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Farmer prioritization of climate-induced problems: Insights from rainfed farming areas of Jammu region

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Abstract
Climate change poses significant challenges to agriculture, particularly in vulnerable rainfed regions where farmers are directly dependent on climate-sensitive resources. This study was conducted to assess and prioritize the major climate change-induced problems faced by farmers in vulnerable villages. Data were collected through structured surveys and problem confrontation index was applied to convert rank-based responses into quantitative scores for comparison and prioritization. The findings revealed that the most severe issue perceived by farmers was the change in rainfall pattern over time, which disrupted cropping cycles and agricultural planning. This was followed by low yield or crop failure and crop damage due to excessive rain, both reflecting the direct effects of extreme weather events on farm productivity. Other significant problems included moisture stress due to dry spells, stunted crop growth and drying of seedlings after germination. In contrast, problems such as soil erosion and poor quality of farm produce were generally perceived as less severe. The study concludes that rainfall variability both excess and deficit has emerged as the most critical driver of vulnerability in the region. These insights emphasize the urgent need for adaptive measures, such as improved irrigation systems, drought-resistant crop varieties and localized climate advisory services. By identifying the most pressing issues through farmer perspectives, the study provides an evidence base for designing focused and need-based climate-resilient agricultural interventions.

Keywords: Climate change, rainfed farming, farmer prioritization

1. Introduction

Climate change poses a profound threat to agriculture and food security, particularly in developing countries where the sector forms the backbone of rural livelihoods. According to the Food and Agriculture Organization (FAO, 2019) [10], climate-resilient agriculture (CRA) encompasses a set of practices and strategies aimed at helping agricultural systems adapt to the changing climate while maintaining or enhancing productivity, sustainability and livelihoods. CRA focuses on integrating climate change adaptation and mitigation into agricultural planning and practices, ensuring that farming systems become more resilient to environmental shocks and long-term climate variability (Ademola *et al.*, 2016; Ruel *et al.*, 2017) [1, 20]. However, despite growing recognition of the benefits of CRA, its widespread adoption remains limited in many regions.

Globally, rising temperatures, erratic rainfall patterns, increasing frequency of extreme weather events and the emergence of new pests and diseases have significantly increased the vulnerability of agriculture (Canevari-Luzardo, 2019; IPCC, 2014) [6, 12]. These climate-induced changes threaten food production, disrupt value chains and undermine rural livelihoods. In response, climate-resilient agricultural practices such as drought-tolerant crops, water-harvesting systems, integrated pest management and agroforestry have been developed and promoted as adaptive solutions. These practices not only improve adaptive capacity but also contribute to environmental sustainability by reducing greenhouse gas emissions and conserving natural resources (Mbuli *et al*., 2021; Chandra & McNamara, 2018) [16, 7]. Yet, despite their proven benefits, the uptake of CRA practices among smallholder farmers remains low. Numerous studies and field assessments have identified a complex web of barriers that hinder adoption. These include limited awareness and access to climate information, inadequate technical knowledge, weak extension systems, financial constraints, lack of access to inputs and markets and absence of enabling policies and institutional frameworks (World Bank, 2021; Dinesh & Vermeulen, 2016) [25, 8]. Additionally, cultural norms, gender disparities, land tenure insecurity and climate uncertainty further complicate the adoption landscape. In many cases, farmers are reluctant to adopt unfamiliar practices due to perceived risks, short-term opportunity costs or limited evidence of effectiveness under local conditions. In the Indian context, these barriers are particularly pronounced. India’s agricultural sector supports nearly 70 per cent of the population and contributes significantly to national food security and employment. However, the sector is highly climate-sensitive due to its dependence on seasonal rainfall, small and fragmented landholdings and resource-constrained farmers. India is projected to experience a temperature rise between 2.3 °C and 4.8 °C by the end of the century, along with increasing climate variability, which will significantly impact agricultural productivity and rural incomes (Nagargade *et al.*, 2017; Kumar & Gautam, 2014) [18, 15]. Studies suggest that even a one standard deviation increase in high-temperature days can reduce agricultural output and real wages by over 10 per cent (Burgess *et al*., 2014) [5]. Given these projections, the need for CRA adoption is urgent. Government initiatives and development programs have introduced CRA technologies and services in various agro-ecological zones across India. These include the promotion of climate-resilient crop varieties, precision irrigation, crop diversification and soil health management. While some success stories exist, adoption rates remain uneven and often low, particularly in rainfed areas where exposure to climate risks is highest and institutional support is weakest. This highlights the need for a deeper understanding of the local drivers and constraints influencing farmers' decisions (Atube *et al*., 2021) [2]. Moreover, the non-adoption of CRA practices carries significant implications. Continued reliance on traditional farming systems without climate adaptation exacerbates food insecurity, increases vulnerability to shocks and threatens the long-term sustainability of agriculture. It also widens the gap between policy intentions and ground realities. As climate change accelerates, the inability to implement effective adaptive practices may result in irreversible damage to agricultural productivity and rural welfare.

