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Impact of Global Warming on Indian Agriculture

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ABSTRACT: Global warming is the long-term heating of Earth's surface observed since the pre-industrial period (between 1850 and 1900) due to human activities, primarily fossil fuel burning, which increases heat-trapping greenhouse gas levels in Earth's atmosphere.

KEYWORDS: global warming, Indian, agriculture, human activities, climate change, earth

I.INTRODUCTION

Global warming is the long-term warming of the planet's overall temperature. Though this warming trend has been going on for a long time, its pace has significantly increased in the last hundred years due to the burning of fossil fuels. As the human population has increased, so has the volume of fossil fuels burned. Fossil fuels include coal, oil, and natural gas, and burning them causes what is known as the "greenhouse effect" in Earth's atmosphere.[1]

The greenhouse effect is when the sun's rays penetrate the atmosphere, but when that heat is reflected off the surface cannot escape back into space. Gases produced by the burning of fossil fuels prevent the heat from leaving the atmosphere. These greenhouse gasses are carbon dioxide, chlorofluorocarbons, water vapor, methane, and nitrous oxide.[2] The excess heat in the atmosphere has caused the average global temperature to rise overtime, otherwise known as global warming.

Global warming has presented another issue called climate change. Sometimes these phrases are used interchangeably, however, they are different. Climate change refers to changes in weather patterns and growing seasons around the world.[3] It also refers to sea level rise caused by the expansion of warmer seas and melting ice sheets and glaciers. Global warming causes climate change, which poses a serious threat to life on Earth in the forms of widespread flooding and extreme weather. Scientists continue to study global warming and its impact on Earth.[4]

II.DISCUSSION

Like other countries, India has also started experiencing extreme weather events which lead to change the climate. As mentioned earlier, global warming is one of the major parameter to change the climate. In India, it is observed that the annual mean temperature has increased at the rate of 0.42°C [19]. Indian agriculture system is based upon south-west and north-east monsoon. Almost 80% of the total precipitation comes from south-west monsoon in India. Progress has been significant in climate science and the direct and indirect influences of climate on agricultural productivity.[5] With the likely growth of the world's population toward 10 billion by future, demand for food crops will grow faster than demand for other crops. The prospective climate change is global warming (with associated changes in hydrologic regimes and other climatic variables) induced by the increasing concentration of radiatively active greenhouse gases. Climate models project that global surface air temperatures may increase by 4.0–5.8 °C in the next few decades. These increases in temperature will probably offset the likely benefits of increasing atmospheric concentrations of carbon dioxide on crop plants. Climate change would create new environmental conditions over space and time and in the intensity and frequency of weather and climate processes.[6] Therefore, climate change has the potential to influence the productivity of agriculture significantly. Climate variability has also become a reality in India. The increase in mean temperature by 0.3–0.6 °C per decade since the 1860s across India indicates significant warming due to climate change. This warming trend is comparable to global mean increases in temperature in the past 100 years. It is projected that rainfall patterns in India would change with the western and central areas witnessing as many as 15 more dry days each year, whereas the northern and northwestern areas could have 5 to 10 more days of rainfall annually. [7]Thus, dry areas are expected to get drier and wet areas wetter. It is projected that India's population could reach 1.4 billion by future and may exceed further. If agricultural production is adversely affected by climate change, livelihood and food security in India would be at risk.

Because the livelihood system in India is based on agriculture, climate change could cause increased crop failure and more frequent incidences of pests. Therefore, future challenges will be more complex and demanding. [8]

Agriculture sector in India is vulnerable to climate change. Higher temperatures tend to reduce crop yields and favour weed and pest proliferation. Climate change can have negative effects on irrigated crop yields across agro-ecological regions both due to temperature rise and changes in water availability.Rainfed agriculture will be primarily impacted due to rainfall variability and reduction in number of rainy days.Analysis of impact of climate change under National Innovations in Climate Resilient Agriculture (NICRA) project has found that climate change is expected to affect yields, particularly in crops like rice, wheat and maize. [9,10]

