Plant Archives Vol. 26, No. 2, 2026 pp. 2100-2106 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org

DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2026.v26.no.2.288

THROUGH THE EYES OF PEARL MILLET GROWERS: UNDERSTANDING PERCEPTIONS OF CLIMATE CHANGE IN RAJASTHAN

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(Date of Receiving-03-08-2026; Date of Revision-02-10-2026; Date of Acceptance-08-10-2026)

ABSTRACT

Climate change has emerged as one of the most pressing global challenges, with significant implications for agriculture-particularly in developing countries where farming remains the primary source of livelihood. Rising temperatures, erratic rainfall patterns, extended droughts, floods, and the increasing prevalence of pests and diseases pose substantial threats to crop productivity and food security. This study was conducted in Agro-Climatic Zone IC (Hyper-Arid Partially Irrigated Zone) of Rajasthan, involving a sample of 360 pearl millet growers. The findings revealed that the majority of farmers demonstrated medium level of perception regarding the effects of climate change on pearl millet cultivation. Notably, farmers exhibited a high level of perception concerning seed treatment, irrigation methods, and varietal selection, while their understanding of weed control was comparatively low. Correlation analysis indicated that variables such as age, family size, education, social participation, annual income, extension agency contact, innovativeness, economic motivation, landholding size, and farm mechanization were positively and significantly associated with farmers' perception of climate change effects. Conversely, factors including family type, farming experience, occupation, irrigation sources, credit-seeking behaviour, mass media exposure, risk orientation, and scientific orientation showed positive but statistically non-significant relationships with perception levels. Overall, the perception of pearl millet growers towards cultivation practices under changing climatic conditions reflects a growing awareness of the need for adaptive strategies to sustain agricultural productivity. This underscores the importance of promoting climate-smart agricultural practices to enhance resilience and ensure food security in vulnerable regions.

***Key words*:** Climate Change, Agriculture, Perception, Food Security, Adaptation, Climate-Smart Practices

Introduction

Pearl millet (*Pennisetum glaucum*) ranks as the sixth most important cereal crop globally, following rice, wheat, maize, barley, and sorghum. It is cultivated extensively across 30 million hectares in the arid and semi-arid tropical regions of Asia and Africa, contributing to nearly half of the world's total millet production. Owing to its resilience to drought and high temperatures, pearl millet plays a crucial role in ensuring food and nutritional security in marginal environments. Climate change is a significant global challenge that directly affects agricultural productivity by influencing key biophysical parameters, including plant growth, pest and disease prevalence, and water availability. It also impacts various stages of the food system, from production to processing and distribution. The complex interrelationship between climate change and agriculture underscores the need for a comprehensive understanding of climate dynamics and their effects on farming systems. In the Indian context, agriculture remains highly vulnerable to climate variability due to its heavy reliance on monsoonal rainfall, especially in rain fed regions. Shifts in average temperatures, unpredictable precipitation patterns, increased frequency of extreme weather events, and the emergence of new

pest and disease complexes are already affecting crop yields and farmer livelihoods. These challenges are particularly critical for a densely populated country like India, where a large proportion of the population depends on agriculture for their sustenance.

Pearl millet, being a climate-resilient crop, holds immense potential to counteract some of the adverse effects of climate change. Its adaptability to harsh climatic conditions makes it an important cereal for enhancing food security and farm incomes in arid zones. As noted by Satyavathi *et al.*, (2021), the promotion of such resilient crops is vital for sustainable agricultural development under changing climatic scenarios. The perception of farmers regarding climate change plays a pivotal role in shaping their responses to climate-induced challenges. Educated and well-informed farmers are more likely to recognize climatic risks and adopt appropriate adaptation strategies. Consequently, understanding farmers' perceptions is critical for developing and implementing effective climate-smart agricultural practices. Limited access to timely and accurate climate information remains a significant constraint, especially for smallholder farmers. Bridging this information gap can improve their awareness, decision-making capacity, and readiness to adopt adaptive measures. Furthermore, identifying the challenges faced by farmers in implementing these adaptation strategies and addressing them can enhance their overall perception and responsiveness to climate change. Perception analysis, therefore, becomes an essential tool in evaluating farmers' awareness, readiness, and adaptive capacity in the face of climatic uncertainties. The primary objective of this study is to examine the perception of pearl millet growers regarding the effects of climate change on pearl millet cultivation.

