocean, which happens as trade winds weaken and warm water that is usually confined to the western Pacific flows eastwards, away from Indonesia and towards Peru. This creates a huge release of heat into the atmosphere that influences global weather patterns. It is a natural phenomenon and an El Niño happens approximately every seven or eight years. These events are usually weak or moderate, but occasionally an extra-strong or 'super' El Niño happens.

Climate Change and its effects on Agriculture and Economy:

Climate change is not an isolated issue. It has several aspects and inter-linkages namely, science and technology, economy and trade, diplomacy and politics - that makes it not just another issue in this

complicated world of proliferating issues, but the mother of all issues. The global economy is adversely being influenced very frequently due to extreme events such as droughts and floods, cold and heat waves, forest fires, landslips etc.

The agriculture sector both contributes to climate change, as well as will be affected by the changing management. Since climatic factors serve as direct inputs to agriculture, any change in climatic factors is bound to have a significant impact on crop yields and production. (Dinar et al.(1998). Climate change is projected to have significant effects on agriculture production and hence on food security. The rising temperatures, carbon dioxide levels and uncertainties in rainfall associated with global warming may have serious direct and indirect impacts on crop production. Climate change is expected to influence crop and livestock production, hydrologic balances, input supplies and other components of agricultural systems.

Climate Change and its effects on Indian Agriculture:

Many studies in the past have shown that India is likely to witness one of the highest agricultural productivity losses in the world in accordance with the climate change pattern observed and scenarios projected. Climate change projections made up to 2100 for India indicate an overall increase in temperature by 2-40 c with no substantial change in precipitation quantity.(Kavikumar, 2010). India is a large country with 15 agro-climatic zones, diverse seasons, crops and farming systems. For a majority of the people in India, agriculture is the main source of livelihood. Agriculture is also most vulnerable to climate change because it is inherently sensitive to climate variability. Climate change will have an impact on Indian agriculture in various direct and indirect ways besides affecting the lives and livelihood of millions of Indians. Agriculture and allied activities, such as livestock and fisheries, constitute an important component of India's Gross Domestic Product (GDP) contributing nearly 25 per cent of the GDP.

Meteorological data compiled over the past century suggest the earth is warming. In keeping with this, for India as a whole mean annual temperature shows a significant warming trend of 0.51 degrees Celsius per 100 years during the period 1901-2007 (Kothawale et al., 2010). Similarly, global projections of temperature and for precipitation augur a warmer and wetter world, on average. Simulations with regional climate models project similar trends for both variables for India—by 2030s annual mean temperatures and summer monsoon rainfall are both expected to increase on average (GoI 2010).

Literature Review:

There are plenty of research work are done on climate change and global warming we have highlighted a few as follows.

According to Adams et al (1998) Changes in crop yields are the result of climate changes and any human mitigating responses such as increasing fertilizer or water use or adoption of new crop varieties. Crops that decline in supply will rise in price, *ceteris paribus*. Higher prices reduce consumption levels and adversely affect consumer welfare, but in longer run higher prices stimulate producers to seek ways to increase supply, resulting in new equilibrium levels of both prices and quantities.

Wunder (2001) in his donor research on scope of synergy between poverty elimination and tropical forest has find that only in very few case the forest are able to reduce the poverty on national level. His finding has significant implication on sustainable forest development and strategies for conservation of forest and poverty elimination. He argued that for alleviating poverty he cannot invest much in forest, while education, health and institutional capacity building will be his area of interest. He further say that agriculture is yet another factor helpful in reducing poverty and at last he will like to invest minor share of his funds in forest conservation especially in forest rich areas.

Convey (2005) has studied the Nile basin and its adaption to climate variability. He observe that during 1990 the high flows of Nile has given Egypt an opportunity to expand its irrigation capacity which on the positive side resulted in better sociopolitical and economic condition but has exposed Nile flows to climate driven fluctuations. Although Analysis of climate change projections for the region shows there is no clear indication of how Nile flows will be affected because of uncertainty about future rainfall patterns in the basin but it is becoming essential for Egypt needs to cope up with climate variability because climate variability will add to the national water scarcity problem that Egypt is already facing due to rapid population growth.

Guiteras (2007) in his empirical research has employed a panel data methodology to show that the impact of climate change on Indian agriculture his finding reveals that climate change could depress consumption among India's poor by at least 18 percent and if the farmer are not been able to go for rapid and full adaption in agricultural practice long-run climate change could impact up to 25 percent of crop yields. His finding address a major issue that how quickly will developing countries farmer's be able to adjust their farming practices to adapt to the changing climate and what policies or technologies will enable this rapid adaptation.

Rajya sabha secretariat report (2008) highlight the concern over climate change and sighted it as the greatest challenge to sustainable development. They emphasize on addressing this issue by all countries with a shared perspective which should be free from narrow and myopic considerations. They suggested sustainable development should be based on addressing the needs of the poor and should focus on optimal harnessing of scarce resources of water, air, energy, land, and biodiversity, which is only possible through more cooperative endeavors.