III.RESULTS

One of the major challenges facing humankind is to provide an equitable standard of living for present and future generations: adequate food, water, energy, safe shelter and a healthy environment. But, global environmental issues such as land degradation, loss of biodiversity, stratospheric ozone depletion along with human-induced climate change, threatens our ability to meet the basic human needs. The Third Assessment Report (TAR) of the Intergovernmental Panel on Climate Change (IPCC)[11,12] reaffirms that the climate is changing in ways that cannot be accounted for by natural variability and that 'global warming' is happening. Global mean temperatures have risen (0.6oC in the last century), with the last decade being the warmest on record. Climate change will, in many parts of the world, adversely affect socio-economic sectors, including water resources, agriculture, forestry, fisheries and human settlements, ecological systems and human health, especially in developing countries due to their vulnerability.[13,14]

Vulnerability to climate change is closely related to poverty, as the poor have fewer financial and technical resources. They are heavily dependent on climate-sensitive sectors such as agriculture and forestry; they often live on marginal land and their economic structures are fragile. This is true for a developing country like India where agriculture remains the mainstay of the economy, contributing nearly 27% of the total Gross Domestic Product (GDP) and employing nearly two-thirds of the country's population. Agriculture exports account for 13 to 18% of total annual exports of the country. However, given that 62% of the cropped area is still dependent on rainfall, Indian agriculture continues to be fundamentally dependent on the weather.[15]

Climate change will have an economic impact on agriculture, including changes in farm profitability, prices, supply, demand and trade. The magnitude and geographical distribution of such climate-induced changes may affect our ability to expand the food production as required to feed the populace. Climate change could thus have far reaching effects on the patterns of trade among nations, development and food security.

Agriculture is sensitive to short-term changes in weather and to seasonal, annual and long term variations in climate. Crop yield is the culmination of a diversified range of factors. Parameters like soil, seed, pest and diseases, fertilizers and agronomic practices exert significant influence on crop yield. The burgeoning population, along with human-induced climate change and environmental problems is increasingly proving to be a limiting factor for enhancing farm productivity and ensuring food security for the rural poor.[16,17]

Agricultural productivity can be affected by climate change in two ways: first, directly, due to changes in temperature, precipitation and/or CO2 levels and second, indirectly, through changes in soil, distribution and frequency of infestation by pests, insects, diseases or weeds. Acute water shortage conditions, combined with thermal stress, could adversely affect wheat and, more severely, rice productivity in India even under the positive effects of elevated CO2 in the future. The mean temperature in India is projected to increase by 0.10 C to 0.30C in kharif (summer) and 0.30C to 0.70C in rabi (winter) by 2010 and to 0.40C to 2.00C in kharif and 1.10C to 4.50C in rabi by 2070 (IPCC, 1996). Mean rainfall is projected not to change by 2010 but may increase by 10% during rabi by 2070. At the same time, there is an increased possibility of climate extremes, such as the timing of onset of monsoon and intensities and frequencies of droughts and floods.[18]

Implications

The Sustainable Development Goal (SDG) 2 aims to 'end hunger, achieve food security, enhance nutrition, and promote sustainable agriculture.' However, food security remains a long-lost development goal for India. Despite the economic growth, the burden of malnutrition remains unacceptably high. Climate change further poses a challenge to food security challenges with its influence on food production, costs, and security. Excessive heat or shortage of water can impede crop

growth, reduce yields, and influence irrigation, soil quality, and the ecosystem on which agriculture depends. Various factors influence the food security risk including natural calamities and water scarcity.[19]

Changing weather patterns

The impact of excessive rainfall causing floods or no rainfall resulting in drought can be extremely detrimental to crop production in the country. Evidence suggests a strong relationship between agricultural output and increased extreme weather conditions such as severe and frequent droughts and floods. According to the World Bank, domestic food prices have tracked the rise in global food prices, which has been exacerbated by droughts. Food price inflation in India had also extended to several of its neighbours, including Bangladesh, Bhutan, Nepal, and Sri Lanka. Domestic demand in India surged during the inflationary era of 2008 and was aggravated by the El Nino weather pattern in 2009, which caused food shortages as a result of the drought.

