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Influence of socio-economic and agronomic factors on climate resilience management among farmers in Marathwada

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Abstract
The present study was conducted during 2023–24 in the Marathwada region of Maharashtra to examine the relationship between farmers' profile characteristics and their climate resilience management level. Out of the eight districts in the region, Nanded, Dharashiv, and Hingoli were purposively selected based on their significant climatic variability in terms of rainfall and temperature. Within each selected district, two tehsils were randomly chosen, resulting in a total of six tehsils. Further, two villages were randomly selected from each tehsil, and 15 farmers from each village were randomly chosen, making a total of 180 respondents. An ex-post facto research design was adopted, and data were collected using a pre-designed interview schedule through personal interactions to ensure accuracy, validity, and completeness. Statistical tools such as frequency, percentage, mean, standard deviation, and Pearson's coefficient of correlation were employed for data analysis and interpretation. The findings revealed that independent variables such as education, landholding, annual income, cropping pattern, scientific orientation, mass media exposure, economic motivation, risk orientation, awareness of climate-resilient agricultural (CRA) technologies, farm mechanization level, and extension contact had a positive and significant relationship with climate resilience management. In contrast, age and farming experience showed a negative and significant relationship, while the source of irrigation had a negative but non-significant relationship with climate resilience management. These insights highlight the influence of socio-economic and agronomic factors on farmers' climate resilience management levels, providing a foundation for developing targeted interventions to enhance their climate resilience.

Keywords: Profile characteristics, climate resilience management, relationship, Marathwada

Introduction
Agriculture is the backbone of the Indian economy, supporting the livelihoods of millions of farmers. However, climate change poses significant challenges to agricultural productivity, sustainability, and food security. The Marathwada region of Maharashtra, characterized by erratic rainfall patterns, increasing temperatures, and recurrent droughts, is particularly vulnerable to climate-induced risks. In this context, enhancing the climate resilience of farmers is crucial for sustaining agricultural livelihoods and ensuring long-term food security. Climate resilience in agriculture refers to the ability of farmers to anticipate, prepare for, and adapt to climate-related stresses while maintaining or improving productivity and profitability. The resilience level of farmers is influenced by various socio-economic and agronomic factors, collectively known as their profile characteristics. These characteristics, including education, landholding, income, cropping pattern, scientific orientation, mass media exposure, and risk-taking ability, play a significant role in determining how effectively farmers manage climate risks. While some factors facilitate resilience by enabling access to resources, technology, and information, others may act as constraints, limiting adaptation capacity. Previous studies have highlighted the importance of socio-economic factors in shaping farmers' adaptive capacities. However, limited research has been conducted to establish a systematic relationship between farmers' profile characteristics and their climate resilience management levels, particularly in the Marathwada region. Understanding these relationships can provide valuable insights for policymakers, extension agencies, and agricultural stakeholders in designing targeted

interventions to strengthen farmers' resilience to climate change. Therefore, this study aims to assess the relationship between farmers' profile characteristics and their climate resilience management level in the Marathwada region of Maharashtra. By analyzing key factors influencing resilience, the study seeks to contribute to the development of evidence-based strategies that enhance climate adaptation efforts among farmers.

Materials and Methods

The present study was conducted during 2023–24 in the Marathwada region of Maharashtra, India, to examine the relationship between farmers' profile characteristics and their climate resilience management levels. The study area was selected purposively from the eight districts of the Marathwada region, focusing on three districts—Nanded, Dharashiv, and Hingoli—due to their significant climatic variability in terms of rainfall and temperature. Within each selected district, two tehsils were randomly chosen, resulting in a total of six tehsils. Furthermore, two villages were randomly selected from each tehsil, and 15 farmers from each village were randomly chosen as respondents, ensuring a diverse and representative sample. This multi-stage random sampling procedure resulted in a total of 180 respondents. An ex-post facto research design was adopted for the study, as it allows for the investigation of existing relationships without manipulating variables. Data were collected using a pre-designed interview schedule to ensure the systematic and structured collection of relevant information. Farmers were personally contacted to enhance the accuracy, validity, and completeness of their responses. For data analysis and interpretation, various statistical tools were employed, including mean, standard deviation, frequency, percentage, and Pearson's coefficient of correlation**.** These methods enabled a comprehensive understanding of the influence of farmers' socio-economic and agronomic profile characteristics on their climate resilience management level. The findings from this study are expected to contribute to the formulation of effective strategies aimed at enhancing farmers' climate resilience.