Materials and Methods

The current investigation was conducted in Rajasthan's agro-climatic zone IC (Hyper-Arid Partially Irrigated Zone), which was purposely selected for the research study based on its largest geographical area, lowest rainfall, and highest maximum and minimum temperatures among all the agro-climatic zones in the state of Rajasthan. The United Nations has declared 2023 as the International Year of Millets, and its primary objective is to increase public awareness about the health benefits of millets. Pearl millet is a major millet crop in India as well as in the state of Rajasthan. Therefore, the pearl millet crop for the present investigation was purposely selected based on the largest area under pearl millet cultivation in Rajasthan. The selected agro-climatic zone covers three districts namely; Jaisalmer, Bikaner, and part of Churu. Out of these three districts, Churu and Jaisalmer districts were selected purposely for the present investigation on the basis of largest area under pearl millet cultivation as compared to Bikaner district. Two tehsils from each district were purposely selected for the research study on the basis of largest area of pearl millet cultivation. Thus, four tehsils were selected from each district. As a result, three villages were selected from each tehsil, resulting in a total of 12 villages selected from the Churu and Jaisalmer districts of Rajasthan. Following consultations, a complete list of all pearl millet growers was obtained from the Department of Agriculture, Pant Krishi Bhawan, Jaipur, Rajasthan. From these, 30 pearl millet growers with 10 or more years of farming experience were randomly selected from each selected village for the research study. Thus, a total of 360 pearl millet growers were selected for this research study. A semi-structured interview schedule was developed to collect the necessary information from the respondents, keeping in mind the proposed study objectives. Analysis was conducted using various statistical tools, such as frequency distribution, percentages, mean, standard deviation, mean percent score, t-test, z-test, and correlation coefficient (r).

Results and Discussion

Perception of Pearl Millet Growers about the Effects of Climate Change

Perception can be defined as the understanding, awareness, and interpretation of pearl millet growers regarding the effectiveness and necessity of various cultivation practices in response to the challenges posed by climate change. It reflects how farmers observe, evaluate, and adapt their traditional methods, such as land preparation, seed selection, sowing techniques, and pest management, based on their experiences, knowledge, and exposure to changing climatic conditions, with the aim of sustaining productivity and ensuring resilience in pearl millet cultivation.

Pearl millet growers' perception of cultivation practices in the context of climate change reflects an increasing awareness of the need for adaptive measures to maintain productivity under shifting environmental conditions. Farmers recognize that timely land preparation is crucial to ensure better moisture conservation, especially in arid and semi-arid regions. There is a growing preference for High-Yielding Varieties (HYVs) and hybrids that are more drought-tolerant and climate-resilient. Seed treatment is perceived as essential for enhancing germination and protecting against soil-borne diseases, while appropriate seed rate, spacing, and timely

Table 1: Distribution of Pearl Millet Growers on the basis of Perception about the Effects of Climate Change.

S. No.	Categories	Pearl Millet Growers					
		Churu (n=180)		Jaisalmer(n=180)		Overall (N=360)	
		f	%	f	%	F	%
1.	Low (<54.80 score)	23	12.78	28	15.56	51	14.17
2.	Medium (54.80-62.34 score)	132	73.33	123	68.33	255	70.83
3.	High (>62.34 score)	34	13.89	29	16.11	54	15.00
	Total	**180**	**100.00**	**180**	**100.00**	**360**	**100.00**
F= Frequency, %=Percentage; Mean-58.57, SD-3.77							

sowing are seen as critical for optimizing plant population and making the best use of erratic rainfall patterns. Effective weed management is valued for reducing competition for scarce resources, and irrigation practices are being adjusted to maximize water use efficiency amid declining water availability. Additionally, integrated pest and disease management is increasingly adopted as farmers observe new pest dynamics due to changing temperatures and humidity, indicating a shift toward more climate-smart agricultural practices in pearl millet cultivation.

The perception of pearl millet growers about the effects of climate change plays a crucial role in determining their level of awareness, preparedness, and willingness to adopt appropriate adaptation strategies. Understanding how farmers perceive changes in temperature, rainfall patterns, frequency of extreme weather events, and their impact on crop growth and yield provides valuable insights into their decision-making process. Such perceptions are often shaped by their personal experiences, local knowledge, and access to information and extension services. Assessing these perceptions helps in identifying gaps in knowledge and areas where targeted interventions can enhance climate resilience. The following section presents the results related to the perception of pearl millet growers regarding the effects of climate change.

