

Original Article

Impact of Climate Change on Marginal Farmers: A Socio-Economic Study of Satara District

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Abstract:

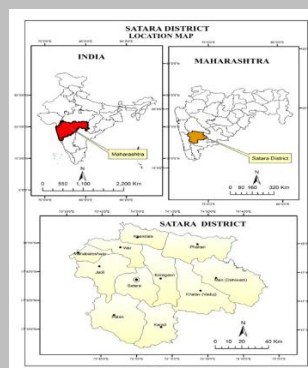
Climate change has emerged as one of the most critical challenges affecting agricultural sustainability and rural livelihoods in India. Small and marginal farmers are particularly vulnerable due to limited landholdings, inadequate financial resources, and high dependence on monsoon rainfall. The present study examines the socio-economic impact of climate change on small and marginal farmers in Satara District of Maharashtra. This research examines how climate change influences crop yields, income, livelihood security, and adaptation strategies of marginal farmers in Satara. The study integrates secondary climatic data and agricultural data with primary socio-economic insights to assess impacts and policy priorities for climate-resilient agricultural development.

Keywords: Climate Change, Small and Marginal Farmers, Agricultural Productivity, Vulnerability, Adaptation

Introduction:

Agriculture is the backbone of many rural economies in India, and Satara district is no exception. A large proportion of households in Satara depend on rain-fed farming and horticulture. Climate change refers to long-term alterations in temperature, precipitation patterns, and extreme weather events that affect ecological and economic systems. Climatic variables such as rainfall, temperature, and weather extremes play a critical role in determining crop yields and farming success. However, recent observations show increasing fluctuations in rainfall patterns, rising heat and more frequent extreme events conditions broadly associated with climate change. These changes disproportionately affect marginal farmers, who have limited resources, low adaptive capacity, and high dependency on climatic stability for their livelihoods. This study attempts to analyze the socio-economic consequences of climate change on small and marginal farmers in Satara District and evaluate their adaptive responses. Satara District in Maharashtra experiences diverse agro-climatic conditions ranging from high rainfall zones in the Western Ghats to drought-prone areas in eastern talukas. Increasing instances of irregular monsoon, delayed rainfall onset, and prolonged dry spells have affected agricultural productivity and farm incomes. Crops such as sugarcane, paddy, Jowar and horticultural produce are sensitive to climatic fluctuations.

Study Area: Satara district is situated between 17°05' to 18°11' N latitude and 73°33' to 74°54' E longitude (Fig.No.1.1).



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The western region includes high rainfall zones (Mahabaleshwar, Jaoli, Patan), while eastern talukas (Man, Khatav) experience semi-arid conditions. Agro-Climatic Zones are **High Rainfall Forest Zone, Transitional Mixed Zone, Semi-Arid Plateau Zone**. Annual rainfall ranges from 600 mm (east) to over 6000 mm (western highlands)

Satara district is situated ecologically sensitive Western Ghats region of Maharashtra, India. The Sahyadri mountain range lies to the west, while the eastern part consists of semi-arid plateau regions. Talukas such as Jaoli, Mahabaleshwar, and Patan have dense forest cover, whereas Khatav, Man, and Karad experience semi-arid climatic conditions.

The study is conducted in Satara district of Maharashtra, located in western India. The district includes both high rainfall areas such as Mahabaleshwar and drought-prone regions like Man and Khatav talukas. The Krishna and Koyna rivers provide irrigation support, but many farmers depend on monsoon rainfall. Due to its geographical diversity, the district provides an ideal setting for a study of agriculture.

Objectives:

- To examine the trends of climate variability in Satara District.
- To analyze the impact of climate change on crop productivity among small and marginal farmers.
- To assess the socio-economic consequences on income, employment, and livelihood security.

Data Collection:

The present study is based on primary and secondary data sources. Primary data was collected through Survey of 150 small and marginal farmers from 15 villages across different agro-climatic zones. And secondary data through Indian Meteorological Department rainfall records, District Statistical Abstracts, Agricultural Department reports.

Results and Discussion:

Satara District has experienced noticeable fluctuations in rainfall patterns, increasing temperature variability, and a rising frequency of extreme weather events such as droughts, unseasonal rainfall, and heat waves. These climatic irregularities have altered the agricultural calendar, affected sowing and harvesting periods, and created uncertainty in crop planning. The results presented in this section are based on climatic trend analysis, agricultural productivity data, and socio-economic responses collected from marginal farming households.

1. Climate Trends:

An analysis of climatic data over the past decade reveals significant changes in temperature and rainfall patterns in Satara District. These trends indicate increasing climate variability, which directly affects agricultural productivity and rural livelihoods.

1. Increase in Average Temperature (0.8°C)

The rise of approximately 0.8°C in average temperature over the last decade reflects a warming trend in

the district. Even a moderate increase in temperature can have serious implications for agriculture:

- **Heat stress on crops** during critical growth stages such as flowering and grain filling reduces yield.
- Increased **evapotranspiration** leads to faster soil moisture loss, especially in rain-fed areas.
- Higher temperatures raise **irrigation demand**, increasing input costs for small and marginal farmers.

This warming trend shortens crop duration and reduces productivity, especially for temperature-sensitive crops.

2. 15–20% Variability in Monsoon Rainfall

Monsoon rainfall in Satara shows significant inter-annual fluctuations, with variability ranging between 15–20%. This variability affects agriculture in multiple ways:

- **Delayed onset of monsoon** disrupts sowing schedules.
- **Uneven distribution** (heavy rainfall in short periods followed by dry spells) leads to waterlogging in some areas and drought-like conditions in others.
- Reduced rainfall during critical crop growth periods lowers yields.

