



IMPACT OF CLIMATE CHANGE ON AGRICULTURE: A CASE STUDY OF WESTERN MAHARASHTRA

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ABSTRACT:

Climate change has emerged as a significant global challenge, with profound implications for agriculture, particularly in regions heavily reliant on farming. Western Maharashtra, a key agricultural zone in India, has been increasingly affected by changing climatic patterns, including erratic rainfall, rising temperatures, and frequent droughts. These climatic variations have disrupted traditional farming systems, leading to declining crop yields, soil degradation, and water scarcity. Crops such as sugarcane and rice, which dominate the region, are particularly vulnerable due to their high water requirements.

This study examines the impact of climate change on agricultural productivity, water resources, and farmer livelihoods in Western Maharashtra. It highlights adaptive strategies employed by farmers, such as the adoption of drought-resistant crop varieties, micro-irrigation, and diversification of crops. The role of government interventions, including crop insurance and water management programs, is also analyzed.

The findings emphasize the urgent need for sustainable agricultural practices, efficient water resource management, and enhanced policy support to mitigate climate risks. By integrating traditional knowledge with modern technologies, Western Maharashtra can build resilience against climate change and ensure long-term agricultural sustainability.

INTRODUCTION:

Climate change is one of the most pressing global issues of the 21st century, profoundly affecting ecosystems, economies, and livelihoods. Agriculture, being heavily dependent on climatic conditions, is particularly vulnerable to its impacts. Changes in temperature, precipitation patterns, and

the frequency of extreme weather events have significantly disrupted farming systems worldwide. In India, where agriculture contributes substantially to the economy and supports a majority of the rural population, these disruptions pose severe challenges to food security and farmer livelihoods.

Western Maharashtra, a prominent agricultural region, is known for its diverse cropping patterns, including sugarcane, rice, wheat, and fruits. However, the region's dependency on monsoons and groundwater resources makes it highly susceptible to climate variability. In recent decades, farmers in this area have faced challenges such as delayed monsoons, prolonged droughts, and unseasonal rainfall, which have adversely impacted crop productivity and soil health.

This paper aims to explore the implications of climate change on agriculture in Western Maharashtra. It analyzes the changing climatic trends, their effects on agricultural productivity, and the adaptive measures adopted by farmers. By examining the region's specific vulnerabilities and responses, the study highlights the need for sustainable and climate-resilient agricultural practices to secure the livelihoods of millions and ensure long-term food security.

OBJECTIVES:

1. To analyze the trends in climatic variables such as temperature, rainfall patterns, and frequency of extreme weather events in Western Maharashtra.
2. To assess the impact of climate change on crop productivity and agricultural practices in the region, focusing on key crops like sugarcane, rice, and fruits.
3. To evaluate the socio-economic implications of climate change on farmer livelihoods, including income stability, resource availability, and migration patterns.
4. To examine the adaptive strategies employed by farmers, such as the adoption of climate-resilient crops, advanced irrigation techniques, and crop diversification.
5. To provide policy recommendations for sustainable agricultural practices and effective climate adaptation measures to mitigate the impacts of climate change on agriculture in Western Maharashtra.

IMPORTANCE OF THE STUDY:

The study on the impact of climate change on agriculture in Western Maharashtra is crucial for understanding the region's agricultural vulnerabilities and resilience. Western Maharashtra, a significant agricultural hub, faces severe challenges due to erratic rainfall, rising temperatures, and frequent droughts, which directly affect crop yields and farmer livelihoods. By identifying the crops and farming systems most sensitive to climatic variations, the study provides insights that can guide the adoption of sustainable agricultural practices and resource management strategies. It emphasizes the importance of efficient use of water and soil resources, which are critical in a drought-prone region.

This research also highlights the socio-economic implications of climate change, such as income instability, migration, and increased input costs, and examines adaptive measures employed by farmers, like crop diversification and advanced irrigation techniques. The findings are essential for designing data-driven policies and promoting climate-resilient farming, ensuring food security for the region. Furthermore, the study raises awareness about the long-term impacts of climate change on agriculture, fostering collaborative action among farmers, policymakers, and researchers. Its relevance extends beyond Western Maharashtra, serving as a model for addressing similar challenges in other semi-arid agricultural regions worldwide.

RESEARCH METHODOLOGY AND DATA COLLECTION:

This study employs a mixed-method approach to analyze the impact of climate change on agriculture in Western Maharashtra. The research combines quantitative and qualitative methods to provide a comprehensive understanding of climatic trends and their effects on agricultural systems. Secondary data, including historical temperature and rainfall records, is sourced from meteorological departments and government reports to analyze changes in climatic patterns over the past three decades. Agricultural data, such as crop yields and productivity, is collected from official statistics and research publications.

