

## The Impact of Climate Change on Agricultural Productivity in Developing Countries: A Quantitative Study

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### Abstract

Climate has a significant impact on agricultural output, particularly in nations like India where more than two thirds of arable land is irrigated by rainfall. As a result, both the direct and indirect consequences of climate change on agriculture are significant and extremely concerning. Global temperature rise, intensified precipitation, rising sea levels, ice sheet melt, shifting agricultural growing seasons, and an increase in the frequency of extreme weather events like floods and droughts are some of its symptoms. The impact of all these factors is significant on agricultural production in emerging nations. Depending on the severity and kind of consequences it is bringing, these impacts might be both long-term and short-term. They include things like soil deterioration, effects on water availability, significant losses in crop productivity, etc. The economy of nations like India, where the bulk of the population relies heavily on agriculture for a living, is also impacted by the climate change.

**Keywords:** Impact of Climate Change, Climate Change and Agriculture, Crops and Climate Change, Food Security, Agricultural Production

### Introduction

Growing data suggests that greenhouse gases are already warming the planet. The burning of fossil fuels and also changes in land use are expected to contribute considerably to a rise in greenhouse gas emissions over the course of the next century if no action is taken to reduce emissions. As a result, future temperatures will rise, which will undoubtedly cause precipitation patterns to change. Although there are anticipated to be many implications of global climate change, agriculture is one of the most significant ones. Growing data suggests that greenhouse gases are already warming the planet. The productivity of agriculture will suffer if no steps are taken to lower it. Global dynamics are intricately entwined with agriculture and climate. Even little climatic changes have a detrimental effect on agriculture, which lowers output. The global warming phenomenon, which has grown to be the major phenomena that will significantly influence the path of current events, causes an increase in the average air temperature. Growing data suggests that greenhouse gases are already warming the planet. Economic losses from natural disasters would rise globally if nothing were done to halt it, and the agriculture sector would be especially vulnerable (Arora, Goel, Singh, 2009 and Joshi, and Tyagi, 2017).

It is crucial to comprehend the main effects of climate change that might have an influence on agricultural output. The main effect is flooding. Global warming is predicted to aggravate the hydrological cycle, increasing the likelihood of floods and the intensity of intense precipitation

events. The other effect of climate change in many Indian regions is drought. Climate change may result in long stretches without rain, which might exacerbate the drought situation in many nations. The worst effects of climate change include heat waves and storm waves in many nations. The extreme nature of these waves makes it impossible for plants to survive, and as a result, they eventually perish. The weather and climate have a direct impact on agriculture productivity. It is expected that future changes in temperature, rainfall, and carbon dioxide saturation will have a significant influence on crop growth (Karmakar, Das, Dutta, & Rakshit, 2016).

### **Literature Review**

In research it was found that the monsoons, which come from the Indian and Arabian Oceans, directly affect India's rainfall. The water cycle will be accelerated by a warmer climate, changing the frequency, amount, and timing of rainfall. The evaporation of surface moisture will increase because warm air contains more moisture. Climate change directly impacts crop evaporation and transpiration. Climate change impacts the groundwater levels in various places as well as soil humidity, groundwater replenishment, and the regularity of extreme weather events. The water cycle will be impacted by climate change. Also, when the sea level rises, there will be a greater chance of periodic or persistent saline intrusion into rivers and groundwater, which will affect the purity of the water and its viability for residential, agricultural, and industrial applications. There could be numerous impacts of climate change on agriculture (Pathak, Pramanik, Khanna, Kumar, 2014).

According to research the production patterns of several crops will be adversely impacted by rising temperatures and shifting precipitation patterns. The rising atmospheric carbon dioxide will have an impact on agricultural output as well. The susceptibility of the poor and impoverished will rise as a result of all these developments. Extreme effects of climate change have been seen in India. An unsettling trend brought on by the rise in average global temperatures is the sudden onset of excessive rainfall after extended periods of no rain. This has resulted in extreme weather events, particularly floods that have claimed lives, destroyed homes and agricultural yields, and cost the world a significant amount of financial resources. Most of the population in the nation depends only on agriculture for survival. Due to the modest number of landholdings, the majority of individuals do not have any extra land. A significant portion of cultivable land is being swept away or become barren with the touch of floods because of river erosion, sedimentation, and inundation. Owing to this, a few wealthy farmers have switched from home to lucrative farming, especially in the rural area next to the river (Kumar, Aggarwal, Rani, Saxena, Chauhan, & Jain, 2014).

