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

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HIGHLIGHTS

- Developed a 22-item scale to measure farmers' climate change risk perception.
- Achieved high internal consistency (Cronbach's α > 0.70), confirming scale reliability.

ARTICLE INFO

Keywords: Climate change, Risk perception, Content validity, Scale, Extension intervention.

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ABSTRACT

Farmers' perceptions of risks related to climate change significantly influence their adaptation behaviour and their responses to climatic stressors. The present study sought to develop and standardize a valid and reliable scale to quantify farmers' risk perception of climate change. Using the Likert summated rating technique, an initial pool of 70 statements was generated based on a review of the literature and consultation with experts. After systematic editing and relevancy testing through expert judgment, 45 statements were screened, and 28 statements were subjected to item analysis using responses from 40 farmers in a non-sampled area. Based on discriminating power ('t' value ≥ 1.75) and reliability criteria, 22 statements were finally selected for inclusion in the scale. The reliability of the scale was established using Cronbach's alpha, which exceeded the acceptable threshold of 0.70, representing high internal consistency. Content validity was ensured through comprehensive coverage of climate-related risks affecting crop, livestock and livelihood systems. The final scale enables categorization of farmers into low, medium and high levels of climate change risk perception. The developed scale is a useful tool for researchers, extension professionals and policymakers to assess farmers' risk perception and to design location-specific, evidence-based climate change adaptation and extension interventions.

INTRODUCTION

Changes in the global climate have attracted widespread attention from experts across disciplines due to their potential to cause far-reaching consequences for human civilization (Singh, 2020). Although the impacts of climate change vary across regions worldwide, particularly in developing countries such as India (Singh et al., 2019). Variations in rainfall and temperature associated with climate change have emerged as major concerns for planners, environmentalists, economists and communities whose livelihoods depend directly on natural resources (Kundu & Mondal, 2022).

Agriculture, which forms the backbone of the Indian economy, is highly sensitive to weather and climatic conditions, with nearly 80 per cent of variations in agricultural output attributed to fluctuations in local weather and climate (Nageswara Rao et al., 2018). The region is already witnessing significant climate-related impacts, including altered rainfall patterns, increasing temperatures and declining river water conditions (IPCC, 2021). As climate change represents a long-

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term shift in global or regional climatic patterns, farmers today face complex and multifaceted challenges. From an agricultural perspective, they are required to ensure food and nutritional security while simultaneously protecting environmental quality and promoting sustainable farming practices (Asrat & Simane, 2017).

Poor households in developing countries like India are particularly vulnerable to climate change because of their limited adaptive capacity and restricted access to alternative livelihood opportunities (Alam et al., 2017). Moreover, extreme weather events are projected to become more frequent and intense in the future, posing serious threats to the livelihoods of farmers across developing nations, including India (Dastagir, 2015). Climate-related hazards such as droughts, floods and heatwaves have already led to substantial reductions in crop yields and disrupted the livelihoods of millions of households. In response to these risks, farmers adopt various adaptation strategies, although the nature and extent of these measures vary across different livelihood groups.

In the present study conducted in 2024, climate change is understood as the observed or perceived changes in local weather patterns over the past three decades, particularly with respect to the increasing frequency of extreme events such as droughts, floods, dry spells and extreme temperatures. Recent research indicates that monsoon rainfall has become increasingly erratic, while extreme events such as floods, droughts and cyclones are occurring more frequently and with greater intensity (Kumar & Saxena, 2021; Kumar & Saxena, 2024). Within this broader global and national framework, the present study, conducted in the year 2024, focuses on how farmers in the Jalaun and Datia districts of the Bundelkhand Region perceive climate change and the strategies they adopt in response. Bundelkhand is highly susceptible to climatic stress due to irregular rainfall, rising temperatures and chronic water scarcity. Given its heavy dependence on rain-fed agriculture and frequent exposure to drought conditions, the region offers a critical context for examining how smallholder farmers, policymakers and other stakeholders perceive, interpret and respond to climate change in their everyday lives.