Results and Discussion

1) Profile characteristics of farmers in the Marathwada region

Table 1: Profile characteristics of farmers

Sr. No.	Characteristics	Farmers (n = 180)	
		Frequency	Percentage
1	**Age**		
	Young (Up to 36 years)	32	17.78
	Middle (37 to 58 years)	106	58.89
	Old (59 years & above)	42	23.33
2	**Education**		
	Illiterate	16	8.89
	Primary school level	49	27.22
	High school level	60	33.33
	Jr. College level	28	15.56
	Diploma/ Graduation	27	15.00
3	**Land holding**		
	Marginal (up to 1.00 ha)	55	30.56
	Small (01 to 2.00 ha)	72	40.00
	Semi medium (2.01 to 4.00 ha)	39	21.67
	Medium (4.01 to 10.00 ha)	12	6.67
	Large (above 10.00 ha)	2	1.11
4	**Annual income**		
	Low (Up to Rs. 72,600)	22	12.22
	Medium (Rs. 72,601 to Rs. 2,50,743)	135	75.00
	High (Rs.2,50744 & above)	23	12.78
5	**Farming Experience**		
	Low (up to 9 years)	41	22.78
	Medium (10 to 35 years)	98	54.44
	High (36 years & above)	41	22.78
6	**Source of Irrigation***		
	Well	65	36.11
	Borewell	102	56.66
	Canal	8	4.44
	River	3	1.67
	Farm Pond	2	1.11
	Pond	0	0.00
	No Source	20	11.11
7	**Cropping Pattern**		
	Poor	34	18.89
	Fair	121	67.22
	Good	25	13.89
8	**Scientific orientation**		
	Low	37	20.56
	Medium	99	55.00
	High	44	24.44
9	**Mass media exposure**		
	Low	47	26.11

	Medium	106	58.89
	High	27	15.00
10	**Economic motivation**		
	Low	36	20.00
	Medium	115	63.89
	High	29	16.11
11	**Risk orientation**		
	Low	28	15.56
	Medium	118	65.56
	High	34	18.89
12	**Awareness about CRA Technologies**		
	Low	52	28.89
	Medium	89	49.44
	High	39	21.67
13	**Farm mechanization level**		
	Low	51	28.33
	Medium	112	62.22
	High	17	9.44
14	**Extension contact**		
	Low	32	17.78
	Medium	111	61.67
	High	37	20.56

(*Multiple sources)

Table 1 indicated that, socio-economic, psychological and agronomic profile characteristics of farmers surveyed in the Marathwada region highlights the diversity and challenges in their agricultural practices.

2) Overall Climate Resilience Management Level

Table 2: Distribution of respondents according to their overall Climate Resilience Management Level

Sr. No	Category	Frequency	Percentage
1	Low (up to 62)	18	10
2	Medium (63 to 79)	136	75.56
3	High (80 & above)	26	14.44
Total		180	100
Mean: 71.53		SD: 9.13	

The findings presented in Table 2 indicate that the majority of farmers (75.56%) exhibited a medium level of climate resilience management. Additionally, 14.44% of farmers demonstrated a high level of climate resilience management, while the remaining 10% fell into the low resilience category. These results suggest that while a significant proportion of farmers in the Marathwada region are adopting measures to cope with climate variability, their resilience strategies remain at a moderate level. This indicates a need for further support, awareness, and intervention to enhance their adaptive capacity and strengthen climate resilience efforts in the region.

3) Relationship between profile of farmers and their climate resilience management level

Table 3: Relationship between profile of farmers and their overall climate resilience management level

Sr. No.	Independent Variables	Correlation coefficient (r)
1.	Age	-0.428**
2.	Education	0.696**
3.	Land holding	0.239*
4.	Annual income	0.298**
5.	Farming experience	-0.458**
6.	Source of Irrigation	-0.037^{NS}
7.	Cropping Pattern	0.373**
8.	Scientific Orientation	0.590**
9.	Mass media exposure	0.446**
10.	Economic motivation	0.529**
11.	Risk Orientation	0.448**
12.	Awareness about CRA technologies	0.537**
13.	Farm Mechanization Level	0.304**
14.	Extension Contact	0.438**

** Significant at 0.01 level
* Significant at 0.05 level
NS-Non significant

Age with climate resilience management level

It was observed that there was negative and significant relationship between age and climate resilience management level.

