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The effects of changing climate on agriculture and agronomic practices

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Abstract

Around the globe, people are starting to see climate change as the top environmental concern. This research looked at four crops-rice, pepper, coconut, and rubber-to see how They may understand the impact of climate change on their output in Rajasthan. The state's general climatic trend was examined using thirty years of climate data (1985–2014). We looked at the four crops' production statistics to see how climate change may affect them. We surveyed 400 homes in four different districts (Alwar, Dausa, Jaipur, and Sikar) to find out how people there see the consequences of global warming and the ways in which they are doing to prepare for them. According to research on Rajasthan's climate changes, the state's rainfall patterns were very consistent from 1985 to 2014.

Keywords: Climate, Agriculture, Unpredictable, economy, warming

Introduction

One of humanity's main worries is the ever-changing and unpredictable climate. For Droughts and floods pose a serious threat to the way of life for countless individuals whose subsistence is mostly dependent on agricultural land. Natural calamities of extreme temperature (hot, cold, flood, drought, etc.), forest fires, landslides, and so on, have a negative impact on the world economy regularly Hazards such as volcanic eruptions, tsunamis, and earthquakes are not technically meteorological catastrophes, but they may alter the atmospheric chemical makeup nevertheless. Consequently, natural catastrophes will be the result. The rise caused by the burning of fossil fuels, which releases greenhouse gases such as carbon dioxide., chlorofluorocarbons (CFCs), perfluorocarbons (PFCs), and ozone depletion-along with other factors like volcanic eruptions, the "human hand" in deforestation through the eradication of wetlands and forest fires the main causes of increased aerosols, which are atmospheric pollutants. In the absence of trees to absorb precipitation, water runs off the landscape, washing away topsoil and making flooding and droughts more common. In paradox, when there aren't enough trees to slow down the soil's evaporation, dryness becomes more worse in dry years. Because of its ability to absorb and then release long-wave radiation, carbon dioxide (CO2) stands out among greenhouse gases due to the fact that it is the main cause of climate change. If the average air temperature of Earth's surface continues to rise, this is known as a "global warming" occurrence. surface rises slightly but noticeably due to anthropogenic greenhouse gas emissions. The term "climate change" describes these long-term shifts in the average air temperature, which have a negative effect on precipitation. Climate variability occurs when these metrics exhibit yearly fluctuations or cyclical tendencies

Climate change and human health

Additional worldwide trends include expanding human populations, increasing urbanization, shifting land uses, and diminishing supplies of fresh water., will occur alongside climate change. These changes will have their own effects on health and may interact with climate change to worsen them. One of us (AH) delivered the Lecture given by Harben at the Royal Institute of Public Health in 2005 on this same paper. It touches on some of the same topics as before, but it expands on them by talking about adaption choices and how "mitigation strategies" (such renewable technology and energy efficiency) might help bring about short-term decreases in mortality Climate change and its effects on people's well-being may be felt via several

pathways. There are both short-term and long-term impacts of weather extremes including heat waves, floods, and droughts on death rates. One possible consequence is a long-term uptick in the prevalence of prevalent mental diseases in flood-affected communities.

The commodities and services provided by ecosystems are crucial to human survival, but they are also under danger from the effects of climate change, which endanger biodiversity. health condition Modifications to precipitation and temperature may influence the dispersal of disease vectors (such as dengue and malaria) and the occurrence of diarrhoeal illnesses. The links between climate and air pollutant levels are not well known; for instance, tropospheric ozone pollution may be worse in some European regions than others 4 Rising sea levels pose a particularly serious threat to those who reside in low-lying coastal regions., especially in nations where the cost of building sea defenses and other mitigation strategies is prohibitive. Some worry that climate change-related disasters like droughts and floods can cause population explosions. displacement and more environmental refugees.

Scientists studying the effects of climate change on human health have focused on three primary areas (Fig. 1): the existing links between weather and illness, the results of the most recent climatic shifts, as well as the information required to foretell the repercussions of climate change in the far future. The average world temperature has been steadily rising over the last 20–30 years. Now more than ever, determining the exact health effects of these changes is a major scientific challenge. Scientists project a 1.5–5.8 degree Celsius increase in the average global temperature by the century's conclusion. due to the persistence and acceleration of this warming trend. 6 More severe and harder-to-foresee negative consequences are likely to occur at the higher end of the spectrum.