Since a large portion of farmers in the district depend on rain-fed agriculture, such rainfall variability increases production risk and uncertainty.

3. Increased Frequency of Drought Years

The past decade has witnessed more frequent drought-like conditions, particularly in the eastern rain-shadow regions of the district. Drought impacts include:

- Decline in soil moisture and groundwater levels.
- Reduced crop yields and in some cases complete crop failure.
- Increased fodder scarcity affecting livestock.
- Rising indebtedness due to repeated agricultural losses.

Recurring droughts weaken farmers' adaptive capacity over time, forcing them to rely on credit, government relief, or migration for survival.

The combined effect of rising temperatures, irregular monsoon rainfall, and frequent droughts indicates increasing climatic instability in Satara District. These changes intensify agricultural vulnerability, particularly for small and marginal farmers who have limited financial and technological resources to cope with such risks. Climate variability is therefore not only an environmental issue but also a socio-economic challenge affecting livelihood security in the region.

Climate Change Trends Affecting Agriculture in the District

- **Temperature rise:** Climate studies for Maharashtra indicate a general increase in both maximum and minimum temperatures, which creates heat stress for many crops and disrupts crop growth cycles and yield formation.
- **Erratic rainfall:** Satara has shown fluctuating rainfall patterns, with some years experiencing drought-like conditions and others facing intense rainfall events that can lead to floods and waterlogging.

- **Extreme weather events:** Recent occurrences of sharp, heavy rainfall have damaged crops such as soybeans, bananas, and fodder, negatively affecting agricultural output and farmer incomes.

Impact of Climate Change on Crop Productivity

Satara district in western Maharashtra is an agriculturally active region with a large proportion of *small and marginal farmers* who largely depend on rain-fed agriculture and traditional crops. These farmers typically have limited landholdings, less access to irrigation, adaptive technologies, and financial buffer, making them more vulnerable to climatic changes.

Irregular rainfall and temperature anomalies influence crop productivity. Water stress, whether due to drought-like conditions or waterlogging from heavy rains, directly harms growth stages and yields. Increased temperature extremes also affect flowering and grain filling stages of crops.

Climate change impacts productivity in multiple ways:

1. Reduced Yields

Erratic rain and higher temperatures disrupt flowering, grain filling, and crop maturity, leading to yield reductions particularly in traditional rain-fed crops like jowar, bajra, pulses, and soybean. Extreme weather events, such as sudden floods, physically damage crops and reduce standing biomass.

2. Increased Variability of Output

Variability in climate causes year-to-year fluctuations in productivity, which reduces predictability and planning for small farmers who depend on stable yields for their livelihood.

. Economic Stress

Lower yields directly reduce household income for small and marginal farmers, often increasing reliance on loans and debt. Research in Satara shows climate variability undermines financial stability due to rising input costs and yield losses.

Small and marginal farmers are particularly affected because:

Small and marginal farmers of satara district are affected by following reasons.

- **Dependence on monsoon:** With limited irrigation coverage, they rely heavily on rainfall. Any deviations droughts or excess rain have immediate impacts on crop success.
- **Limited adaptive capacity:** They often lack access to climate-resilient seeds, technology, financial resources, and crop insurance.
- **Higher risk exposure:** Farm size is too small to absorb losses, so climate shocks can quickly translate into livelihood insecurity.
- **Lower access to information and extension services:** This reduces knowledge of adaptation strategies or advanced climate-smart practices.

Socio-Economic Impact on Marginal Farmers:

Marginal farmers typically those owning less than 1 hectare form a majority of the agricultural workforce in Satara. These farmers have limited access to irrigation and thus rely heavily on monsoon rains. Restricted financial capital, making them sensitive to crop failure or losses. High dependence on credit, often forcing loans during bad seasons. Climate change has significant socio-economic consequences for small and marginal farmers in Satara district. Since agriculture is the primary source of livelihood in the district, fluctuations in crop productivity directly influence income, employment, food security, and overall living standards. 22% of surveyed households reported seasonal migration. Average farm income declined by 14% during drought years. Increased indebtedness due to crop loss and input costs. Reduced livestock productivity due to fodder scarcity.

Conclusion:

The study confirms that climate change significantly affects small and marginal farmers in Satara District. Erratic rainfall, rising temperatures, and frequent droughts have reduced agricultural productivity and increased socio-economic vulnerability. While farmers have adopted various adaptation strategies, limited financial resources and institutional support constrain resilience. Climate-resilient agricultural practices and supportive government policies are essential for sustainable rural development. Climate change profoundly affects the socio-economic stability of marginal farmers in Satara District by disrupting agricultural patterns and economic security. The interplay of climatic shifts with water scarcity, extreme weather events, and livelihood vulnerabilities underscores the need for integrated adaptation strategies and supportive policies. Addressing these challenges can contribute to resilient rural livelihoods and sustainable agricultural development.

Suggestions:

1. Expansion of micro-irrigation (drip and sprinkler systems).
2. Strengthening crop insurance coverage and awareness.
3. Development of localized weather forecasting systems.
4. Encouraging water conservation measures such as farm ponds and watershed development.
5. Institutional credit support for small and marginal farmers.
6. Capacity-building programs on climate adaptation techniques.

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Conflicts of interest



The authors declare that there are no conflicts of interest regarding the publication of this paper

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