Therefore, it is essential to identify and address the multifaceted barriers that limit CRA adoption. A comprehensive and context-specific approach is needed-one that combines awareness-raising, knowledge dissemination, skill development, financial incentives, infrastructure investments and policy coherence. Collaboration among stakeholders including governments, research institutions, farmer organizations, civil society and the private sector is also vital to creating enabling environments for CRA. The primary objective of the present study was to identify, rank and analyze the major climate change-induced problems as perceived by the farmers in vulnerable villages. The study aimed to prioritize these problems based on their severity, with the goal of informing the development of targeted, climate-resilient agricultural strategies and interventions.

1.1 Profile of the study area

The Jammu region is one of the two main divisions of the Union Territory of Jammu and Kashmir, the other being the Kashmir Valley. Geographically located in the southern part of the UT, the Jammu region is bordered by Punjab and Himachal Pradesh and serves as a transition zone between the plains of northern India and the mountainous terrain of the Himalayas. The majority of the population in the region is engaged in agriculture**,** horticulture**,** livestock rearing and government services. Jammu district has a sub-tropical climate with hot and dry climate in summer and cold climate in winter. Being in the foothills of the mountains, nights are generally cooler. Minimum and Maximum temperature is around 4℃ and 47℃ respectively. Rainy season usually starts from the end of June or the beginning of July. Average rainfall in the district is about 1246 mm. Bhalwal Block, located in Jammu District of Jammu Division, is a semi-arid and rainfed region selected for a pilot project aimed at addressing climate-induced agricultural challenges. The block is the part of the Kandi belt and Siwalik hills, experiences excessive runoff, soil erosion, land degradation and erratic rainfall distribution, leading to frequent water stress during cropping seasons. With a deep groundwater table and streams carrying debris during the rainy season, agricultural productivity is significantly affected by monsoon variability. Agriculture remains a key livelihood, with 4,823 cultivators and 1,201 agricultural labourers. Of the total 6,921 ha, only 238 ha are irrigated, leaving 6,683 ha rainfed, making the region highly vulnerable to climatic fluctuations.

2. Materials and Methods

2.1 Locale of the study

The present study was conducted in the Jammu district of J&K, UT. From Jammu district, Bhalwal block was selected purposively for the present study as the project entitled "Climate Resilient Sustainable Agriculture in Rainfed Farming Areas of Jammu and Kashmir" has been implemented since 2016-17 in the said block.

2.2 Selection of villages

A baseline survey for the vulnerability assessment of 51 villages in the Bhalwal block of Jammu district was conducted during 2016-17. Based on this assessment, 25 villages were identified as climatically vulnerable and the project entitled "Climate Resilient Sustainable Agriculture in Rainfed Farming Areas of Jammu and Kashmir" has been implemented since 2016-17 in these 25 vulnerable villages of said block. Thus, these 25 vulnerable villages were purposively selected for the present study to examine the problems perceived by the farmers due to climate change. To determine the sample size of farmers from the vulnerable villages, Slovin's formula (Equation 1), as proposed by Yamane (1967) [26], was employed.

$$n = \frac{N}{(1+Ne2)} \quad \text{……………………(1)}$$

Where,

n = required sample size

N = the total number of farmers (N=1250)

e = adjust margin of error at level of significance 5 per cent

2.3 Selection of respondents

From vulnerable villages, 12 farmers were selected from each selected vulnerable villages using random sampling technique. Thus, the sample size from vulnerable villages was 300. The data used for this study was exclusively from primary source and were collected with the help of a designed interview schedule designed administrated at the household level through face-to-face interview. The present study addressed the problem confrontation of farmers w.r.t climate induced problems. The study used a four-point Likert-type scale for estimating problem confrontation scores. The farmers were required to respond to 10 climate-related issues in the adaptation process. Each problem was assigned scores of 4, 3, 2, and to indicate "most severe", "medium severe", "low severe" and "not at all", respectively. The application of PCI is appropriate because it helps to identify and analyze the most critical problem confrontation (Alam & Rashid, 2010; Masud *et al*., 2017; Roy *et al.*, 2014; Uddin *et al.*, 2014) [27, 28, 29, 30]. The PCI is estimated as follows:

PCI= Most severe × 4 + Medium severe × 3 + Low severe × 2 + Not at all ×1

3. Results and Discussion

3.1 Distribution of farmers based on the extent of problem confrontation due to climate change

The most severe climate change-induced problem faced by farmers is the change in rainfall pattern over time, with 77 per cent of farmers rating it as the most severe issue. This highlights the unpredictability and irregularity of rainfall as a critical concern, affecting the timing of agricultural operations and reducing farmers' ability to plan effectively. Farmers often rely on historical weather patterns to guide their agricultural practices, but increasing unpredictability challenges this reliance (Wagaye *et al.,* 2020) [23]. It is followed by low yield of crops or crop failure (51%) and crop damage due to excessive rain (45%), indicating that extreme weather events are directly impacting productivity and threatening household food security. These findings reflect the increasing vulnerability of rainfed farming systems to both excessive and insufficient rainfall, which disrupt crop growth, damage standing crops and contribute to income instability. In Northern Ghana, rainfall variability has been linked to negative correlations with crop yields, particularly for maize, millet and sorghum (Ndamani and Watanabe, 2014) [19]. On the other hand, the least severe problems reported include poor quality of farm produce, with 61 per cent of farmers rating it as low severe and 39 per cent stating it is not a problem at all and vulnerability to soil erosion, which was not considered a problem by 54 per cent of farmers (Table 1). This suggests that while some aspects of climate change, such as rainfall variability and yield loss, are widely experienced, others may be more localized or already managed through existing practices. Overall, the results emphasized the need for targeted climate-resilient agricultural strategies such as improved water conservation, use of stress-tolerant crop varieties and early warning systems to help farmers adapt to climate-induced challenges and sustain their livelihoods in the face of increasing climatic uncertainty.

Table 1: Distribution of farmers based on the extent of problem confrontation due to climate change (% farmers)

S. No.	Problems	The extent of problem confrontation			
		Most severe (4)	Medium severe (3)	Low severe (2)	Not at all (1)
1.	Difficult to work in the field due to severe temperature	0	43	33	24
2.	Crop damage due to excessive rain	45	22	26	07
3.	Moisture stress increases due to continuous dry spell	45	23	25	07
4.	Causes stunted growth of crops	40	23	30	07
5.	Drying of seedlings after germination	25	21	49	05
6.	Low yield of crops/crop failure	51	20	06	23
7.	Poor quality of farm produce	0	0	61	39
8.	Increases vulnerability to soil erosion	0	0	46	54
9.	Change in rainfall pattern overtime	77	19	04	0
10.	Increases pests/diseases infestation	0	55	30	15

3.2 Weighted scores of climate-induced problems

The highest overall confrontation score was recorded for the change in rainfall pattern over time (score: 4351), emphasizing it as the most pressing issue disrupting agricultural planning and cropping cycles. This aligns with the broader concern that unpredictable precipitation patterns have intensified, leading to increased risks to food production and water availability. The overarching trend of increasing rainfall unpredictability continues to pose significant challenges to agricultural planning and food security across various regions (Sharangi and Acharaya, 2023) [21]. Following this, the issue of low yield of crops or crop failure scored 4277, reflecting farmers' acute perception of declining productivity due to erratic climatic events. Similarly, crop damage due to excessive rain (score: 4074) and moisture stress from prolonged dry spells (score: 4040) were also rated as major concerns, both of which highlight the dual nature of climate extremes adversely affecting crop health. Problems like stunted crop growth (score: 3882) and increased pest and disease infestation (score: 3963) also scored high, indicating the biological stress imposed by changing weather patterns. These findings resonate with Islam and Nilahyane (2019) [13], who reported that moisture stress impairs plant physiological functions such as stomatal conductance and photosynthesis, leading to yield decline, and Jarrett *et al.* (2023) [14], who emphasized the need for adaptive farming practices to counter prolonged dry spells. In contrast, issues such as poor quality of farm produce (score: 2919) and soil erosion vulnerability (score: 2873) were mostly rated under low severity and not at all, suggesting they are considered secondary in immediacy (Table 2). Likewise, difficulty in working in fields due to extreme temperatures (score: 3219) was commonly ranked as medium or low severe, indicating it is viewed more as a discomfort than a critical constraint. This is consistent with findings by Mubangizi *et al.* (2019) [17], who highlighted that farmers in Uganda adopt diversification and agronomic practices for resilience, and by Sharma *et al*. (2024) [22], who stress that integrating traditional knowledge with modern techniques enhances farmers' adaptive capacity to climate change.

