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A REVIEW

Climatic change and its impact of agriculture in India

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Abstract : A nation's economy depends heavily on its agriculture sector, which is also the sector most atrisk from climate change. India's agricultural productivity and output are suffering as a result of climate change. According to the IPCC' spredictions, India's temperature is predicted to rise by 3–4°C by the end of the twenty-first century, which would result in a loss of 3–26% in net agricultural earnings. In the end, exacerbated climate conditions will reduce plant productivity, raising prices to levels that the general public can not pay. In the next years, agricultural revenue may decrease by 12–40% if no mitigation and adaptation measures are taken. In an agrarian nation like India, this problem is crucial for livelhood, economic growth and guaranteeing the security of food and employment. It is imperative to address the root causes of the deterioration of soil and water ecosystems, as well as the rise in green house gases. According to IPCC report 2007, crop productivity in nations in the southern hemisphere may drop by as much as 20%, withless developed countries suffering amost detrimental effects.

Key Words : Climatic change, Impact of agriculture

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INTRODUCTION

Over the past several decades, the national and international research communities have created a progressively better understanding of how and why the Earth's climateis changing as well as the effects of climate change on numerous human and natural systems. Climate change has resulted in decreased food quality and quantity, soilde gradation, ozone layer depletion, increased air and marine pollution and soon. Changes that occura bove the typical atmospheric conditions and are driven by natural occurrences such as the sun's warmth, volcanic eruptions, crustal movements, and human activities accelerate global climate change, although natural factors also contribute. In comparison, anthropogenic activities including as deforestation, emissions from industries, cars and power plants and the combustion of fossilfuels release massive amounts of carbon dioxide and suspended particulate matter (SPM) in to the atmosphere. Human activities cause the release of 35 billion metric tonnes of carbondioxide in to the atmosphere each year. Though the Green Revolution enabled India to achieve'self-sufficiency' in food grain production (Abrol and Sangar, 2006), it also brought a slew of environmental (e.g., loss of soil fertility, water logging, ground and surface water pollution, intensified pests and diseases) and socio-economic (e.g., increased

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farm input prices, regional disparity) (Cummings, 2019). Climate change, ontop of all of this, has given a new dimension to the existing difficulties by posing a substantial danger to Indian agriculture in general and food security in particular (Rao *et al.,* 2016). India is also one of the most susceptible countries to climate change (INCCA, 2010). According to recent studies, there has been a considerable increase in temperature, as well as frequent heat waves, droughts, extreme precipitation events, and high cyclonic activity (Rohini *et al.*, 2016; Sharma and Majumder, 2017; Ray *et al.*, 2019). Saha *et al.* (2014) also documente daweakening of the Indian summer monsoon in the later part of the twentieth century, which is the key water supply in India's agricultural sector. These developments have revealed the agriculture industry in a variety of ways. Auffhammer *et al.* (2012), observed considerable production loss in India as a result of the regular droughts that began in 1966. Climate change, according to Guiteras (2009), will cut yields by 4.5 to 9 per cent in the near term (2010-2039), but by at least 25 per cent in the long run (2070-2099) if no adaptation is implemented. Crop water consumption is also expected to rise as temperatures rise, necessitating greater irrigation (Venkateswarlu and Singh, 2015). However, excessive ground water extraction and irrigation have already caused a significant drop in ground water levels. If irrigated agriculture is continued, even locations that are experiencing higher precipitation due to climate change will require excessive ground water withdrawal (Zaveri *et al.,* 2016). Farmers are the first to experience the harshest effects of the changing climate and agricultural production systems, which will have an impact on food security (Soubry *et al.,* 2020). Crop loss causes farmer hardship, inflation, and other serious economic repercussions. At the moment, losses from the average yearly crop losses brought on by extreme weather are projected to amount to 0.25 per cent of India's GDP (Singh *et al.*, 2019). In addition, it is said that environmental stresses make farmers' debt loads worse, which leads to some of them committing suicide (Carleton, 2017). As a result of the rapid reduction of cultivators across India, agricultural labourer over took farmers for the first time since the country's independence (Gupta, 2016). The climate-sensitive agricultural sector is still India's mainsource of livelihood, despite its dropping percentage of the country's Gross Domestic Product (GDP), adecline of cultivators, and incidences of farmer suicide.

