InSight Bulletin: A Multidisciplinary Interlink International Research Journal
Peer Reviewed International, Open Access Journal.
ISSN : 3065-7857 / Website: https://ibrj.us / Volume-2, Issue-4 / April - 2025

Original Article

Rainfall Variation, Adaptaion, and Mitigation Strategies: Farmers' Perceptions in Solapur District

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Manuscript ID:
IBMIIRJ -2025-020402

Submitted: 02 Mar 2025

Revised: 16 Mar 2025

Accepted: 03 Apr 2025

Published: 30 Apr 2025

ISSN: 3065-7857

Volume-2

Issue-4

Pp. 4-9

April 2025

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OPEN ACCESS

Quick Response Code:

Web. https://ibrj.us

DOI: 10.5281/zenodo.15963779

DOI Link:
https://doi.org/10.5281/zenodo.15963779

Abstract

Rainfall variability, a key manifestation of climate change, poses significant challenges to rain-fed agriculture, impacting crop productivity, soil quality, and farmers' livelihoods. This study investigates farmers' perceptions of rainfall variability and their adaptation and mitigation strategies across 11 tahsils in a drought-prone region. Based on a survey of 550 households, the findings reveal that 88.91% of farmers perceive changes in rainfall patterns over the past decade, with droughts (70.73%) being the dominant form of variability. Adaptation strategies include irrigation (68.36%), crop diversification (44.73%), and rainwater harvesting (61.82%), while mitigation efforts involve soil conservation (58.18%) and crop insurance (86.91%). However, limited government support (rated "poor" or "very poor" by 60.72%) and low interaction with agricultural extension services (48.91% never interacted) highlight gaps in institutional support. This paper underscores the need for integrated, context-specific strategies to enhance farmers' resilience to climate change. Additional barriers include financial constraints, lack of technical knowledge, and unpredictable weather events that hinder timely responses. This research is based on an extensive analysis of historical rainfall data, agricultural practices, and mitigation strategies employed in the region. The findings will contribute to policy recommendations and practical solutions for managing rainfall variability and mitigating its adverse effects in Solapur district.

Keywords: *Rainfall variability, Climate change, Rain-fed agriculture, Drought-prone region, Farmer perceptions, Adaptation strategies, Irrigation, Crop diversification, Rainwater harvesting, Mitigation efforts, Soil conservation, Crop insurance, Institutional support, Agricultural extension services, Farmer resilience*

Introduction

Rainfall plays a crucial role in sustaining agriculture, water resources, and the overall economy of regions dependent on monsoon patterns. Solapur district, located in the semi-arid zone of Maharashtra, is characterized by erratic and insufficient rainfall, making it vulnerable to frequent droughts and water scarcity. The district experiences high interannual variability in precipitation, leading to challenges in agriculture, groundwater recharge, and livelihood sustainability. Rainfall variability poses significant challenges to farmers, particularly in regions heavily reliant on rain-fed agriculture. It directly impacts crop yields, soil quality, water availability, and overall agricultural productivity, threatening food security and livelihoods. Farmers, being the primary stakeholders in agricultural systems, have developed diverse perceptions and strategies to adapt to these changing climatic patterns. Their understanding of rainfall variability often stems from traditional knowledge, observational experience, and local climatic trends. However, the increasing unpredictability of rainfall due to climate change has amplified the risks, necessitating innovative and sustainable adaptation strategies. These include diversifying crops, adopting drought-resistant varieties, practicing soil conservation, employing water harvesting techniques, and integrating modern technologies with indigenous practices. Government policies and support systems, such as subsidies, weather forecasting services, and access to credit, also play a pivotal role in strengthening farmers' resilience. Exploring farmers' perceptions provides valuable insights into their decision-making processes and the effectiveness of various adaptation measures.