According to Aydinalp and Cresser (2008) due to climate change in some region there will be increase in crop production and in some there will be decrease, they further say so there will be both winner and loser. Climate change could also affect welfare of economic groups differently and therefore it is very important to determine the magnitude of warming which may accompany the CO₂ buildup currently under way in the atmosphere since increase in a level of CO₂ will have larger impact on food production.

Backlund.et. al (2008) studied the effects of climatic change on biodiversity and agriculture in USA according to them warming is very likely to continue in the United States during the next 25 to 50 years, regardless of reductions in greenhouse gas emissions, due to emissions that have already occurred. Climate changes, temperature increases, increasing CO₂ levels, and altered patterns of precipitation are already affecting U.S. water resources, agriculture, land resources, and biodiversity. Climate change will continue to have significant effects on these resources over the next few decades and beyond. Climate change impacts on ecosystems will affect the services that ecosystems provide, such as cleaning water and removing carbon from the atmosphere, but they also find that we still do not yet possess sufficient understanding to project the timing, magnitude, and consequences of many of these effects. They also find the significant lack of integrated analysis of how climate change could affect ecosystem services. They suggested that only comprehensive understanding of impacts of climate change on ecosystem services will only be possible through quantification of anticipated alterations in ecosystem function and productivity.

Gupta et al (2012) has empirically analyzed the two crop rice and millets for finding possible effects of climate change on certain crops in India. They have taken rainfall and temperature as two climatic variables. They find that in case of rice both rainfall and temperature are statistically significant and in case of millets only rainfall is significant variable which means with less rainfall due to global warming the production of both rice and millets will fall down, and as they are the crops of interest matter to the lives of some of the world's poorest people, hence their life will be affected by climate change in long run.

Ashalatha et al (2012) in their study on rain fed agriculture in India has found that variation in climatic such as occurrence of drought have significant impact on the production of Rain fed crops. They further suggest that intensifying effect of climate change should be addressed through policy perspective on priority basis or otherwise it will lead to short term effect such as yield and income loss and long-term effects such as quitting agricultural profession by the Rain fed farmers.

According to Ninan and Bedamatta (2012) In India, the projected impact of climate change on agriculture varies across the regions because India has immense climatic/geographic diversity. In their review study they find that the impact of climate change on agriculture may be greater in developing countries such as India, where agriculture typically plays a larger economic role. They further suggest that it is evident that climate change will reduce agricultural yields significantly and the further damage could be more severe unless the adaptation to higher temperatures is rapid and complete.

Thornton and Cramer(2012) founded very few studies are carried out till date that quantify the impacts of climate change on household food security and livelihoods as well as on the urban populations who rely on cheap food, fuel, water and other necessities. They emphasize on developing and assembling the tools and databases needed assessing options at different scales for research on climatic change at every level from globe to the household. They have found it evident that the impacts of changes in climate and climate variability on agricultural production will have substantial effects on smallholder and subsistence farmers, pastoralists and fisher folk in many parts of the tropics and subtropics. And hence much research is needed in the area of climate change and its effect on agriculture.

Sofanov, G. and Safonaova,Y (2013) studied economic impact of climate change on Russia they suggest that a systematic approach must be taken to adapt agricultural production to climate change. This approach must take into consideration the long-term scope for as well as the variety of negative impacts in different areas, and provide an adequate assessment of the risks involved and take steps to manage those risks. Further they also found that costs of adaptation are likely to be significantly less than costs to repair the damage that they can prevent.

Mahato (2014) finds agriculture sector as the most sensitive sector to the climate changes as climate is the primary determinant of agricultural productivity which directly impact on food production across the globe .She further adds that to cope with the impact of climate change on agriculture and food production, India will need to act at the global, regional, national and local levels

Zacharias et al (2015) studied Regional climate models (RCMs) for providing regional climates for impact studies their results indicated that using RCM -PRECIS baseline model for daily weather forecast may cause bias in crop performance assessments. Since the bias in baseline will be carried forward in the assessment of future climatic impacts, they suggest that there is need of more reliable regional climate scenarios for the Indian region.

According to Torquebiau (2015) the interactions between agriculture and climate change needed to be analyzed at all scales from the microscopic to the macroscopic. He argued that solutions for fighting against climatic change lies in combining adaption and mitigation together especially in developing country, although very few scientific references are available on this. He further suggest that supportive political, financial and institutional framework is needed for creating resilience, not only in agricultural production processes, but in the entire food system.

Bruinsma (2015) projected that there are likelihood of an appreciable increase in carbon sequestration by agricultural soils. The main impacts of climate change on global food production are not projected to occur until after 2030, but thereafter they could become increasingly serious. Up to 2030 these

potential decreases in food production are relatively small and most countries should be able to compensate for climate change impacts by improving agricultural practices.

OXFAM MEDIA BRIEFING (2015) warns international community not to repeat their previous mistake while fighting the climate change. They observe El Niño conditions climatic disruption increases which will lead to intense storms and droughts ,extreme whether condition will act as the threat to achieve the goal of eradicating hunger by 2030.