It indicates that younger farmers are more likely to adopt adaptive practices due to their openness to innovation, better access to modern information channels, and a higher willingness to take risks. In contrast, older farmers may rely on traditional methods, be less inclined to embrace change, and face challenges in adapting to evolving climate conditions. The above finding is consistent with Khati and Amardeep (2020) [4].

Education with climate resilience management level

It was observed that there was positive and highly significant

relationship between education and climate resilience management level.

The positive and highly significant relationship between education and climate resilience management level suggests that higher levels of education enable farmers to better understand climate-related challenges, access and apply scientific knowledge, and adopt innovative farming practices. Educated farmers are more likely to stay informed through various resources, make informed decisions, and implement adaptive strategies to enhance their resilience to climate change. The above finding is consistent with Murthy (2019) [7].

Land holding with climate resilience management level

It was observed that there was positive and significant relationship between land holding and climate resilience management level.

The result observed in Table 3 can be attributed to the fact that farmers with larger landholdings often have better access to resources, such as capital, modern farming techniques, and technology, which enhance their capacity to implement effective climate resilience strategies. Additionally, larger landholdings may provide greater opportunities for crop diversification and risk mitigation, enabling farmers to better adapt to the impacts of climate variability and secure their livelihoods. This demonstrates that landholding is a crucial factor influencing a farmer's ability to manage climate-related challenges effectively. The above finding is consistent with Khati and Amardeep (2020) [4].

Annual income with climate resilience management level

It was observed that there was positive and significant relationship between annual income and climate resilience management level.

The above result indicates that farmers with higher incomes are better equipped to invest in adaptive measures, advanced technologies, and climate-resilient practices. Higher income levels provide the financial flexibility to adopt improved irrigation systems, quality inputs, and modern equipment, as well as to access training and information, enabling more effective management of climate risks. The above finding is consistent with Kumbhani et.al (2023) [5].

Farming experience with climate resilience management level

It was observed that there was negative and significant relationship between farming experience and climate resilience management level.

The negative and significant relationship between farming experience and climate resilience management level suggests that farmers with more experience were old aged and may rely heavily on traditional farming practices and may be less inclined to adopt modern, climate-resilient techniques. This reliance on conventional methods could limit their ability to adapt to changing climatic conditions, as compared to less experienced farmers who might be more open to innovative approaches and scientific interventions. The above finding is consistent with Khati and Amardeep (2020). [4]

Source of irrigation with climate resilience management level

It was observed that there was negative and non significant relationship between source of irrigation and climate resilience management level.

Farmers with access to reliable irrigation sources may focus more on optimizing water use for current agricultural needs rather than adopting broader climate resilience strategies. Additionally, the availability of irrigation might create a sense of security, reducing the urgency to implement adaptive measures against climate risks. This could explain the lack of a significant relationship between source of irrigation and climate resilience management level. The above finding is consistent with Thakuriya (2023) [8].

Cropping pattern with climate resilience management level

It was observed that there was positive and significant relationship between cropping pattern and climate resilience management level.

A positive and significant relationship between cropping pattern and climate resilience management level indicates that diversified and climate-resilient cropping patterns enable farmers to better adapt to changing climatic conditions. Farmers adopting improved or varied cropping systems are more likely to mitigate risks, optimize resource use, and enhance productivity, contributing to higher resilience levels. This adaptability reflects their proactive approach to managing climate-related challenges. The above finding is consistent with Bilaiya (2019) [1].

Scientific orientation with climate resilience management level

It was observed that there was positive and significant relationship between scientific orientation and climate resilience management level.

A positive and significant relationship between scientific orientation and climate resilience management level suggests that farmers with a higher inclination toward scientific approaches are more likely to adopt modern technologies, evidence-based practices, and innovative strategies to address climate challenges. Their willingness to experiment and implement scientifically proven methods enhances their ability to manage climate risks effectively and improve overall resilience. The above finding is consistent with Khati and Amardeep (2020) [4].

Mass media exposure with climate resilience management level

It was observed that there was positive and significant relationship between mass media exposure and climate resilience management level.

Farmers with greater mass media exposure are more likely to access timely and relevant information about climate change, adaptive practices, and modern agricultural techniques. This exposure enhances their knowledge and awareness, enabling them to make informed decisions and adopt effective strategies for managing climate risks. As a result, mass media serves as a crucial tool in improving their climate resilience management level. The above finding is consistent with Haddimani (2016) [2].