How to cite this article:
Sarwade, G. M., & Nimbalkar, V. B. (2025). Rainfall Variation, Adaptaion, and Mitigation Strategies: Farmers' Perceptions in Solapur District. Insight Bulletin: A Multidisciplinary Interlink International Research Journal, 2(4), 4–9. https://doi.org/10.5281/zenodo.15963779

It also highlights the gaps between policy frameworks and ground-level realities, paving the way for tailored interventions. Understanding these perceptions and strategies is critical for designing context-specific solutions that address the dual challenges of climate variability and sustainable agriculture.

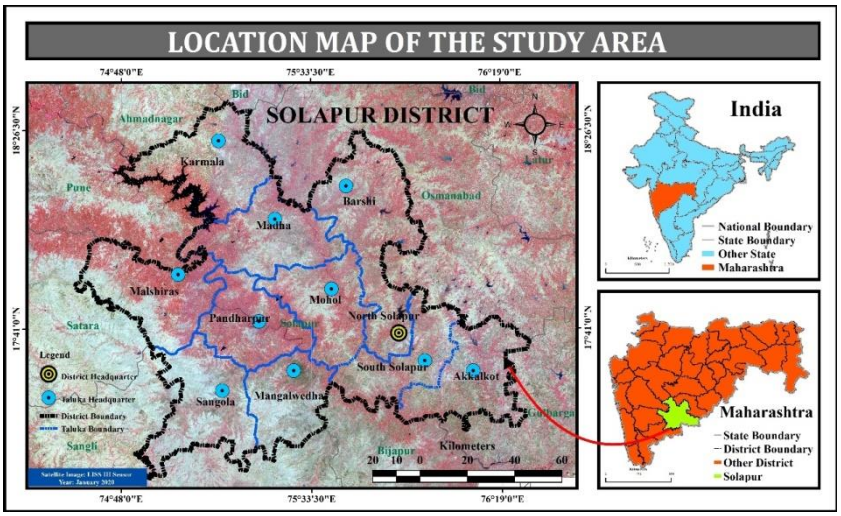
This study aims to analyze the patterns of rainfall variation in Solapur district and assess its implications on farmers. Furthermore, it explores various adaptation and mitigation strategies, including water conservation techniques, improved irrigation practices, drought-resistant crop varieties, and policy interventions. By understanding rainfall trends and implementing sustainable measures, the district can enhance its resilience against climatic uncertainties and ensure long-term agricultural and economic stability. This research is based on an extensive analysis of historical rainfall data, agricultural practices, and mitigation strategies employed in the region. The findings will contribute to policy recommendations and practical solutions for managing rainfall variability and mitigating its adverse effects in Solapur district.

Methodology

Study Area and Sample Selection

The study spans 11 tahsils, with five villages selected per tahsil: two along riversides, two away from riversides, and one chosen randomly, totalling 55 villages. Ten households per village were surveyed, resulting in 550 respondents. This stratified sampling approach ensures representation of diverse geographical and socio-economic contexts.

Objectives



1. To assess the farmers' awareness and perceptions about variation in rainfall in the study region.
2. To study various adaptation practices used by farmers and identify the determinants of farm level adaptation strategies.
3. To suggest policy measures regarding climate change of district level based on the empirical results from the study.

Data Collection and Analysis

Primary Data

Primary data were collected through the scheduled focusing on demographics, rainfall perceptions, crop productivity impacts, and adaptation strategies. To examine the perception and adaption practices of farmers, simple statistical tools like percentages and frequencies is used.

Cartographic Software

All maps and diagrams of this research made in QGIS software. Graphs are made in MS-Excel software.

Data Analysis Applications

1. The tabular type of data processed in MS-Excel. Statistical analysis also done in MS-Excel.
2. Descriptive statistics, including percentages and frequency distributions, were used to analyze the data, supplemented by graphical representations (tables, bar charts, and pie charts).