To complement the secondary data, primary data is gathered through field surveys and interviews with farmers in Western Maharashtra. These interactions focus on understanding farmers' perceptions of climate change, its impact on their livelihoods, and the adaptive measures they have employed. Case studies of specific villages and crops, such as sugarcane and rice, provide

detailed insights into localized effects. The study also incorporates Geographic Information System (GIS) tools to map changes in land use, water availability, and soil health. Data analysis involves statistical methods to identify correlations between climatic variables and agricultural outcomes, ensuring a robust and evidence-based conclusion.

Table No.1: Climatic Trends in Western Maharashtra

Sr. No.	Year	Average Annual Rainfall (mm)	Average Temperature (°C)	Extreme Weather Events
1	2010	850	25.5	2
2	2012	790	26.1	3
3	2015	720	27	4
4	2020	680	27.5	5

The data presented in Table No. 1 highlights significant changes in the climatic conditions of Western Maharashtra over the past decade. Average annual rainfall has steadily decreased from 850 mm in 2010 to 680 mm in 2020, a decline of approximately 20%. This reduction in rainfall may exacerbate water scarcity, especially for agriculture that depends heavily on monsoon rains. Average temperatures have gradually increased from 25.5°C in 2010 to 27.5°C in 2020, signaling a warming trend in the region. Higher temperatures can contribute to increased evaporation, soil dryness, and heat stress on crops. The frequency of extreme weather events has risen from 2 events in 2010 to 5 events in 2020, indicating a growing occurrence of unpredictable weather patterns, including droughts, unseasonal rains, and heatwaves.

Table No.2: Impact on Crop Yields

Sr. No.	Crop	2010 Yield (tons/ha)	2020 Yield (tons/ha)	% Change
1	Sugarcane	100	85	-15%
2	Rice	2.8	2.3	-18%
3	Wheat	3.5	3	-14%
4	Grapes	8.5	7.2	-15%

The data in Table No. 2 demonstrates a clear decline in crop yields in Western Maharashtra from 2010 to 2020, reflecting the adverse effects of climate change. Sugarcane yields decreased by 15%, from 100 tons/ha in 2010 to 85 tons/ha in 2020, likely due to reduced rainfall and higher temperatures affecting water availability. Similarly, rice production fell by 18%, from 2.8 tons/ha to 2.3 tons/ha, indicating that water-intensive crops are particularly vulnerable to shifting rainfall patterns. Wheat yields dropped by 14%, from 3.5 tons/ha to 3

tons/ha, with rising temperatures and inconsistent rainfall negatively impacting crop growth. Finally, grape production also saw a 15% decrease, from 8.5 tons/ha to 7.2 tons/ha, which can be attributed to the combined effects of heat stress and unseasonal weather events. This trend underscores the growing challenge of maintaining agricultural productivity under changing climatic conditions, with significant impacts on crop yields across multiple sectors.

Table No.3: Water Resource Availability

Sr. No	Source	2010 (BCM)	2020 (BCM)	% Change
1	Groundwater	3.2	2.4	-25%
2	Surface Water	1.5	1	-33%
3	Total Water Available	4.7	3.4	-28%

The data in Table No. 3 reveals a significant reduction in water resources in Western Maharashtra between 2010 and 2020. Groundwater availability decreased by 25%, from 3.2 BCM in 2010 to 2.4 BCM in 2020, reflecting over-extraction and reduced replenishment due to decreased rainfall. Similarly, surface water availability dropped by 33%, from 1.5 BCM to 1 BCM, signaling a decline in reservoir levels and reduced inflow, likely influenced by changing precipitation patterns. As a result, the total water available in the region decreased by 28%, from 4.7 BCM in 2010 to 3.4 BCM in 2020.

This decline in water resources directly impacts agricultural practices, as farmers face growing challenges in securing adequate water for irrigation, especially in drought-prone years. The reduced water availability underscores the urgency for implementing efficient water management practices and climate-resilient farming strategies to sustain agricultural productivity in the region.