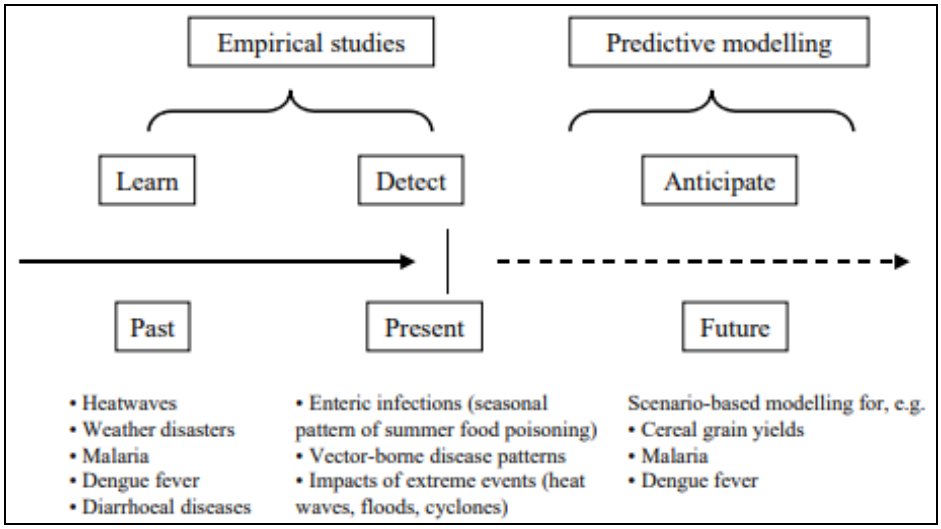

Fig 1: Three significant avenues for further study, shown by pertinent cases "Climate variability and change and associated health impacts in the Caribbean" (McMichael AJ, 2002. WHO/PAHO Conference on). Copyright © 2014 All Rights Reserved.

The fiscal economy of agriculture in the age of climates warming

issues related to society and the economy, including poverty, unsustainable scientific progress, wellbeing, and security. The terms of commerce, state budgets, and rates of economic development are all affected by changes in agricultural production, labor productivity, and pollution management as well as floods and forest conservation. (due to changes in agricultural yield and labor productivity, loss of natural resources), as well as social welfare (due to price increases, pollution, and health According to Cuervo and Gandhi (1998) [6], all of these things will be impacted by climate change. According to the UNFCCC definition, "climate change" is used to describe a shift in the global climate as a result of human activities. All of this includes natural climate variability as well as changes caused by human activities in the atmosphere (UN, 1992). Climate change, according to the Intergovernmental Panel on Climate (2007), may be defined as long-term shifts in the average and/or variability of climatic variables that last for several years, if not decades. Accordingly, the term "climate change" encompasses both natural and anthropogenic climatic variations throughout time.

Literature Review

Rezaei, Ehsan *et al*. (2023) [1]. Attempts to sustain and enhance agricultural output face problems in several places due to climate change. The worldwide major cereal crops, which include rice, wheat, millet, and sorghum-have their yields analyzed in this Review in relation to changes in water availability, increased carbon dioxide levels, and higher temperatures. C3 crops, like rice and wheat, may benefit from increased CO2 levels, but other factors, including heat and drought, can counteract this. High levels of CO2, on the other hand, alleviate drought stress only in C4 plants, which include sorghum, millet, and maize. Without adaptation, the worst-case scenario for climate change results in predicted agricultural output reductions of 7–23%. While adaptive strategies like CO2 fertilization may mitigate or even reverse the negative impacts at higher latitudes, the practice has less of an impact at lower latitudes, where C4 crops predominate. The most successful adaptation strategies, such as fertilizer management and irrigation, may increase wheat production by up to 40% at higher latitudes compared to the baseline, but they are costly and may not work everywhere, particularly in places where water is scarce. In order to better identify and assess yield

reactions Addressing climate change will include conducting multifactor experiments, creating protocols for biotic stress modelling, combining process-based and data-driven models, and conducting integrated impact evaluations.