Results and Discussion

Demographic Profile

The respondents' demographic characteristics provide context for their perceptions and adaptive capacities. Over 60% of farmers are under 45 years old, with 32.73% aged 31–45 and 28.91% aged 18–30, indicating a youthful farming population. However, the sector remains male-dominated (77.09% male vs. 22.91% female). Education levels are low, with 41.64% below SSC and 28.36% illiterate, potentially limiting access to modern adaptation technologies. Farming experience varies, with 34.36% having 11–20 years of experience.

Table 1: Demographic Characteristics of Respondents

Variable	Category	No. of Respondents	% of Respondents
Age	18–30	159	28.91
	31–45	180	32.73
	46–60	112	20.36
	Above 60	99	18.00
Gender	Male	424	77.09
	Female	126	22.91
Education	Illiterate	156	28.36
	Below SSC	229	41.64
	HSC	110	20.00
Farming Experience	0–5 years	98	17.82
	6–10 years	136	24.73
	11–20 years	189	34.36
	Above 21 years	127	23.09

Perceptions of Rainfall Variability

Farmers recognize rainfall variability as a climate change outcome, with 88.91% observing changes over the past decade. Perceptions of current rainfall patterns are nearly split, with 50.55% deeming them regular and 49.45% irregular. Droughts dominate variability experiences (70.73%), followed by floods (20.36%) and both (8.91%). Notably, 68.73% find rainfall patterns increasingly unpredictable, and 88.91% attribute this to climate change.

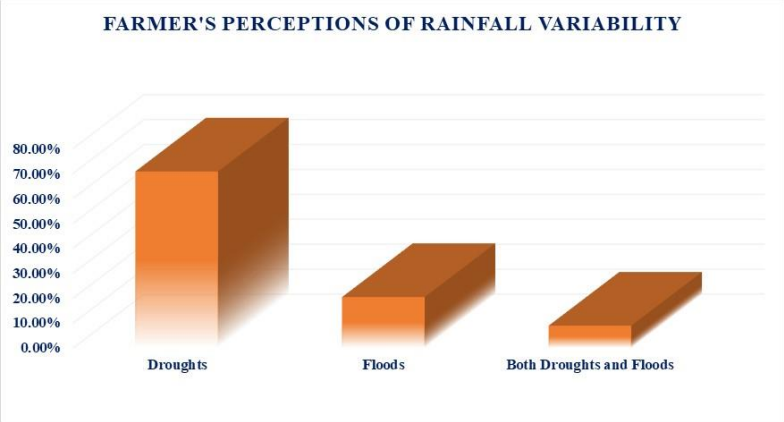


Figure 1: Farmers' Perceptions of Rainfall Variability

Perception of rainfall variability has shown that majority of the respondents have observed changes in the rainfall patterns over the three decades (1991-2021).

3.3 Impacts on Crop Productivity

Rainfall variability significantly affects crop productivity, with 63.45% of farmers reporting decreased yields. Fruit crops (47.09%) and vegetables (26.91%) are most affected, while sugarcane (1.82%) is least impacted. Primary crop yields decreased for 70.73% of farmers, and 72.18% noted a decline in crop quality, all of whom reported reduced quality. Soil moisture changes (88.55%) and delayed planting schedules (68.91%) further exacerbate production challenges. The stark differences in crop distribution between 1994 and 2021 illustrate the profound impact of rainfall on agricultural practices. In contrast, the abundant rainfall in 2021 enabled a significant shift toward water-demanding crops such as sugarcane, soyabean, and corn.

Crop productivity in Solapur district was significantly higher in 2021 compared to 1994. Jawar retained its prominence but saw a reduction in its share, reflecting diversification in cropping patterns. Jawar, Tur, Sunflower, Maize, and Wheat are crops that show the least variation in yield due to rainfall variability, though they still experience changes in crop quality. The study reveals that 68.91% of farmers reported delayed planting schedules as a direct consequence of rainfall variability, significantly disrupting traditional agricultural calendars and contributing to the broader production challenges in the region.