Distribution of Pearl Millet Growers on the basis of Perception about the Effects of Climate Change

The data in Table 1 reveals that the majority of the pearl millet growers' *i.e.*73.33 per cent in Churu district had medium level of perception whereas, in Jaisalmer district, 68.33per cent were having medium level of perception about the effects of climate change in pearl millet cultivation. Additionally, 13.89 per cent and 16.11per cent had high level of perception in Churu and Jaisalmer districts, respectively. While, 12.78 per cent in Churu and 15.56 per cent in Jaisalmer had low level of perception about the effects of climate change in pearl millet cultivation.

It is apparent from the data contains in Table 1 that out of 360 pearl millet growers, majority of pearl millet growers *i.e.*70.83 per cent had medium level of perception about the effects of climate change in pearl millet cultivation, followed by high (15.00%) and low (14.17%) level of perception, respectively. The findings are in accordance with the findings of Ali *et al.,* (2021), Khunt & Jadav (2022) and Sangappa *et al.,* (2023) who concluded that the majority of respondents had medium level of perception about the effects of climate change.

Practice-wise Perception of Pearl Millet Growers about the Effects of Climate Change

The result presented in Table 2 illustrates that in case of Churu district pearl millet growers, "seed treatment" (56.11 MPS) was perceived as highest and assigned rank first by the respondents, followed by the second highest rank was assigned to "irrigation method" (49.52 MPS), subsequently "use of varieties" (47.81 MPS), "method of sowing" (45.06 MPS), "major insect, pest & disease" (44.13 MPS), "land preparation" (42.65 MPS), "nutrient management" (42.08) and "weed control" (39.68) were assigned rank third, fourth, fifth, sixth, seventh and eighth, respectively. Further, the data in Table 2 reveals that in case of Jaisalmer district's pearl millet growers, "seed treatment" (53.27 MPS) was perceived as the most important practice and was assigned rank first by the respondents. This was followed by "irrigation method" (48.89 MPS), which secured the second rank. Subsequently, "use of varieties" (47.60 MPS), "major insect, pest & disease management" (44.55 MPS), and "land preparation" (43.52 MPS) were assigned third, fourth, and fifth ranks, respectively.

The practices of "method of sowing" (43.45 MPS), "nutrient management" (42.44 MPS) and "weed control" (40.02 MPS) were assigned the sixth, seventh, and eighth ranks, respectively, indicating their comparatively lower perceived importance.

Additionally, the results presented in Table 2 shows that in case of overall respondents, "seed treatment" (54.69 MPS) was perceived as the most important cultivation practice and had given rank first, followed by "irrigation method" (49.21 MPS), which secured the

Table 2: Practice-wise Perception of Pearl Millet Growers about the Effects of Climate Change.

S. No.	Practice	Pearl Millet Growers					
		Churu (n=180)		Jaisalmer(n=180)		Overall (N=360)	
		MPS	Rank	MPS	Rank	MPS	Rank
1.	Land Preparation	42.65	VI	43.52	V	43.08	VI
2.	Use of Varieties	47.81	III	47.60	III	47.71	III
3.	Method of Sowing	45.06	IV	43.45	VI	44.25	V
4.	Seed Treatment	56.11	I	53.27	I	54.69	I
5.	Weed Control	39.68	VIII	40.02	VIII	39.85	VIII
6.	Nutrient Management	42.08	VII	42.44	VII	42.26	VII
7.	Irrigation Method	49.52	II	48.89	II	49.21	II
8.	Major Insect, Pests and Diseases	44.13	V	44.55	IV	44.34	IV
	Pooled	**45.88**		**45.47**		**45.67**	
				r =0.92			

rs = Rank Correlation; MPS = Mean Percent Score; **Significant at 0.01 Level of Probability t = 4.71**

second rank, and "use of varieties" (47.71 MPS) was assigned third rank. Further, "major insect, pest & disease management" (44.34 MPS) and "method of sowing" (44.25 MPS) were ranked fourth and fifth, respectively. The practices of "land preparation" (43.08 MPS), "nutrient management" (42.26 MPS) and "weed control" (39.85 MPS) were perceived as relatively less important and were placed at sixth, seventh, and eighth ranks, respectively.