Mall, Rajesh *et al*. (2017) [2]. A significant drop in agricultural productivity might result from world warming, which is associated with increased greenhouse gas emissions, different patterns of precipitation, and generally warmer temperatures. Crop yields are vulnerable to climate change. Furthermore, severe weather occurrences including heat waves, droughts, and floods that have been caused by heavy rainfall have become more common. With a rising population and the unknowns of climate change adding stress to already heavy demands, increasing agricultural production is no small task. As a result, we need to devote more resources to studying adaptation and mitigation, developing our capacities, changing our policies, working together on a national and regional level, and supporting adaptation funds on a global and national scale. One way to lessen the impact of climate change in the long run is to learn to live with the uncertainty and extremes of our changing environment. Adjusting planting Some easy adaptation strategies that could help lessen There are a number of ways in which water conservation and management may be enhanced as a result of climate change. These include making better use of irrigation and fertiliser, expanding crop types, better managing pests, and using varieties that are climate-ready or can withstand thermal stress. Additionally, farmers may be able to better prepare for any climate calamities with the use of early warning systems and reliable local weather forecasts.

Gnanasekaran, Madhavan *et al*. (2024) [3]. There will be far-reaching effects on agricultural output in light of the fact that climate change endangers global food supplies, economic development, and the ability of rural populations to sustain themselves. An examination of a focus on the direct consequences of shifting weather patterns, more intense storms, and new temperature regimes; and the intricate web of relationships between climate change and agriculture. These climatic changes have a detrimental impact on crop quality and reduce agricultural productivity. Transmission of pests, illnesses, and alien species is already a major problem in agriculture, and climate change is making it worse. A thorough understanding of the weaknesses in agricultural systems is required since indirect consequences, such soil erosion, decreased water availability, and changed nutrient cycles, amplify these problems. Because of their low adaptation capability, small-scale farmers and communities with limited resources are especially at risk from the diverse and unpredictable impacts of global warming on food production. This chapter explores the consequences extensively, illustrating their effects on different crops and agricultural techniques via case studies and current research. In order to influence policies and actions, robust scientific assessments are essential for reducing climate change's detrimental effects on farming. Addressing the main issues of climate change is the goal of this chapter as we work to build agricultural systems that can maintain productivity and food security in a changing environment. environment. Subjects: Integrated Farming Systems, Animal Husbandry, Precision Agriculture, Climate-Resilient Agriculture, Sustainable Agriculture, and Extreme Weather Events.

Birthal, Pratap *et al*. (2014) [4]. From 1969 to 2005, the research tracked variations in temperature and rainfall, two key climatic factors, and calculated how those changes affected agricultural production. The mean monthly temperature rose significantly, especially after the rains had stopped. On the other hand, there was little variation in rainfall. In contrast to the negative impact of higher maximum temperatures on crop However, most crop yields were positively affected by a corresponding increase in minimum temperatures. Nevertheless, this perk was insufficient to completely mitigate the unfavorable consequences of elevated peak temperatures. Wheat, chickpeas, pigeon peas, and rice were the most affected by rising temperatures. Rainfall helped most crops, but it couldn't compensate for the heat's negative effects. Significant changes in precipitation and temperature are anticipated to reduce wheat production by 22% and impact rice output by 15%. the year 2100, according to climate impact forecasts. Pulses will be more impacted than cereals, although coarse cereals will be less so. Crop loss will be less severe if the climatic changes are not substantial. Even in the near term, the effects on the environment won't be too bad.

ALOTAIBI, Majed. (2023) [5]. Worldwide, agricultural yield has been lowered due to severe weather events and climate change, which presents major concerns to agriculture with the safety of one's food supply. By the turn of the next millennium, experts foretell a 59-centimeter rise in sea levels and an average global temperature increase of 2.0 to 6.4 °C. Heat waves, droughts, floods, and unexpected rains are becoming more often as a result of the exceptional increase in temperature. The impact on food security on a regional and global scale will be significant. output, and long-standing methods of agricultural cropping due to these shifts. Pests, diseases, weeds, and insects are all at risk from the many ways in which climate change affects the natural world, such as changes in distribution patterns, the ability of some organisms to endure from one generation to the next, and the likelihood of surviving harsh winters. Keeping agricultural production steady in the face of accelerating climate change is, hence, the top priority. To mitigate the effects of climate change on agricultural crop production, adaptive strategies are crucial. In this overview, we have covered the broad strokes of how climate change is already impacting farming methods and how it will continue to pose challenges to agricultural production in the future. Agronomic methods, climate-resilient crop production, and nanotechnology for abiotic stress (such as drought) are other subjects we've discussed., heat, salinity, and temperature. We have also covered transgenic approaches to biotechnology and functional genomics.