Table 2: Rainfall Variability Affecting Crop Productivity

Impact	No. of Respondents	% of Respondents
Increased	114	20.73
Decreased	349	63.45
No Change	87	15.82

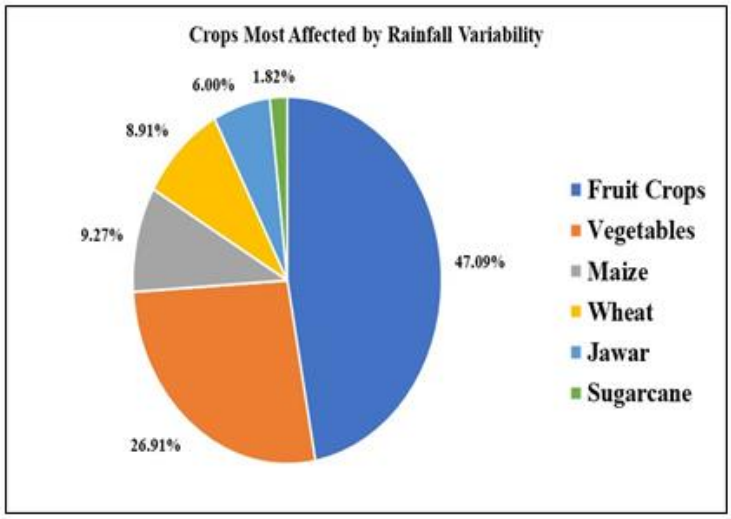


Figure 2: Crops Most Affected by Rainfall Variability

Adaptation and Mitigation Strategies

Farmers employ diverse strategies to cope with rainfall variability:

Irrigation: 68.36% use irrigation methods, predominantly drip (44.15%) and sprinkler (30.05%) systems.

Crop Diversification: 44.73% changed crop types, with 51.22% shifting to drought-resistant crops.

Soil Conservation: 58.18% adopt techniques like mulching (32.19%) and crop rotation (27.90%).

Rainwater Harvesting:

54.36% practice harvesting, using farm ponds (70.90%) and tanks (21.07%). The lowest mean rainfall distribution was observed during 1991-2000, with the highest crop yield occurring in 1991, while the period 2011-2021 experienced significantly reduced rainfall averaging between 730.20 mm and 437.77 mm. Addressing rainfall variability is crucial for farmers as it significantly impacts agricultural productivity.

Crop Insurance: 86.91% insure crops to mitigate losses.

Loans: 55.27% take loans, primarily from cooperative banks (40.79%) and banks (36.84%).

50.30% of respondents did not use weather forecasts to plan their farming activities.

The researcher tried to find the perception of farmers that, whether the rainfall variability is due to climate change or not. 88.91% respondents expressed that rainfall variability is due to climate change.