Perceptions of climate change:

A variety of psychological factors, including information, beliefs, attitudes and worries regarding whether and how the climate is changing, are included in the complicated process of climate change perception (Whitmarsh and Capstick, 2018). The features of the person, their experiences, the information they get and the cultural and geographic setting in which they live all affect and shape perception (vander Linden, 2015; Whitmarsh and Capstick, 2018). As a result, it is difficult to measure perceptions of climate change and try to identify their causes. One of the numerous difficulties in separating typical short-run changes from climate change expressions is the unpredictability that local weather might have from one day to the next, from one season to the next and between years (Hansen *et al.*, 2012). In reality, local short-term changes frequently have a greater influence on perceptions of climate change than long-term trends because they are more noticeable locally (Lehner and Stocker, 2015). Farmers, for example, who directly depend on the weather for atleast aportion of their income, tend to have perceptions that are more accurate than those of their counterparts, but they maystill struggle to accurately interpret changes in the weather based on their personal experience with weather variables and feel compelled to take action (Weber, 2010 and Whitmarsh and Capstick, 2018).

People's perceptions are influenced by their life experiences, and those who have personally experienced catastrophic climatic occurrence stend to believe that they are likely to occur again (Patt and Schröter, 2008). Additionally, the information that a person gets might affect or modify her impression of climate change Weber, 2010). Finally, it should be remembered that perception is partially a subjective process, therefore even when persons in the same location experience the same weather patterns, they may create distinct views of climate change (Simelton *et al.*, 2013).

Climate change perception and agricultural system adaptation :

According to Nwakile *et al.* (2020), perception is the act of being aware of one's environment through sensory experiences and it denotes one's capacity for knowledge While adaptation refers to the act of changing to the existing or predicted climate and its effects in order to reduce or prevent harm or take advantage of opportunities (IPCC, 2001). Never the less, adaptations might not necessarily be a planned response to climatic stimuli but instead an unanticipated response to environmental change and/or changes in the human economy or welfare (IPCC, 2014).

Depending on whether the accompanying adaptations are gradual, systemic, or transformative, Howdenetal. (2010) differentiated three types of adaptation acts. By making minor adjustments to the individual components, incremental adaptations preserve the character and integrity of present technology, organisations, administration and values without changing the systems themselves (Howden *et al.*, 2010). Systemic adaptation involves some fundamental changes in the agricultural system, not just little adjustments to the system (Howden *et al.*, 2010). A transformation, in contrast, involves changing the system as a whole rather than just making changes insideit. Transformational adaptation (TA) in agriculture has been defined as follows for the purposes of this study significant changes include (but are not limited to) the following :

– Major changes in" landuse and/or employment through trying to do more or something different".

– Changes in the location of" an agricultural activity and/or agriculturalists".

– A notable change in the scale or intensity at which the current system operates (Kates *et al.,* 2012).

According to Rickards and Howden (2012), the primary goal of changing land use and/or occupation is to reduce the vulnerability of the adapters by switching to a less climate-sensitive style of operation. In contrast, spatial transfer or displacement looks for a new location thatwould be better ideal for adapters to restart their former occupation in order to lessen their exposure. Additionally, these TAs might help maintain agricultural productivity eveniffarming shifts from food-based to non-food-based, and they could even include a total exit from agriculture (Ricards and Howden, 2012). However, even if the incremental adaptations are implemented on a greater scale or in a method that is far more successful than previously, they may become TAs (Kates *et al.,* 2012). Finally, when one progresses from incremental to transformative, the accompanying 'complexity, expense, and risk' are likely to rise. However, such changes are not always consecutive (Howden *et al.,* 2010).