Table No. 4: Farmer Perception on Climate Change (Survey Results)

Sr. No.	Question	Yes (%)	No (%)	Not Sure (%)
1	Have you observed changes in rainfall?	85	10	5
2	Has your crop yield been affected?	78	15	7
3	Are you using adaptive farming techniques?	65	25	10

The survey results in Table No. 4 reflect a clear recognition of climate change impacts by farmers in Western Maharashtra. A significant 85% of farmers have observed changes in rainfall patterns, indicating heightened awareness of the shifting climate. Additionally, 78% of farmers report that their crop yields have been negatively affected, with only 15% unaffected. Regarding adaptive strategies, 65% of farmers are adopting adaptive farming techniques, such as crop diversification and water-saving methods, while 25% have not yet implemented such strategies. This data suggests that while farmers are aware of the challenges posed by climate change, there is a considerable gap in the widespread adoption of adaptive practices. The findings highlight the need for greater support in promoting and educating farmers about climate-resilient agricultural techniques.

Table No. 5: Adaptive Strategies Employed by Farmers

Sr. No.	Adaptive Measure	Percentage of Farmers Adopting (%)
1	Drought-resistant crop varieties	40
2	Micro-irrigation techniques	35
3	Crop diversification	50
4	Use of weather forecasting tools	20

The data in Table No. 5 reveals a variety of adaptive strategies being employed by farmers in Western Maharashtra to cope with climate change. Crop diversification is the most common strategy, with 50% of farmers adopting this approach to minimize the risk of crop failure due to weather fluctuations. Drought-resistant crop varieties are used by 40% of farmers, helping them withstand periods of low rainfall. The use of micro-irrigation techniques has been adopted by 35% of farmers, enhancing water efficiency in irrigation. However, only 20% of farmers are utilizing weather forecasting tools, indicating a gap in the adoption of modern technologies that could assist in better planning and decision-making. These findings highlight that while farmers are taking adaptive measures, there is room for greater adoption of innovative strategies, particularly in water management and climate forecasting.

FINDINGS:

- 1) The data reveals a clear trend of decreasing rainfall and rising temperatures in Western Maharashtra over the past decade, with a 20% decline in rainfall from 2010 to 2020 and a 2°C increase in temperature. Additionally, the frequency of extreme weather events has steadily increased, reaching 5 events by 2020, indicating greater climatic instability that negatively impacts agriculture and water resources in the region.
- 2) The data in Table No. 2 reveals a consistent decline in crop yields from 2010 to 2020 across all major crops in Western Maharashtra. Sugarcane saw a 15% reduction, rice dropped by 18%, wheat decreased by 14%, and grapes saw a 15% decline. These yield decreases are indicative of the negative impact of climate change, particularly in terms of reduced rainfall, rising temperatures, and the occurrence of extreme weather events, all of which have contributed to lower agricultural productivity in the region. The findings highlight the need for adaptation strategies to mitigate these climate-related challenges and ensure the sustainability of agriculture.
- 3) The data in Table No. 3 highlights a significant decline in water resources over the past decade. Groundwater has decreased by 25%, surface water by 33%, and total water availability by 28%. This reduction in water resources poses a major challenge for agriculture in Western Maharashtra, as farmers increasingly struggle with water scarcity, particularly during dry spells and drought conditions. The findings emphasize the need for effective water conservation and management strategies to ensure sustainable agricultural practices in the face of climate change.
- 4) The survey results in Table No. 4 indicate that 85% of farmers have noticed changes in rainfall patterns, suggesting strong awareness of climate variability. 78% of farmers report that their crop yields have been affected, highlighting the significant impact of climate change on agricultural productivity. Despite these challenges, 65% of farmers are adopting adaptive farming techniques, though there is still room for improvement in the widespread adoption of such practices to cope with changing climatic conditions.
- 5) The data in Table No. 5 shows that 50% of farmers are adopting crop diversification as a key strategy to manage climate risks. 40% of farmers are using drought-resistant crop varieties, and 35% are employing micro-irrigation techniques to optimize water usage. However, only 20% of farmers are utilizing weather forecasting tools, suggesting that there is a gap in the

adoption of technology-driven solutions for climate adaptation. These findings highlight the importance of promoting innovative farming practices and technologies to help farmers cope with the challenges of climate change.

CONCLUSION:

The study on the impact of climate change on agriculture in Western Maharashtra reveals significant challenges faced by farmers in the region. The analysis shows a marked decline in both rainfall and water resources, along with rising temperatures, which have led to reduced crop yields across key agricultural sectors such as sugarcane, rice, and wheat. Despite these challenges, farmers have begun adopting adaptive strategies like crop diversification and drought-resistant varieties. However, the widespread use of advanced techniques like weather forecasting tools remains limited. The findings highlight the urgent need for enhanced climate-resilient agricultural practices and the promotion of technology to improve water management and forecasting capabilities. Policymakers and agricultural experts must collaborate to provide training and resources to farmers to better equip them for the changing climate. Only through such collective efforts can the region's agricultural sustainability be ensured amidst growing climate variability.

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