Summary Table

S.No	Author	Findings
1	Adams et al (1998)	Climate change will lead to decline in crop yield which in longer run will lead to new equilibrium in both price and quantity.
2	Wunder (2001)	Forests are contributing in poverty elimination but education, health and agriculture are more important to alleviate poverty.
3	Convey (2005)	Egypt needs to cope up with climate variability because climate variability will add to the national water scarcity problem that Egypt is already facing due to rapid population growth.
4	Guiteras (2007)	We will have to see that who fast developing countries farmer's be able to adjust their farming practices to adapt to the changing climate and what policies or technologies will enable this rapid adaptation.
5	Rajya sabha secretariat report (2008)	Sustainable development should be based on addressing the needs of the poor and should focus on optimal harnessing of scarce resources of water, air, energy, land, and biodiversity.
6	Aydinalp and Cresser (2008)	Climate change could also affect welfare of economic groups differently and therefore it is very important to determine the magnitude of warming.
7	Backlund.et. al (2008)	Comprehensive understanding of impacts of climate change on ecosystem services will only be possible through quantification of anticipated alterations in ecosystem function and productivity.
8	Gupta et al (2012)	World's poorest people life will be affected by climate change in long run
9	Ashalatha et .al (2012)	Intensifying effect of climate change should be addressed through policy perspective on priority basis.
10	Ninan and Bedamatta (2012)	Climate change will reduce agricultural yields significantly and the further damage could be more severe unless the adaptation to higher temperatures is rapid and complete.
11	Thornton and Cramer(2012)	The impacts of changes in climate and climate variability on agricultural production will have substantial effects on smallholder and subsistence farmers, pastoralists and fisher folk in many parts of the tropics and subtropics. And hence much research is needed in the area of climate change and its effect on agriculture.
12	Sofanov and Safonaova (2013),	Costs of adaptation are likely to be significantly less than costs to repair the damage that they can prevent.
13	Mahato(2014)	To cope with the impact of climate change on agriculture and food production, India will need to act at the global, regional, national and local levels.
14	Zacharias et al (2015)	There is need of more reliable regional climate scenarios for the Indian region.
15	Torquebiau (2015)	Solutions for fighting against climatic change lies in combining adaption and mitigation together especially in developing country.
16	Bruinsma (2015)	The main impacts of climate change on global food production are not projected to occur until after 2030, but thereafter they could become increasingly serious
17	OXFAM MEDIA BRIEFING (2015)	Emphasize on need of stable political leadership, effective coordination and cooperation for allocation of resources especially money to strengthened and support vulnerable populations.

Research Gap

The previous studies done on Climatic Change are mainly predictive in nature. There are few empirical studies on these issues, like Guiteras (2007) and Gupta et al (2012) but more empirical research is needed on the issue of global warming and climate change. We have found a significant research gap when it comes to overall effects of climate change on all factors which can contribute towards sustainability of life form on earth i.e. the factors like biodiversity, forest, wildlife, flora and fauna, agriculture etc, especially in India. Our findings are also supported by Backlund et al (2008) as they also find a significant lack of integrated analysis of how climate change could affect ecosystem services. We also suggest some research work is needed to be carried out which quantifies the anticipated alterations in ecosystem function and productivity and same findings are supported by Backlund et al (2008). Thornton and Cramer (2012) found very few studies are carried out till date that quantify the impacts of climate change on household food security and livelihoods also the emphasis on need of developing and assembling the tools and databases for proper assessment of climatic change at different scales and at every level from globe to the household. There is a significant gap on impacts of climate change on urban populations the same gap is found by Thornton and Cramer (2012). Recent research on the topic also finds a research gap like Zacharias et al (2015) that there is a need of more reliable regional climate scenarios for the Indian region and we suggest some researches on making a climatic model to assess more reliable regional climate scenarios for the Indian region. Torquebiau (2015) also finds a gap in analyzing interactions between agriculture and climate change at all scales from the microscopic to the macroscopic. He also finds very few scientific references on combining adaptation and mitigation to fight climatic change.

Conclusion

The climatic change and global warming are the biggest threat which the world is fighting today. The researches suggest due to global warming the overall productivity and crop cycle of the agriculture will decline, the major adverse impacts of climate change is projected from 2030. The major sufferers of the climatic change are world's poorest people and developing country. There is an urgent need to address this issue by changing and adopting new agricultural practices. The economy across the globe should prioritize this issue and emphasize on changing and adopting agricultural practices. There is also a need of stable political leadership, effective coordination and cooperation for allocation of resources. All countries should ponder over climatic change with a shared perspective, which means developed country need to reduce their carbon emission by significant level and developing country should need to adopt sustainable development practices for fighting climatic change and global warming.

The climate change will have a greater impact on India due to its diverse biodiversity and climatic conditions, major portion of population and industry has a dependency over agriculture and agricultural products hence India need to adopt the climatic resilience cropping system and to change its agricultural practices so that scarce resources like food, water, land, air and ecosystem as a whole will contribute towards the sustainable development.

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