Analysis of Rajasthan's climatic trends

As a result of the incredible variety of topography in Rajasthan, the state experiences a wide range of climates. The lowlands have year-round hot and muggy conditions, in stark contrast to the chilly and pleasant environment of the high-ranges. The climate of Rajasthan has been changing recently, as has the climate of the rest of the world. Over the last ten years, Rajasthan's rainfall pattern has been

somewhat unpredictable. The post-monsoon rainfall has grown substantially, whereas the mean annual rainfall throughout the winter and summer has stayed relatively unchanged.

Climatic Trend in Rajasthan

The Indian state of Rajasthan is located in the northwest and has a dry or semi-arid climate. It is hot all year round and may become quite cold in the winter. May and June are the warmest months. From July to September, you may expect considerable rainfall throughout the monsoon season.

Summer, Monsoon, Post-Monsoon, and Winter are the four distinct seasons that characterize Rajasthan's climate

Table 1: Statistical overview of precipitation temperatures for a small number of districts in Rajasthan during 1985–2014

District Rainfall variables	ALWAR (Mean & SD)	DAUSA (Mean & SD)	JAIPUR (Mean & SD)	SIKAR (Mean & SD)
Monsoon Rainfall	1019.14 (249.69)	2954.39 (763.58)	2264.11 (513.26)	1873.95 (367.87)
Post-Monsoon Rainfall	258.62 (103.33)	638.88 (235.79)	443.85 (143.88)	548.14 (196.89)
Winter Rainfall	37.84 (63.23)	84.48 (85.87)	30.00 (32.16)	77.41 (63.29)
Summer Rainfall	174.07 (109.03)	432.79 (299.76)	342.87 (221.11)	480.98 (184.45)
Annual mean rainfall	1489.67 (299.19)	4110.54 (905.85)	3080.84 (27.47)	2980.48 (406.21)
Annual mean Temperature	27.82 (0.5)	27.54 (0.44)	28.05 (0.45)	27.54 (0.44)
Annual mean Maximum Temperature	32.27 (0.87)	32.02 (0.61)	31.74 (0.62)	32.02 (0.61)
Annual mean Minimum Temperature	23.45 (0.46)	23.06 (0.56)	24.35 (0.28)	23.06 (0.56)
Annual mean Temperature range	9.02 (1.23)	8.97 (0.79)	7.4 (0.44)	8.97 (0.79)

This information was derived from calculations made at the IMD in Thiruvananthapuram.

Alwar District

The northern Indian district of Alwar is located in the city of Alwar and is part of the Rajasthan state. There are 8,337 km2 in the district. Rewari district in Haryana forms its northern boundary, Nuh district in Haryana and Bharatpur district in Rajasthan form its eastern and southern boundaries, Dausa district in Rajasthan forms its western boundary, and Jaipur district is its westernmost.

It has the third-highest population of any of Rajasthan's 33 districts as of 2011, behind only Jaipur and Jodhpur.

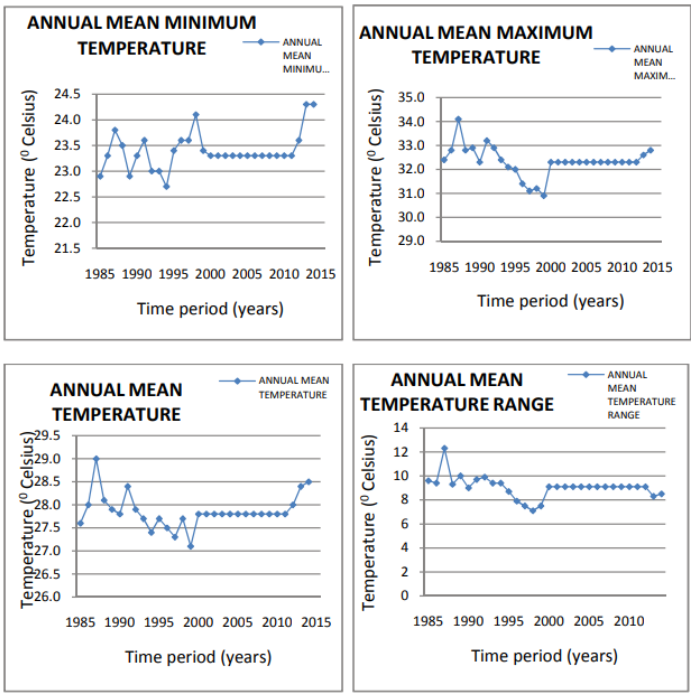

Fig 2: Variations in annual temperature in the Alwar District from 1984 to 2014

A study on the agro-climate change effects in Rajasthan Agricultural Production and a Crop-Wise Evaluation of Climate Change's Economic Effects