Climatic change evidances :

The IPCC defines climate change as any alteration in the climate over time, regardless of whether it is the result of natural variability or human activity. In contrast, the United Nations Frame work Convention on Climate Change (UNFCCC) defines "climate change" as a change in the climatic that can becaused by human activity that alters the composition of the earth's atmosphere in addition to natural climate variability found over comparable time periods. The increase in greenhouse gas concentration in the atmosphere as a result of several anthropogenic and natural activities is the primary driver of climate change. The quantities of carbondioxide, methane, and nitrous oxide in the atmosphere have increased dramatically since 1750 as a result of human activity and they currently significantly exceedpre-industrial values as inferred from ice cores extending back thousands of years. The primary causes of the global increases incarbon dioxide concentration are the use of fossil fuels and changes in land use, whereas the primary causes of the global increases in methane and nitrous oxide are agriculture. Increases in average global temperature (global warming), changes in cloud cover and precipitation, especially over land, melting of ice caps and glaciers, reduced snow cover, and increases inocean temperatures and ocean acidity caused by sea water absorbing heat and carbondioxide from the atmosphere are the main features of climate change.

Crop production and yields :

According to statistics on agricultural output at the global and national levels, across a wide range of nations, crops and eco-systems, climate change has not yet significantly impacted yield and gross production. Hafner demonstrated that there has been an overall increase in agricultural productivity with respect to these data sets in a study of maize, wheat, and rice production during a 40-year period across 188 nations Onlyone-sixth of the datasets showed a decrease in output. Finally, Hafner says: National agricultural datasets with yield growth more than 33.1 kg/ha/yr had significantly higher yields than those with slower yield growth, suggesting that yield growth is not restricted by universal physiological restrictions to crop output.

According to Hafner (2003), in order to sustain present per-capita output levels in 2050, grain yields must increase at a minimum rate of 33.1 kg/ha/yr. A total of 20% of the data sets had yield increases over this threshold, and these datasets were the most important in terms of their contribution to the increase in agricultural output as a whole. Additionally, they were the biggestin terms of harvested land and population growth worldwide.

In terms of yields, Lobell *et al.* (2009) demonstrate via a meta-analysis of several case studies that the difference between actual average yields and yield potential varies greatly, ranging from 20% to 80% of yield potential. In an effort to determine worldwide yield gaps, Licker and Racheal (2010) compared the yields of 18 important crops grown in various regions with comparable weather circumstances. They draw the conclusion that, despite present climate changes, there is still a significant amount of room tonarrow yield disparities globally.

When evaluating gross production or yield, several studies have also tried to as certain if current climate change is having an influence on agriculture while taking into consideration the possibility that such an impact may be obscured by the impacts of other factors. Future study along this line will be crucial Lobell and Field (2007).

In its Working Group II volume, the IPCC's AR4 observes that there is now scant evidence of yield loss or decreased gross agricultural production as a result of climate change. It also mentions several studies that discus show weather affects agricultural output, specifically how warmer and drier conditions in the Sahel (in Africa) have functioned as a catalyst for other variables that have resulted in a fall in peanut production.

As a result, we may summarise the effects of continuing climate change on agriculture as follows:

– Crop phenology and related farm management methods provide some evidence of the effects of continuous climate change on agriculture. The data from Europe provide the majority of the proof for this. But in most countries, the effects of on going climate change on agricultural productivity and harvests have been negligible.

– Global and national yield disparities indicate that there is still much space for improvement in agriculture output and yield. If extra polated along existing trends, it is still unknown if the associated intensification of various crop management and land-use technique swould be viable without having an unfavourable impact on ecosystems. Although it is possible that climate change may not affect these negative effects, it is equally feasible that climate change will amplify them or make people more susceptible to them.

