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Development and Standardization of a Scale to Measure Farmers' Perception of Climate Change

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HIGHLIGHTS

- A 28-item Likert scale was developed and standardized to measure farmers' climate change perception across selected four dimensions with high internal consistency (Cronbach's alpha reliability coefficient of 0.875).
- Content and construct validities were established using expert relevancy scoring and item critical ratio testing.

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ABSTRACT

A standardized Likert Summated Rating Scale was developed during 2025 to measure the perception of farmers towards climate change across four chosen dimensions (Temperature and rainfall variability, Extreme weather events, Crop productivity, and Socio-economic impacts). Initially, 58 statements were framed based on Edwards' criteria, of which 20 statements were eliminated following the relevancy test with 68 expert judges. The remaining 38 statements were pilot tested among 60 respondents from a non-sample area. After conducting item analysis using the critical ratio (t-value) technique, 10 statements were discarded. The final scale consists of 28 statements (7 positive and 21 negative), reflecting the predominantly risk-oriented nature of climate change perception. The internal reliability was established using Cronbach's alpha, which showed a high reliability coefficient of 0.875. Further, the split-half reliability yielded Spearman-Brown and Pearson coefficients of 0.948 and 0.901, respectively, which established a high internal consistency. This scale provides a reliable tool for researchers, extension personnel, and policymakers to accurately assess farmers' perception, thereby facilitating targeted climate resilience and adaptation strategies.

INTRODUCTION

Agriculture is the backbone of the Indian economy, supporting the livelihoods of about 42.30 per cent of its population and contributing approximately 17.70 per cent to India's gross domestic product (GDP) (Economic Survey, 2025-26). However, in the current era of accelerating climate change, agriculture is the most vulnerable sector due to its direct dependency on local weather parameters. According to the Intergovernmental Panel on Climate Change (IPCC, 2007), climate change refers to any identifiable shift in climate over time, arising from natural variability or human activities. Globally, anthropogenically induced warming has already driven a surface temperature increase of 0.85°C over the past century, with predictions estimating a further rise of at least 1.5°C by the end of the 21st century (IPCC, 2014). This increase in average global temperature significantly escalates the risks for rural populations, necessitating immediate adaptation strategies across climate-sensitive regions (IPCC, 2018).

Climate change consequences such as erratic precipitation, shifting seasons, and extreme weather events threaten long term

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agricultural sustainability (Nelson et al., 2009). This vulnerability is further amplified because 87.50 per cent of Indian farmers are small and marginal land holders, turning climate variability into a major challenge for national food and nutritional security (Mishra et al., 2024). According to global climate risk assessment, India ranks among the most vulnerable countries to climate change. Across its diverse mountainous, coastal, and arid ecological zones, this vulnerability manifests as accelerated land degradation, biodiversity loss, and loss of soil fertility leading to declining agricultural productivity and farmers' income (Mishra et al., 2024). The consequences of these climatic disturbances extend beyond agricultural production and affect household livelihood security, employment opportunities, and overall rural well-being. Such multifaceted impacts make climate change not merely an environmental concern but also a significant socio-economic challenge for farming communities (Phebe et al., 2024).

As climate change adaptation is fundamentally a cognitive and behavioral process, understanding these cognitive frameworks is a prerequisite for developing successful grassroots intervention and extension programmes. The effectiveness of climate adaptation initiatives largely depends on how farmers perceive climate-related risks and opportunities. Even within the same agro-ecological region, farmers often differ considerably in their interpretation of climatic changes, severity of impacts, and willingness to adopt adaptation measures. These differences in perception influence decision-making regarding crop management, resource allocations, technology adoption, and long-term livelihood strategies (Kumar & Saxena, 2024). Several climate-related perception scales have been developed for different populations and contexts (Van Valkengoed et al., 2021; Reddy et al., 2025; Pathak et al., 2026). However, most available instruments are either designed for specific climate adaptation programmes, assess only selected dimensions of perception, or are developed under different socio-economic settings. Therefore, there remains a need for a multidimensional, standardized scale suitable for assessing farmers' perception of climate change under Indian agricultural conditions, which could be used for designing need-based extension interventions and climate-resilient agricultural policies. The present study was undertaken to construct and standardize a reliable psychometric scale to measure the farmer's perception regarding climate change and its direct implications on their livelihoods.