The pooled analysis of the responses from both Churu and Jaisalmer districts indicates a high degree of similarity in the perception of pearl millet cultivation practices. The overall Mean Percent Score (MPS) was recorded as 45.67, with Churu contributing MPS of 45.88 and Jaisalmer 45.47, reflecting only a marginal variation between these two districts. Furthermore, the correlation coefficient (r=0.92) reveals a highly positive and significant relationship between the ranks assigned by farmers of both the districts. The obtained t-value (t=4.71) was statistically significant at the one per cent level of significance, confirming that the perceptions of pearl millet growers regarding various cultivation practices were strongly and positively correlated. This strong correlation suggests that farmers across both districts share a common understanding and awareness about the relative importance of different cultivation practices, particularly in the context of seed treatment, irrigation methods, and use of improved varieties. The findings are consistent with the findings of Dhanya & Ramchandran (2015), Dupare *et al.,* (2020) and Bharat *et al.,* (2021) who reported that respondents perceived that climate change was increasing pest & insect infestations, and shifting sowing times.

The analysis of pearl millet growers' perceptions regarding cultivation practices reveals a moderate to high level of awareness and understanding about key agricultural techniques in the context of changing climatic conditions. Most farmers recognize the importance of timely land preparation, appropriate selection of high-yielding and climate-resilient varieties, and the necessity of seed treatment to ensure better germination and crop health. Growers also demonstrate a fair understanding of optimal seed rate, spacing, and timely sowing, which are crucial for improving productivity under arid and semi-arid conditions. However, the perception about advanced practices such as integrated pest & disease management, efficient irrigation methods, and weed control techniques varies across regions and farm sizes. Although, some progressive farmers actively adopt recommended practices, a considerable number still rely on traditional methods due to limited access to knowledge, resources, or institutional support. This highlights the need for enhanced extension services, awareness programmes, and access to updated agricultural technologies to strengthen the adoption of climate-smart cultivation practices among pearl millet growers. Strengthening their perception and knowledge base is essential to improve resilience and sustainability in pearl millet cultivation.

Association between Independent Variables with Perception of Pearl Millet Growers about the Effects of Climate Change

According to the correlation coefficient (r) analysis, the data presented in Table 3 indicates the correlation between the dependent variable, perception and 18 antecedent variables related to pearl millet growers. Through correlation coefficient, the data was thoroughly analysed to assess the individual and combined relative effects of the selected independent variables on the pearl millet growers' perception of perception of pearl millet growers about the effects of climate change. All the

Table 3: Association between Independent Variables with Perception of Pearl Millet Growers about the Effects of Climate Change.

S. No.	Variables	Correlation Coefficient (r)		
		Churu (n=150)	Jaisalmer (n=150)	Pooled (n=300)
A.	**Socio-personal**			
1.	Age	0.234**	0.261**	0.248**
2.	Family Type	0.045^{NS}	0.028^{NS}	0.010^{NS}
3.	Family Size	0.312**	0.387**	0.349**
4.	Education	0.278**	0.395**	0.336**
5.	Farming Experience	0.094^{NS}	0.113^{NS}	0.105^{NS}
6.	Social Participation	0.243**	0.265**	0.254**
B.	**Socio-economic**			
7.	Occupation	0.108^{NS}	0.132^{NS}	0.119^{NS}
8.	Size of Land Holding	0.191*	0.195*	0.198**
9.	Annual Income	0.221**	0.227**	0.239**
10.	Irrigation Source	0.139^{NS}	0.168^{NS}	0.153^{NS}
11.	Farm Mechanization	0.198**	0.186*	0.192*
12.	Credit Seeking Behaviour	0.087^{NS}	0.071^{NS}	0.079^{NS}
C.	**Communication Pattern**			
13.	Extension Agency Contact	0.231**	0.224**	0.228**
14.	Mass Media Exposure	0.109^{NS}	0.083^{NS}	0.095^{NS}
D.	**Psychological**			
15.	Innovativeness	0.244**	0.269**	0.257**
16.	Risk Orientation	0.097^{NS}	0.118^{NS}	0.108^{NS}
17.	Scientific Orientation	0.091^{NS}	0.073^{NS}	0.084^{NS}
18.	Economic Motivation	0.203**	0.219**	0.211**

**Significant at 0.01 Level of Probability; *Significant at 0.05 Level of Probability; NS= Non-Significant; r= Correlation Coefficient

eighteen selected independent variables such as age, family type, family size, education, farming experience, social participation, occupation, size of land holding, annual income, irrigation sources, farm mechanization, credit seeking behaviour, extension agency contact, mass media exposure, innovativeness, risk orientation, scientific orientation and economic motivation used with the perception level of the pearl millet growers about the effects of climate change in the correlation coefficient equation. The findings are presented in Table 3.