Bio-physical impact of climatic change :

In generally, there are two key climate change factors that directly affect crop physiology. The first is the result of fertilising with carbon. This means that higher CO_2 levels in the environment are advantageous for plant development since they both minimise water loss from respiration and because CO_2 is necessary for the synthesis of carbohydrates. However, the strength of this advantageous impact differs a tried to as certain if current cross two major types of crops, known as C_3 and C_4 crops in scientific literature. Carbon fertilisation is more effective in C_3, which includesrice, wheat, and legumes, but it has considerably less of an impact in C_4, which includes maize, millets, sorghum and sugarcane. While more recent studies of carbon fertilisation are based on" Free-Air Concentration Enrichment" (FACE) tests carried out on field crops under agronomic settings, earlier studies of carbon fertilisation were based on laboratory trials. The effect of carbon fertilisation in realistic conditions is about 50% smaller than the effect as observed in laboratory research for C_3 crops, while the effect is almost negligible for C_4 crops, according to the results of the FACE trials (Jayaram, 2011).

Temperature is the second crucial factor in climate change. One of the main consequences of temperature rises is that crops develop more quickly, especially during the grain-filling stage, which lowers yields. Due to the fact that many crops in semi-tropical and tropical regions have already reached the upper limits of their tolerable temperature range, these regions are where this effect is most noticeable. Lower yields might ensue with temperature rises of more than 1-3° C at higher latitudes as well. A crop's need for water increases as a result of increasing transpiration rates an drapid soil moisture loss, two other important effects of rising temperatures.

While temperature rise and carbon fertilisation are the two primary features of global warming that impact crop physiology, it is only via intricate modelling that one can pin point the exact effects of these two factors on crop yields. In addition to carbon fertilisation and temperature rise, other variables that affect crop yields include changes in precipitation, water and energy balances, soil conditions and the availability of nutrients, among others. Of course, these elements themselves could alter as a result of climate change.

Simulated models of crop growth offer in-depth evaluations of the biophysical effects of climate change on crops. These are computer simulations that trytoencompas severy physical and biological influence on crop growth and development. These models, which have been created for a variety of crops, allow for the varying of a number of factors as well as the insertion of different linkages. Such study can include genetic factors under various environmental situations in more complex models.

Simulating the consequences of climate change also has to take into account effects like the inter actions of weeds and pests with other elements. Such interactions will alter the effects of rising CO_2, changing temperatures, and variations in rainfall, while pests' and weeds' behaviour may change on its own as a result of climate change. In the context of elevated CO_2 levels, there is a substantial body of study on potential competition between C_3 and C_4 crops. These investigations cover the conflict between C_3 crops and C_4 weeds. The Third Assessment Report of the IPCC offers a helpful overview of these challenges.

According to the research mentioned there, interactions between pests and important food and cash crops may be complicated due to factors such as rising CO_2 and temperature levels, aswell as increased or decreased precipitation, which might have a secondary impact on crop-pest interactions. For instance, model studies on rice reveal that leaf-blast epidemics are lesslikely to occur in warm, humid tropics as a result of rising temperatures than they are in cold, sub-tropical zones. Another experiment revealed that increasing CO_2 levels reduced nitrogen absorption in plant tissues, which dramatically increased insect damage.

Conclusion:

Active government participation in solving this issue is urgently needed. Only a considerable commitment from the government and other stake holders to vigorously combating the issue of climate change is likely to encourage business and industry to considerably break free from the inertia of current practises. What the people desire and howour governments respond to their requests will, in great part, decide how quickly the issues of global warming and climate change may be handled, in our opinion. If the people want it, logical leaders with both liberal and conservative leanings can discover answers to these issues given the many chances for solving this significant global problem through lucrative entrepreneurial activity on many levels. We appear to be facing a significant struggle on both the political and educational fronts. We can only hope that future generations will praise our decisions.

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