In this part, we will examine how the study region's four main crops-rice, pepper, coconut, and rubber-have been affected by the changing seasons. The effects of climate change will have a disproportionately negative impact on the agricultural sector., thus researchers in Rajasthan state conducted a microscopic investigation of the study region using the state's agro-climatic characteristics. Climate change, ecological services, and agricultural output all interact with one another is complex (Walthall *et al*. 2012) [7]. According to studies conducted by the International Institute of Sustainable Development at the University of California, Berkeley, the most noticeable effect of climate change on the agricultural industry is the observed rise or reduction in crop yields around the world. of Toren to in Canada (1997). Climate change has several unintended consequences, including but not limited to: lower yields; more crop shifting or diversification; less water available for irrigation; more crop loss due to insects, pests, and plant diseases; and more pesticide and insecticide use.

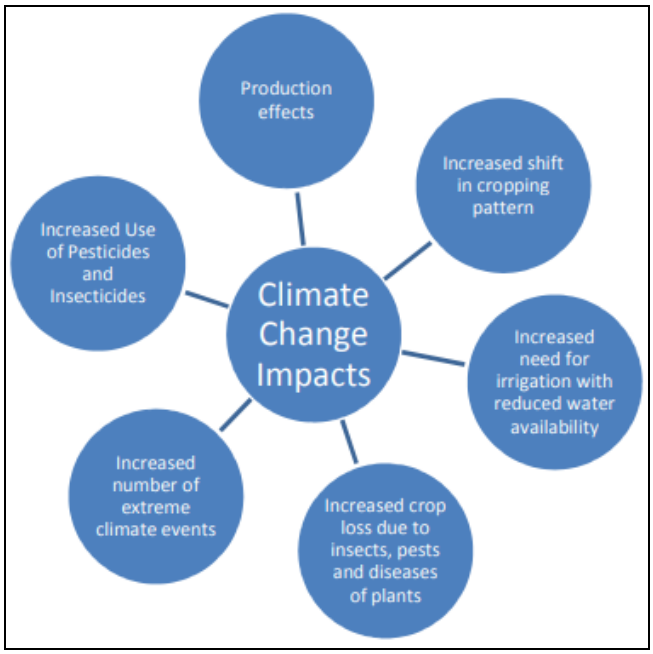

Fig 3: Five main effects of climate change on farming, shown schematically

Paddy production in Alwar District

Table 2: Examining how various weather variables interact with one another and paddy output using a regression model

Variables	b	SEb	β	P
Constant	1103657	404637		.017
$(PMMMT)^2$	-37757	15760	-.508	.048
$(WMMT)^2$	-32268	12427	-.458	.022
$(AMT)^2$	28677	13125	.338	.048

Note: R^2= .461, F= 14.54, p=.001 (All variables are in quadratic terms)

Mean maximum temperature after the monsoon season (PMMMT), mean maximum temperature in the winter (WMMT), and annual mean temperature (AMT)

Conclusion

This research lends credence to the idea that important crop yields in Rajasthan, including rice, pepper, coconut, and rubber, climate change, particularly the warmer temperatures and more unpredictable rainfall, has had a negative influence on. The impacts would have been far more severe in the past due to the fact that farming is dependent on consistent weather patterns.

Reducing the impact associated with global warming via adaptation

In this section, we explore the relatively new notion of adaptation and uses one way ANOVA to investigate its impact on the output of chosen crops. It follows research that examined how rainfall and temperature variations have influenced agricultural productivity in various areas of Rajasthan. Due to the ease with which technical, resource, and managerial changes may be implemented, several studies have shown that the agricultural sector is very flexible. Sudden climate change and catastrophic occurrences cause farmers enormous losses that they cannot overcome on their own, and the issue of when and how to adapt is yet unsolved. Therefore, it is critical to measure the actions taken to lessen immediately felt the effects of global warming. Examining the impact of agricultural adaptation the study's focus was on the impact on Rajasthan's agricultural output final and fourth objective.

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