METHODOLOGY

The scale was constructed using a systematic psychometric procedure involving item collection, relevancy analysis, item analysis, and reliability and validity assessment. The Likert's summated rating scale is a set of perception statements, all of which are considered of approximately equal perception value and to each of which subjects respond with degrees of agreement or disagreement carrying different scores (Likert, 1932). Perception, in this study was operationalized as the process by which a farmer registers and evaluates information received from the internal or external environment, consciously or unconsciously regarding climate change and it was measured across the four dimensions, namely, temperature and rainfall variability, extreme weather events, crop productivity & farming viability, and socio-economic & livelihood impact. Initially, 72 statements were collected and screened using the informal criteria suggested by Edwards (1957). Consequently, 14 statements were removed and 58 statements were selected (out of the initial 72) for relevancy analysis. The 58 statements were then sent to 150 experts purposively selected from Indian Agricultural universities, ICAR institutes, and related organizations. The experts possessed teaching, research or extension experience in the area of climate change, natural resource management, or related disciplines. The experts rated the relevancy of each statement on a three-point continuum- highly relevant, relevant, and least relevant (Thakur et al., 2017; Mukherjee et al., 2018). A total of 73 responses were received, of which five were excluded due to ambiguity and incomplete responses, and the remaining were considered for analysis. Relevancy Percentage (RP), Relevancy Weightage (RW), and Mean Relevancy Score (MRS) were computed for each statement. The Statements having RP > 70 per cent, RW > 0.7 and MRS > Overall Mean Relevancy Score (OMRS) of 2.33 were retained for item analysis (Mukherjee et al., 2018; Reddy et al., 2025). The 38 statements retained after relevancy analysis were pilot tested among 60 farmers from a non-sampled village of Kanpur district selected through simple random sampling. Responses were recorded on a five-point continuum ranging from strongly agrees to strongly disagree. Item analysis was performed using the critical ratio (t-value) technique suggested by Edwards (1957). Respondents were arranged according to their total scores and the upper 25 per cent and the lower 25 per cent groups were used as criterion groups for computing t-values. Statements with t-values equal to or greater than 2.05 (t critical for two tailed test) were retained in the final scale. The reliability of the developed scale was assessed using Cronbach's alpha and split-half reliability techniques. For split-half reliability, the statements were divided into two halves on the basis of random numbers and administered to the respondents. The reliability was estimated using Pearson correlation and Spearman-Brown coefficient (Edwards, 1957). Content validity was established through expert evaluation during relevancy analysis, while construct validity was assessed through item discrimination using the critical ratio (t-value) technique as shown below:

$$RP = \frac{\text{Frequency score of most relevant and relevant}}{\text{Total number of judges}} \times 100$$

$$RW = \frac{\text{Actual scores obtained for the statement}}{\text{Maximum possible scores obtained for the statement}} \times 100$$

$$MRS = \frac{\text{Actual scores obtained for the statement}}{\text{Number of judges responded}} \times 100$$

RESULTS

Relevancy analysis

The relevancy analysis was carried out to assess the suitability of the identified statements for inclusion in the perception scale. Responses obtained from 68 experts were analysed to compute

Relevancy Percentage (RP), Relevancy Weightage (RW), and Mean Relevancy Score (MRS) for each statement. The values of RP, RW, and MRS ranged from 62.90 to 96.77 per cent, 0.64 to 0.85, and 1.92 to 2.56, respectively. Based on these indices and expert suggestions, 38 statements were retained for item analysis after suitable modifications. The detailed relevancy indices of all statements are presented in Table 1.

Item analysis

The calculated t-values of the 38 statements ranged from 0.88 to 11.06. Based on the criterion of t ≥2.05, 28 statements were retained in the final scale, whereas 10 statements were discarded due to inadequate discriminatory power. The selected statements represented all four dimensions of the construct and constituted the final perception scale (Table 1).

Table 1. Relevancy indices of selected items for measuring perception of farmers towards climate change