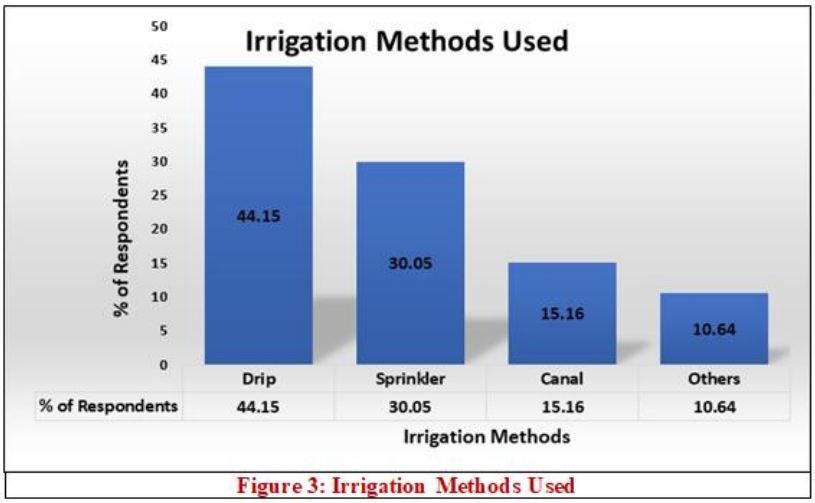


Figure 3: Irrigation Methods Used

Institutional Support and Perceptions

Support from local government is rated poorly, with 34.36% deeming it "poor" and 26.36% "very poor". Interaction with agricultural extension services is minimal (48.91% never interacted), and only 4.73% receive technical support from universities. Despite this, 83.45% believe modern farming equipment helps mitigate impacts, and 64.73% see organic farming as a viable option.

Table 3: Rating of Local Government Support

Rating	No. of Respondents	% of Respondents
Excellent	26	4.73
Good	69	12.55
Fair	121	22.00
Poor	189	34.36
Very Poor	145	26.36

Future Outlook and Confidence

Despite challenges, 67.64% perceive rainfall variability's overall impact as negative, yet 66.91% are optimistic or very optimistic about farming's future. Confidence in managing impacts is high, with 58.37% feeling confident or very confident.

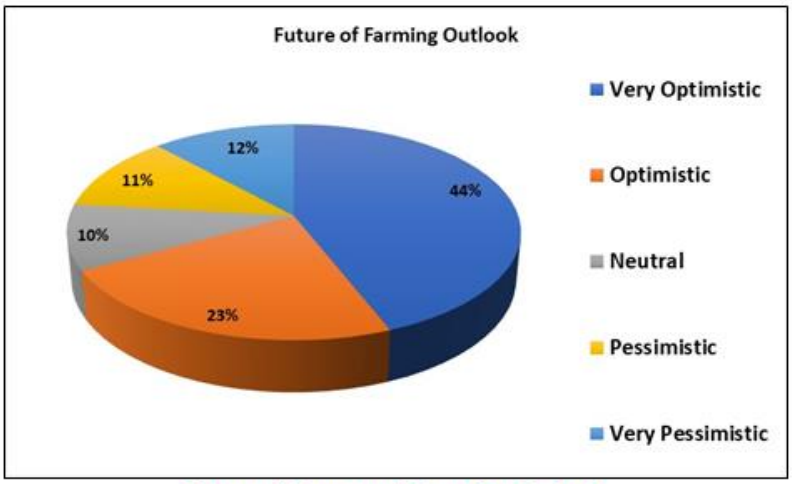


Figure 4: Future of Farming Outlook

Conclusion

This study highlights that rainfall variability, largely attributed to climate change, significantly impacts crop productivity, with droughts posing the greatest threat. Farmers adapt through irrigation, crop diversification, and rainwater harvesting, while mitigation includes soil conservation and insurance. However, inadequate government support and limited technical assistance hinder resilience. Integrating traditional knowledge (valued by 67.09%) with modern technologies, alongside enhanced policy support, is crucial for sustainable agriculture in this region.

Recommendations

1. Strengthen government support through subsidies, reliable weather forecasts, and accessible credit.
2. Enhance agricultural extension services and university outreach to improve technical knowledge dissemination.
3. Promote drought-resistant crops and organic farming as long-term adaptation strategies.
4. Invest in rainwater harvesting infrastructure to address water scarcity (76.91% affected).

Acknowledgment

The completion of this research paper would not have been possible without the guidance, support, and cooperation of many individuals and institutions. First and foremost, I express my sincere gratitude to my research supervisor, Dr. Gunvant M. Sarwade, for his invaluable guidance, encouragement, and insightful feedback throughout the study. I am also thankful to the faculty and staff of the Department of Geography, SBZ Mahavidyalaya, Barhi, and School of Earth Sciences, PAHSU, Solapur for providing the necessary support. Special thanks are due to the farmers across the 11 tahsils of Solapur district, who generously shared their time, experiences, and perspectives, making this research possible. I deeply appreciate their openness and cooperation during the field survey.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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