In research it was found that Agricultural drought is concerned with how drought conditions in the weather and water affect agricultural productivity. A healthy crop cannot develop to maturity when soil moisture and rainfall levels are insufficient, which causes excessive moisture stress and the withering of significant agricultural areas. Soil Moisture drought can cause a serious problem in the production of agriculture because it is linked to insufficient soil moisture, which does not support crop. This occurs because of the meteorological drought, which makes less

water accessible to the soil and increases evaporation. Rainfall during the monsoon season is essential to Indian agriculture. The arable area is primarily rainfed and has little irrigation infrastructure. In years of drought, the impact causes agricultural production to drop down. Drought conditions can adversely impact the agricultural activities of the country. This can also make a country mal-nutritious and insufficient in food production. Drought for a longer period of time can absorb the soil moisture and other necessary nutrients from the soil (Kumar, Patra Ashok., Anand, 2011 and Dash, Chakravarty, Singh, Upadhyay, Singh, Yousuf, 2016).

According to a study, climate change and variability, which are characterised by temperature increases and changes in precipitation frequency, timing, and amount, are making India's agricultural production more and more vulnerable. Agriculture is still influenced by a number of factors despite the substantial development of technologies based on soil, water, and crops in recent years to optimize and sustain agricultural output. Variables including temperature, precipitation, relative humidity, light, water availability, mineral nutrients, etc. have an impact on a plant's growth and development. Each atmospheric factor's strength and duration have an impact on crop yield. A heat wave, as experienced by the general public and technically defined as the occurrence of temperatures higher than average in a particular place, is a protracted period of extremely high temperatures or hot weather. These are uncommon occurrences that, even in the same place, differ in personality and influence. More than simply a high daily maximum temperature is used to identify a heat wave. Due to the tight connection between climate and water, heat waves exacerbate water shortages in many locations, particularly in arid and semi-arid ones. When there is a water shortage, excessive water usage during heat waves can be harmful, particularly given the implications of climate change. Heat wave phenomena are vicious in India because they speed up the pace at which water supplies evaporate. Because of this, there is a greater need for water for both urban and agricultural uses. Indirectly, during this heat wave period, maintaining crops and agricultural animals becomes challenging (Campbell, Hansen, Rioux, Stirling, Twomlow, & Wollenberg, 2018 and Kumar, & Raj Gautam, 2014).

In a research it was found that heat stress, one of the most significant factors limiting crop output, is caused when temperatures rise over a particular ideal level because it affects the shoot net assimilation rates, which in turn reduces plant development. In higher plants, heat stress significantly alters the rates of cell division and elongation, which affects both leaf size and leaf weight. Heat stress causes changes in the rate of respiration and photosynthesis, shortens the life cycle of plants, and lowers their output. A number of events take place in plants when heat stress worsens, affecting the rates of critical metabolic activities such photosynthetic CO<sub>2</sub> absorption, dark respiration, and photorespiration. Heat waves or severe temperatures increased transpiration, which led to more irrigation being used on crops. At numerous areas, the heat wave increased water use, leading to increased groundwater withdrawals that led to groundwater depletion, and increased electricity use that led to increased emissions (Birthal, Khan, Negi, D. & Agarwal, 2014).

According to a study, the incidence of unusually low temperatures and the arrival of dry, chilly winds from the north into the sub-continent area have greatly worsened cold wave occurrences in

recent years. The cold wave's effects on people may result in morbidity or physical harm. During the Rabi cropping season, cold waves cause sudden freeze and frost, which has an impact on crops, horticulture farmlands, and other agricultural support services. Cold waves prevent plants and seedlings from growing vegetatively, which might lead to crop loss. As a result, people's ability to support themselves is negatively impacted. If crops fail, a farmer will also need to spend a lot of money on food and fodder to feed cattle. Frost may have a variety of effects on crops. On stems, leaves, and fruits, it can create ice crystals, which can break plant cells. Ground frost also restricts the amount of moisture and oxygen that plants may get in the soil. Due of the physical harm caused by frost on different plant sections, plants are more susceptible to disease and insect infestations (Mendelsohn, 2008 and Srinivasarao, Gopinath, Prasad, Prasanna, And Singh, 2016).