S. No.	Statements	RW	MRS	RP	T value
	A) Temperature & Rainfall Variability (Effects on weather patterns, water availability, and farming conditions)				
1.	*Frequent temperature fluctuations throughout the year create anxiety. (-)	0.83	2.50	91.94	5.77*
2.	Erratic rainfall pattern is reducing the effectiveness of traditional irrigation methods. (-)	0.85	2.56	91.94	1.61
3.	*Early withdrawal of the monsoon creates confusion when planning for upcoming crop cycles. (-)	0.84	2.53	96.77	2.48*
4.	*Productivity of major crops is declining due to increasing temperature. (-)	0.82	2.47	93.55	5.90*
5.	The increasing number of heat waves in summer causes physical and mental exhaustion of farmers. (-)	0.84	2.53	93.55	1.56
6.	*The emergence of new weed species due to rising temperatures adds to growing uncertainty. (-)	0.78	2.36	87.10	3.77*
7.	*Unexpected rainfall does not seem to have any significant impact on crop yield. (+)	0.83	2.50	96.77	5.13*
8.	*Delayed onset of monsoon raises concerns about disruptions to cropping schedules (-)	0.84	2.52	95.16	6.83*
9.	Unpredictable rainfall during monsoons brings uncertainty in planning farming activities. (-)	0.79	2.37	87.10	1.97
10.	*Rising temperatures cause deep concern about their negative effect on livestock productivity. (-)	0.79	2.37	85.48	4.02*
11.	*The increasing frequency of livestock deaths due to heat stress is troubling. (-)	0.78	2.35	87.10	3.97*
12.	*Falling milk productivity in summer due to heat stress causes concern. (-)	0.83	2.48	93.55	11.06*
	B) Extreme Weather Events (Impact of extreme conditions on farming operations and productivity)				
13.	*Heavy rainfall floods severely disrupt farming logistics. (-)	0.83	2.50	88.71	4.25*
14.	Unpredictable weather events raise concern about crop failure. (-)	0.83	2.50	93.55	1.43
15.	*The occurrence of droughts does not cause real concern regarding long-term agricultural water availability. (+)	0.82	2.45	95.16	3.55*
16.	*Soil erosion during heavy rains affects soil health and productivity. (-)	0.81	2.44	90.32	6.39*
17.	*Extreme weather conditions like floods do not seem to have any significant impact on agricultural sustainability. (+)	0.79	2.37	90.32	4.45*
18.	*Frequent droughts raise concerns about the long-term sustainability of farming. (-)	0.79	2.37	88.71	3.95*
19.	The abandonment of agriculture due to weather-related uncertainties is deeply concerning. (-)	0.80	2.39	87.10	1.56
20.	*Rising fodder shortages due to droughts make livestock management extremely difficult. (-)	0.83	2.50	96.77	4.34*
21.	*Increasing number of livestock deaths due to weather extremes such as floods, feels discouraging. (-)	0.81	2.42	88.71	4.89*
	C) Crop Productivity & Farming Viability (Effects on yields, biodiversity, and financial sustainability)				
22.	*Declining crop yields create uncertainty about the future of agriculture. (-)	0.85	2.55	90.32	4.55*
23.	*Changes in crop ripening stage due to climate change feel discouraging. (-)	0.79	2.37	88.71	4.64*
24.	The inability of crop varieties to adapt to changing weather conditions raises concerns about future harvests. (-)	0.78	2.35	90.32	1.96
25.	Declining crop productivity due to climate change discourages the younger generation from farming. (-)	0.81	2.44	91.94	1.84
26.	*Farm productivity is expected to remain stable despite changing weather conditions. (+)	0.79	2.37	90.32	5.61*
27.	Farming is expected to adapt successfully to future climate changes. (+)	0.78	2.35	93.55	1.88
28.	*Advancements in farming techniques are expected to reduce the effects of climate change. (+)	0.79	2.37	85.48	5.52*
29.	*Disruptions in flowering cycles due to climate change create doubts about crop yields. (-)	0.81	2.42	90.32	3.10*
30.	*The loss of agricultural biodiversity due to climate change is deeply concerning. (-)	0.81	2.42	87.10	4.25*
31.	*The rising threat of pest outbreaks threatens the financial sustainability of farming. (-)	0.82	2.45	91.94	2.87*
	D) Socioeconomic & Livelihood Impact (Migration, income, and farmer perceptions)				
32.	Health risks posed by climate change to farming communities raise concerns. (-)	0.78	2.34	87.10	1.83
33.	*Climate-driven migration is contributing to abandonment of farmlands. (-)	0.80	2.40	90.32	3.09*
34.	*Climate change is contributing to a decline in annual farming income. (-)	0.78	2.34	88.71	2.80*
35.	*The growing unpredictability of weather has reduced confidence in agriculture. (-)	0.78	2.35	88.71	3.03*
36.	*Rural livelihoods appear largely unaffected by changing weather conditions. (+)	0.82	2.45	91.94	3.64*
37.	Constant changes in cropping patterns to cope with climate challenges create uncertainty about the future. (-)	0.78	2.34	90.32	0.88
38.	*Climate change does not appear to be the main reason for rural youth migration. (+)	0.78	2.34	90.32	2.43*

(* selected statement, + denotes positive Statements, – denotes negative statements)

Reliability and validity analysis

The developed scale was further standardized by establishing its reliability and validity. Reliability is the accuracy or precision of a measuring instrument (Kerlinger, 1973). The reliability analysis indicated a high level of internal consistency of the developed scale. Cronbach's alpha coefficient was found to be 0.875. The Pearson correlation coefficient between the two halves of the scale was 0.901, while the Spearman-Brown coefficient was 0.948 (Table 2). These values indicate that the scale possesses high reliability and internal consistency for measuring farmers' perception towards climate change.