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Research indicates that the balancing impact of carbon fertilisation can negate the negative effects of global warming on agricultural output in India and that rising carbon dioxide levels can boost crop yields. A different study from Karnataka also shows how extreme temperatures can majorly affect crop yield/ productivity. These events are often linked to an exponential rise in the incidence of pests and diseases. The resulting conclusion is that climate change has an induced effect on food security even as pests and diseases attack food crops and animals, which culminates in reduced food availability. [20]

Rivers, dams, streams, and groundwater resources are also under stress. Rain-fed agriculture accounts for 65 percent of all cultivated land in India, illustrating the sector's fragility to water scarcity. Extensive areas of the country are already facing water scarcity issues with decreasing reliance on groundwater for agriculture because of the depleting levels. Moreover, weather-related disasters influence the food production value chain, necessitating a multidisciplinary strategy to bridge social capital. Critical research in this field is required to build agricultural and community resilience for present and future agricultural calamities.

The yield of staple crops such as rice and wheat has fallen dramatically along with the decline in nutritional content as a result of climate change. A considerable influence is seen extending to pulse output and livestock. Other components of agricultural production systems, notably animal production, are indirectly impacted, with crop byproducts and residues providing a significant portion of their energy requirements.[21]

The expected detrimental impact of climate change has significant implications since agriculture is the most important means of alleviating poverty. The global food crises of 2007 and 2008 have revealed that the food-insecure populations in developing nations will be severely affected by any future food crisis exacerbated by climate change. Upscaling farming activities by crop rotation and mixed cropping over mono-cropping can help reduce the susceptibility to weather extremes and unpredictable monsoons.

Critical research in this field is required to build agricultural and community resilience for present and future agricultural calamities.

Droughts and floods also have a greater impact in areas with substantial food insecurity and inequality. An assessment of nine villages in Maharashtra's drought-prone Jalna district revealed that local agricultural yields and farmers' yearly incomes decreased by nearly 60 percent during the 2012–13 drought. Another study from Odisha shows an increase in malnutrition due to natural calamities and disasters. In the coastal district of Jagatsinghpur in Odisha, long-term chronic malnutrition is observed in children exposed to recurrent flooding living in flood-prone areas.

Indicators of urban food insecurity in India paint a bleak picture. Given that food is the single largest expense for impoverished urban households, any extreme weather event that causes relocation, loss of livelihood, or damage to productive assets would directly impact household food security. According to Nira Ramachandran, hunger frequently triggers a surge of migration to the cities, displacing whole families into urban slums. These migrant workers mostly work in the low-wage urban informal sector, where there is minimal job security and incomes are below the legal minimum. As a result, the urban poor will become the most vulnerable group to food inflation because of the output shocks and reductions predicted by future climate change.

Farmers require several adaptation methods to maintain agricultural yields throughout climate change.[22]

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Population growth, growing wages, and changes in consumption and food patterns will put an enormous strain on land and other natural resources. Global warming will further impact natural and human systems, biodiversity, and food security.[23]

IV.CONCLUSIONS

The agricultural adaptation toolbox should contain immediate solutions and a long-term strategy to address the various harsh weather patterns. Regional models for the Indian subcontinent should be established, as evidenced by studies undertaken in Tamil Nadu's Cauvery basin, commonly known as India's rice bowl. The study proposes adaptation strategies such as rice intensification, using temperature tolerant cultivars, and green manures/bio-fertilizers to save water and increase rice productivity in warmer climates to downscale climate change scenarios for smaller regions in the near future. As of now, much focus is placed on giving immediate help to impacted households rather than creating long-term adaptive measures.[24] As a result, public investment and training in disaster management, especially in coastal areas, becomes critical, supplemented by long-term undernutrition prevention programs in disaster-affected areas. Climate change is likely to be one of the most important drivers of biodiversity loss in the next decades. Population growth, growing wages, and changes in consumption and food patterns will put an enormous strain on land and other natural resources. Global warming will further impact natural and human systems, biodiversity, and food security. Thus, there is an urgent need for a comprehensive examination of the impact of climate change on food security. Future research should be prioritised and aimed at measuring and quantifying the effect of climate change on food absorption and malnutrition to overcome the looming threat to food security in India.[25]

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