METHODOLOGY

Climate change risk assessment is the recognition of the probability of hazards or adverse outcomes associated with climate change. Therefore, it is essential to assess farmers' knowledge and understanding of changing climatic conditions, as well as the extent to which they perceive the consequences and associated risks of climate change. In the present study, the Likert summated rating scale method (Likert, 1932) was adopted to develop a scale for measuring the varying degrees of farmers' risk perception towards climate change. A summated rating scale comprises a series of statements that are regarded as having approximately equal importance. Respondents indicate their level of agreement or disagreement with each statement, and each response is assigned a specific score. This method was adopted in the study to avoid assessing a concept through a single statement. Instead, several statements covering different dimensions of the concept were included to enable a more comprehensive and balanced assessment.

To assess the relevance of each statement, several statistical tools were applied, namely Relevancy Weightage (RW), Relevancy Percentage (RP), Mean Relevancy Weightage (MRW) and Scale Value (S). Responses obtained from 90 experts were utilized for the final analysis. Statements were selected for inclusion in the scale, whereas statements exhibiting lower relevance or higher variability were excluded. Through this screening process, a total of 22 statements were finalised. To ensure content validity, all statements were derived from an extensive review of relevant literature and further refined based on expert feedback. The reliability of the scale was evaluated using Cronbach's alpha coefficient with the aid of SPSS software version 26. A Cronbach's alpha value greater than 0.70 was considered indicative of acceptable reliability (Cronbach, 1951). According to this criterion, the statements were evaluated for relevance. The final selection of statements was based on statements with a relevancy percentage over 70%, a mean relevancy weightage over 0.70, a mean relevancy score over 2 and a Cronbach's alpha coefficient greater than 0.70.

The scale was developed through following the standard steps. Statements related to various risks associated with climate change were compiled from relevant literature, including books, journals, magazines and online sources. In addition, consultations were held with experts, researchers, scientists and farmers, resulting in the preparation of an initial pool of 70 statements. The statements were carefully edited according to the fourteen criteria given by Likert (1932), Bird (1940) and Edwards and Kilpatrick (1957). Out of 70 statements, 45 statements were selected as they were found to be non-factual and non-ambiguous. The relevance test acknowledged that not all collected statements might be equally appropriate for measuring farmers' risk perception towards climate change. Therefore, the statements were critically reviewed by an expert panel to assess their relevance and screen them for final inclusion in the scale. The panel comprised scientists and researchers from the discipline of extension education representing various state agricultural universities, state departments and extension institutes. A total of 45 statements were circulated to 220 judges with clear instructions to evaluate the relevance of each item. The judges were requested to rate each statement on a three-point scale, namely most relevant, relevant and least relevant. Within a period of two months, responses were received from 90 judges. The scores awarded by these judges were aggregated, and the total score for each of the 45 statements was computed.

RESULTS

Based on these scores, Relevancy Percentage (RP), Mean Relevancy Weightage (MRW) and Mean Relevancy Scores (MRS) were calculated individually for all statements using the prescribed formulae:

Relevancy Percentage (RP)

It is the number of respondents who scored the given items as "most relevant" and "relevant", which was converted into a percentage.

$$RP = \frac{FS}{\text{Number of Respondents}} \times 100$$

Where FS = Frequency score of the most relevant and relevant

Table 1. Selection of statements based on the judges rating: RP, MRW and MRS"