Table 2: Weighted scores of the climate-induced problems

S. No.	Problems	The extent of problem confrontation			
		Most severe (4)	Medium severe (3)	Low severe (2)	Not at all (1)
1.	Difficult to work in the field due to severe temperature	0	384	198	73
2.	Crop damage due to excessive rain	544	198	156	20
3.	Moisture stress increases due to continuous dry spell	532	210	150	22
4.	Causes stunted growth of crops	480	204	180	22
5.	Drying of seedlings after germination	296	192	294	15
6.	Low yield of crops/crop failure	616	177	38	68
7.	Poor quality of farm produce	0	0	366	117
8.	Increases vulnerability to soil erosion	0	0	278	161
9.	Change in rainfall pattern overtime	920	171	26	0
10.	Increases pests/diseases infestation	0	495	178	46

3.3 Ranking of climate-induced problems based on problem confrontation index (PCI)

The highest overall severity score was recorded for change in rainfall pattern over time, with a PCI score of 1117, reaffirming its position as the most critical issue affecting agricultural activities in the study area. This was followed by crop damage due to excessive rain (PCI: 918) and moisture stress due to continuous dry spells (PCI: 914), reflecting farmers' perception of the adverse effects of erratic precipitation and water scarcity on crop performance (Table 3). These findings underscore the seriousness of rainfall-related uncertainties, with studies such as Bagna (2023) [3] highlighting that a significant majority of farmers, including 80% in the Guidimouni basin, recognize climate risks as a threat to agriculture. Low yield of crops or crop failure (PCI: 899) and stunted growth of crops (PCI: 886) also received high scores, showing that both drought and waterlogging stress are impacting crop development and yields across stages of the crop cycle. In contrast, the least severe problems perceived by farmers were increased vulnerability to soil erosion (PCI: 439) and poor quality of farm produce (PCI: 483), suggesting that while these issues exist, they are not viewed as immediate threats. Bhandari *et al*. (2021) [4] acknowledge that soil erosion affects long-term productivity, but its gradual impact might make it less noticeable to farmers in the short term. Difficulty in working in the field due to severe temperatures (PCI: 655) and pest/disease infestations (PCI: 719) were ranked moderately, indicating their tangible but secondary influence. Overall, the findings highlight that climate variability especially in rainfall timing and intensity is the primary concern, necessitating targeted interventions such as water conservation, adaptive cropping strategies, and improved access to localized climate information. As Eze *et al*. (2021) [9] noted, localized weather forecasting significantly aids.

Table 3: Ranking of climate-induced problems based on problem confrontation index (PCI)

S. No.	Problems	PCI	Rank
1.	Difficult to work in the field due to severe temperature	655	VII
2.	Crop damage due to excessive rain	918	II
3.	Moisture stress increases due to continuous dry spell	914	III
4.	Causes stunted growth of crops	886	V
5.	Drying of seedlings after germination	797	VI
6.	Low yield of crops/crop failure	899	IV
7.	Poor quality of farm produce	483	IX
8.	Increases vulnerability to soil erosion	439	X
9.	Change in rainfall pattern overtime	1117	I
10.	Increases pests/diseases infestation	719	VII

4. Conclusion

The study comprehensively examined the perceptions of farmers regarding the severity of various climate change-induced problems in vulnerable agricultural areas. Using the problem confrontation index, the analysis revealed that the most pressing issue affecting farmers is the unpredictability in rainfall patterns, which has far-reaching consequences for agricultural planning, crop productivity and food security. Problems like low crop yield, damage due to excessive rainfall and moisture stress due to dry spells were also ranked high, indicating that both the scarcity and excess of water are adversely impacting farming operations. Meanwhile, factors such as poor quality of produce and soil erosion, though acknowledged, were not viewed as immediate threats by most farmers. The consistency of rankings across severity categories further validates the seriousness of rainfall-related issues. These findings underscore the importance of implementing site-specific and climate-resilient agricultural strategies that can mitigate the negative effects of climate variability. Policymakers and extension agencies should prioritize investments in water conservation, the promotion of drought- and flood-tolerant crop varieties and timely weather forecasts tailored to local conditions. Moreover, improving farmer awareness and access to climate-smart technologies will be essential in enhancing resilience and sustaining agricultural productivity in the face of growing climate risks. By integrating farmer perceptions into vulnerability assessments, this study contributes valuable insights for adaptive planning and decision-making in the agricultural sector.

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