The r-values in Table 3 revealed that in Churu district, the variables such as age (0.234**), family size (0.312**), education (0.278**), social participation (0.243**), annual income (0.221**), extension agency contact (0.231**), innovativeness (0.244**), and economic motivation (0.203**) were found positively and significantly correlated with the perception of pearl millet growers about the effects of climate change at one per cent level of significance. Further, the r-values of size of land holding (0.192*) and farm mechanization (0.198*) had positive and significant relation with the perception of pearl millet growers about the effects of climate change at five per cent level of significance. The other variables such as family type, farming experience, occupation, irrigation sources, credit seeking behaviour, mass media exposure, risk orientation and scientific orientation showed non-significant relation with perception of pearl millet growers about the effects of climate change.

The r-values in Table 3 showed that in Jaisalmer district, the variables such as age (0.261**), family size (0.387**), education (0.395**), social participation (0.265**), annual income (0.227**), extension agency contact (0.224**), innovativeness (0.269**), and economic motivation (0.219**) were found to be positively and significantly correlated with perception at one per cent level of significance. At five per cent significance level, size of land holding (0.195*) and farm mechanization (0.186*) showed positive and significant relationship with the perception of pearl millet growers about the effects of climate change. On the other hand, the variables such as family type (0.028^{NS}), farming experience (0.113^{NS}), occupation (0.132^{NS}), irrigation sources (0.168^{NS}), credit seeking behaviour (0.071^{NS}), mass media exposure (0.083^{NS}), risk orientation (0.118^{NS}), and scientific orientation (0.073^{NS}) were observed to have positive but non-significant relationship with the perception of pearl millet growers.

Further correlation coefficient (r) analysis of Table 3 examined the relationship between various independent variables and the perception of overall pearl millet growers about the effects of climate change. The r-values of the pooled data revealed that age (0.248**), family size (0.349**), education (0.336**), social participation (0.254**), annual income (0.239**), extension agency contact (0.228**), innovativeness (0.257**), and economic motivation (0.211**) were positively and significantly associated with the perception of overall pearl millet growers at one per cent level of significance. At five per cent significance level, size of land holding (0.198*) and farm mechanization (0.192*) were found significantly correlated with perception. While, the variables such as family type (0.010^{NS}), farming experience (0.105^{NS}), occupation (0.119^{NS}), irrigation sources (0.153^{NS}), credit seeking behaviour (0.079^{NS}), mass media exposure (0.095^{NS}), risk orientation (0.108^{NS}), and scientific orientation (0.084^{NS}) exhibited positive but non-significant associations with perception of overall pearl millet growers. The findings are in conformity with the findings

of Ansari *et al.*, (2018), Suryawanshi *et al.*, (2022), Govindbhai (2023) and Chapke *et al.*, (2025) who found that education, age, mass media use, social participation, economic participation and risk orientation had significant relationship with perception of respondents about climate change.

Conclusion

On the basis of the major findings of the study it is concluded that the majority of pearl millet growers possessed a medium level of perception regarding the effects of climate change on pearl millet cultivation. Among various aspects, farmers exhibited the highest perception towards "seed treatment", while "weed control" was perceived as the least important aspect. There was a significant association observed between socio-economic characteristics and perception of pearl millet growers about the effects of climate change. Variables such as age, family size, education, social participation, annual income, size of landholding, farm mechanization, extension agency contact, innovativeness, economic motivation, and risk orientation were found to have a substantial influence on the way farmers perceived, experienced, and responded to climate change impacts. Hence, to enhance their overall understanding from medium to high, regular training and awareness programmes should be organized focusing on less-adopted practices such as weed management, integrated nutrient & pest management, and conservation agriculture. The use of participatory learning approaches, such as Farmer Field Schools (FFS), on-farm demonstrations, and exposure visits, should be encouraged to facilitate experiential learning. In addition, ICT-based platforms, including mobile advisory services, short educational videos, community radio, and WhatsApp groups, can serve as effective tools for disseminating knowledge related to climate-resilient technologies. Such comprehensive efforts would significantly improve farmers' perception levels and encourage them to adopt scientifically sound practices in pearl millet cultivation.

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