Economic motivation with climate resilience management level

It was observed that there was positive and significant relationship between economic motivation and climate resilience management level.

Farmers with higher economic motivation are driven to maximize productivity and profitability, prompting them to adopt innovative and efficient farming practices that enhance their resilience to climate challenges. Their focus on economic gains encourages investment in adaptive measures, improved technologies, and sustainable resource management, contributing to a higher climate resilience management level. The above finding is consistent with Hussain (2018) [3].

Risk orientation with climate resilience management level

It was observed that there was positive and significant relationship between risk orientation and climate resilience management level.

The positive and significant relationship between risk orientation and the climate resilience management level observed in Table 3 indicates that farmers with higher risk orientation are more proactive in adopting strategies to mitigate the impacts of climate variability. Such farmers are more likely to experiment with innovative agricultural practices, invest in adaptive technologies, and diversify their farming activities to reduce vulnerabilities. This proactive mindset enables them to better anticipate and respond to climate-related challenges, thereby enhancing their overall resilience and management capabilities. The above finding is consistent with Lalitha (2016) [6].

Awareness about CRA technologies with climate resilience management level

It was observed that there was positive and significant relationship between awareness about CRA technologies and climate resilience management level.

The positive and significant relationship between awareness about Climate-Resilient Agriculture (CRA) technologies and the climate resilience management level observed in Table 3 suggests that farmers who are more aware of CRA technologies are better equipped to adopt practices that mitigate the adverse effects of climate change. Awareness enables farmers to understand the benefits and applications of innovations such as drought-resistant crops, water conservation techniques, and integrated pest management. This knowledge empowers them to make informed decisions, enhancing their ability to adapt to climate variability and improve agricultural sustainability, thereby strengthening their climate resilience management. The above finding is consistent with Murthy (2019) [7].

Farm mechanization level with climate resilience management level

It was observed that there was positive and significant relationship between farm mechanization level and climate resilience management level.

The result observed in Table 3 indicates that higher levels of mechanization enhance farmers' capacity to adapt to climate variability. Mechanized farming reduces labour dependency, increases efficiency in resource utilization, and supports timely agricultural operations, such as sowing, harvesting, and irrigation management, which are critical in responding to unpredictable climatic conditions. Furthermore, mechanization facilitates the adoption of advanced agricultural practices, such as precision farming, thereby enabling farmers to implement effective resilience strategies and improve overall productivity and sustainability. The above finding is consistent with Hussain (2018) [3].

Extension contact with climate resilience management level

It was observed that there was positive and significant relationship between extension contact and climate resilience management level.

The positive and significant relationship between extension contact and the climate resilience management level observed in Table 3 suggests that frequent interactions with agricultural extension services significantly enhance farmers' knowledge and capacity to manage climate-related challenges. Extension services provide critical information on climate-resilient practices, improved crop varieties, weather forecasts, and adaptive technologies, enabling farmers to make informed decisions. Regular contact with extension personnel also facilitates access to training, demonstrations, and expert guidance, empowering farmers to adopt effective resilience strategies and improve their overall adaptive capacity to climate variability. The above finding is consistent with Khati and Amardeep (2020) [4].

Conclusion

The study revealed a significant relationship between various socio-economic and psychological characteristics of farmers and their climate resilience management level. Age and farming experience exhibited a negative and significant relationship, indicating that younger and less experienced farmers are more adaptable to climate resilience strategies, whereas older farmers tend to rely on traditional methods. Conversely, education, landholding, annual income, and farm mechanization demonstrated a positive and significant relationship, highlighting that better access to knowledge, resources, and technology enhances adaptive capacity. Psychological attributes such as scientific orientation, economic motivation, risk orientation, and awareness of Climate-Resilient Agriculture (CRA) technologies also positively influenced climate resilience management. Farmers with greater mass media exposure and regular extension contact were found to be better informed and more likely to implement adaptive measures. Additionally, cropping patterns that emphasize diversification contributed to improved resilience. These findings underscore the importance of targeted interventions, including educational programs, financial support, and technological advancements, to enhance climate resilience among farmers. Policies should focus on improving farmers' access to scientific knowledge, modern agricultural practices, and risk-mitigation strategies to strengthen their adaptive capacity against climate variability.

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