### Methodology

This study is descriptive in nature in which data is obtained from 225 respondents who have expertise in agriculture and climate change. A checklist question was used to analyze and interpret the data. In a checklist question respondents choose “Yes” or “No” for all the questions.

**Table 1 The Impact of Climate Change on Agricultural Productivity in Developing Countries**

	<b>The Impact of Climate Change on Agricultural Productivity in Developing Countries</b>	<b>Yes</b>	<b>%Yes</b>	<b>No</b>	<b>%No</b>	<b>Total</b>
1	Climate change Impacts Agricultural productivity	211	93.78	14	6.22	225
2	Climate change Increases food prices	202	89.78	23	10.22	225
3	Climate change results in drought which hamper food availability	178	79.11	47	20.89	225
4	Climate change destroys crop due to heat and cold wave	181	80.44	44	19.56	225
5	Climate change hampers plant growth	174	77.33	51	22.67	225
6	Climate change forces farmers to shift towards other occupational activities	179	79.56	46	20.44	225
7	Climate change decreases nutrients in food	182	80.89	43	19.11	225
8	Climate change results in degradation of soil nutrients and moisture	187	83.11	38	16.89	225
9	Climate change decreases the income of agricultural labors	189	84.00	36	16.00	225

Table 1 shows that 93.78% respondents agree that climate change impacts agricultural productivity, while 89.78% respondents agree that climate change increases food prices. 84.00% respondents agree that climate change decreases the income of agricultural labors, while 83.11% respondents agree that climate change results in degradation of soil nutrients and moisture. 80.89% respondents agree that climate change decreases nutrients in food while 80.44% respondents agree that climate change destroys crops due to heat and cold waves. 79.56%

respondents agree that climate change forces farmers to shift towards other occupational activities while 79.11% respondents agree that climate change results in drought which hampers food availability. 77.33% of respondents agree that climate change hampers plant growth.

## Conclusion

According to the studies mentioned above, climate change has a direct influence on India's rainfall cycle. The change in water cycle results in more frequent extreme weather events, higher water levels, soil humidity, and enhanced evaporation and transpiration. Moreover, it will increase the likelihood of intermittent or ongoing salt intrusion into rivers and groundwater, which will reduce the water's cleanliness and capacity to be used for industrial, agricultural, and domestic purposes. Moreover, increased atmospheric carbon dioxide will affect agricultural productivity, making the poor and destitution more vulnerable. Severe climate change consequences have been observed in India, where heavy rains have caused floods that have claimed lives, wrecked houses, and agricultural outputs, and cost the global economy a sizable sum of money. The productivity of agriculture may be significantly impacted by weather and water shortages. Rainfall and soil moisture can contribute to severe moisture stress, which can cause agricultural regions to wither. Indian agriculture depends on rain during the monsoon season, and a drought may cause a decline in output. Due to its ability to rob soil moisture and other vital nutrients from it, drought may also cause a nation to be undernourished and produce insufficient amounts of food. A prolonged period of very high temperatures or hot weather is caused by a number of factors, including temperature, rainfall, relative humidity, light, water. This causes widespread water shortages, especially in arid and semi-arid regions, which raises the demand for water for both urban and agricultural needs. One of the most important variables limiting crop yield is heat stress since it has an impact on shoot net assimilation rates, which slows down plant growth. In higher plants, it also influences the rates of cell elongation and division, which influences the size and weight of the leaves. Increased agriculture irrigation may result from heat waves. Rapid freezing and frost brought on by cold waves affect crops, horticulture farmlands, and other agricultural support services. Frost may produce ice crystals, which can damage plant cells, limit moisture absorption, and reduce oxygen uptake. As a result, plants become more vulnerable to disease and insect infestations.

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