Table 2. Split-half reliability test indices

	Reliability statistics
Cronbach's Alpha Value	0.875
Correlation Between Forms	0.901
Spearman-Brown Coefficient	0.948

Content validity is the representativeness or sampling adequacy of the content substance, the matter, and the topics of a measuring instrument. Content validity of the scale was ensured through expert evaluation during the relevancy analysis stage. Suggestions received from the experts were incorporated while refining the statements. Construct validity was established through item analysis, wherein only statements demonstrating adequate discriminatory power ($t \leq 2.05$) were retained. Thus, the final 28-item scale was considered both valid and reliable for measuring farmers' perception towards climate change.

DISCUSSION

The high reliability and validity coefficients obtained during the standardization process of the scale clearly demonstrate that the developed scale is a statistically sound and dependable instrument for measuring farmers' perceptions of climate change. The Cronbach's alpha value of 0.875 indicates a high level of internal consistency among the final 28 statements, confirming that the statements are well-aligned and measured the same underlying cognitive construct. Furthermore, the Spearman-Brown coefficient of 0.948 and the high Pearson correlation value of 0.901 verify the high stability and repeatability of the scale over time. These psychometric values are in complete agreement with the methodological parameters suggested by Edwards and Kilpatrick (1948), Cronbach (1946) and Thurstone and Chave (1929). Similar high reliability trends in climate-related scale development have also been reported by Pathak et al. (2026) and Reddy et al. (2025), who emphasized that rigorous item screening is crucial for capturing farmers' perceptions and responses to climate-related risks.

The retention of 28 statements across four distinct dimensions i.e., temperature and rainfall variability, extreme weather events, crop productivity, and socio-economic impacts, provides a holistic structure to the scale. By evaluating these specific dimensions, the tool captures not just the physical awareness of changing climate patterns, but also the farmers' understanding of subsequent field-level vulnerabilities and economic shocks. The elimination of 30 statements out of the initial 58 during the relevancy analysis and item analysis demonstrates the necessity of filtering out ambiguous or non-discriminating items. The remaining 28 statements are highly sensitive to individual differences in perception, which will allow researchers to differentiate clearly between highly perceptive, moderately perceptive, and low-perceptive groups within the farming community. The predominance of negatively worded statements reflects the inherently risk-oriented nature of climate change, which is consistent with empirical observations that farmers generally experience climate change through production risks, livelihood uncertainties, and weather-related disruptions rather than through perceived benefits. This structural soundness of the developed scale is in agreement with the findings of Shitu et al. (2018), Van et al. (2021), and Mallick et al. (2026) who noted that psychometric assessment tools were critical for diagnosing localized agricultural extension gaps, especially for a complex construct like climate change. This standardized approach ensures that the scale can be effectively used in future research and policy assessments related to perception of farmers towards climate change. The developed scale may also serve as a diagnostic tool for identifying perception gaps among different categories of farmers. Such information can help extension agencies prioritize interventions, improve climate communication strategies, and strengthen the adoption of climate-resilient agricultural practices. The scale can further be utilized for baseline assessments and monitoring changes in farmers' perception over time, thereby providing valuable feedback for extension planning and policy formulation.

CONCLUSION

A multi-dimensional Likert summated rating scale was systematically constructed and standardized in this study to evaluate the farmers' perception towards climate change. The scale comprises 28 statements capturing farmers' perceptions of climate-related risks and resilience. The final scale was systematically refined through expert relevancy analysis and pilot-study item analysis using the critical ratio (t-value) technique to ensure its high statistical reliability and discriminatory power under field conditions. This standardized scale holds immense practical utility for field researchers, policy workers, and frontline extension networks like Krishi Vigyan Kendras (KVKs). Utilizing this tool for baseline field studies will help extension personnel to easily understand the actual perception levels of local farmers before introducing a climate resilient technology or launching a climate smart agriculture programme. Ultimately, identifying these gaps will help in designing proper training programs and extension activities, for better adaptation and long-term livelihood security of the farming community.

DECLARATIONS

Ethics approval and informed consent: Informed consent from the specialist possessing specialized knowledge were sought to obtain validation.

Conflict of interest: The authors declare that this research was carried out without any financial contribution that could be considered as potential conflicts of interest. The authors further affirm that they independently reviewed, revised, and edited the manuscript throughout its preparation and accept the final content of this publication.

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