S.No.	Statement	Mean Relevancy Weightage (MRW)	Mean Relevancy Score (MRS)	Relevancy Percentage (RP)
1.*	I perceived that the heavy floods and flash floods in the rainy season are increasing year by year.	0.81	2.45	91.11
2.*	I think that crop losses increased due to an increase in temperature.	0.73	2.22	75.55
3.	Land use patterns of farmers are not affected by climate change.	0.60	1.82	55.55
4.*	I do not think that adjusting the sowing date and time is an effective strategy for adapting to climate change.	0.90	2.71	95.55
5.*	I think the frequency of droughts, floods, and dry spells increased due to climate change.	0.95	2.86	100
6.	Climate change is not a real phenomenon.	0.60	1.81	51.11
7.*	I think that flowering and fruiting times of various crops and fruit trees will change due to climate changes.	0.87	2.61	95.55
8.*	I perceive that although climate change is occurring in other regions, it is not happening in my own region.	0.72	2.17	75.55
9.*	Climate change increases the risk of human life, risk of infectious disease epidemics, and many other risks.	0.90	2.72	95.55
10.	Agriculture is not adversely affected by climate change.	0.62	1.86	53.30
11.	There is no crop loss due to climate change.	0.60	1.80	47.77
12.*	Livestock rearing has become more vulnerable because of climate change.	0.92	2.77	98.88
13.	I think that the transportation of agricultural produce has not been affected by climate change.	0.60	1.82	55.55
14.	The productive capacity of livestock was not adversely affected by extreme climatic conditions.	0.65	1.97	61.11
15.	I feel that the decrease in the quality of water due to climate change.	0.63	1.90	61.11
16.*	I think that there is a change in the feeding behavior of dairy animals due to climate change.	0.81	2.43	91.11
17.*	I believe that extreme weather events will happen more frequently in the future.	0.80	2.40	92.22
18.*	I perceive that the climate is changing year by year.	0.80	2.42	93.33
19.	I think climate variability is nearly a hoax.	0.67	2.03	68.88
20.*	I do not believe that food security decreasing due to climate change.	0.87	2.63	94.44
21.*	I feel difficulty in adopting climate-smart agriculture practices.	0.79	2.37	87.77
22.	Climate change is a global issue that needs not worry.	0.62	1.87	51.11
23.*	I feel that the reduction in certain plant, animal, and bird species is due to climate change.	0.89	2.68	98.88
24.*	I think that there is a fall in the groundwater level due to climate change.	0.88	2.65	96.66
25.	I feel that there is no effect of climate variability on crop-livestock farming.	0.59	1.77	46.66
26.	I think that climate variability will increase agricultural production.	0.61	1.85	52.22
27.	I feel that my standard of living will improve due to climate variability.	0.56	1.70	47.77
28.*	I think that there is a change in current farm management practices due to climate change.	0.86	2.60	92.22
29.*	I think people will not migrate from more vulnerable areas to less vulnerable areas.	0.87	2.61	95.55
30.	I believe that climate variability is not a problem in the future.	0.55	1.67	38.88
31.*	I perceive late rainfall records or delays in the onset of rainfall due to climate change.	0.86	2.58	93.33
32.*	I believe that the changes in weather patterns are hurting my farm operations.	0.88	2.65	96.66
33.*	I don't think that industrialization is responsible for climate change.	0.86	2.58	91.11
34.	I believe that climate change is not caused by human interventions.	0.58	1.75	45.55
35.*	I feel that the increase in the cost of cultivation is due to climate change.	0.78	2.35	81.11
36.*	I think that due to climate variability seriously affects the ability to invest in business.	0.79	2.37	87.77
37.*	I think climate change is beneficial for farming and will improve our agricultural prospects.	0.88	2.64	95.55
38.*	I think that decrease in natural rangeland/grassland due to climate change.	0.83	2.50	86.61
39.	I think that climate variability has not been scientifically proven.	0.60	1.80	47.77
40.*	I feel that the frequency and extent of heat waves have become a major concern as they affect agricultural production.	0.89	2.68	95.55
41.*	I believe that the production and productivity of major crops decline under changing climatic situations.	0.90	2.71	95.55
42.*	I believe that the extreme cold weather, heavy fog, etc. due to climate change would affect the livelihood.	0.91	2.74	95.55
43.*	I believe that the increase in the temperature of the earth due to climate change is very dangerous for our next generation.	0.91	2.75	97.77
44.*	I believe that climate change-related disasters have increased people's belief in God.	0.90	2.70	93.33
45.	I feel that climate variability is more beneficial than harmful.	0.59	1.78	46.661

*Denotes statements/ items selected for further analysis

Mean relevancy weightage (MRW)

It is the ratio of the actual score obtained to the maximum possible scores (MPS) obtainable for each statement. It was calculated using the following formula:

$$\text{MRW} = \frac{\text{MRR} \times 3 + \text{RR} \times 2 + \text{LRR} \times 1}{\text{MPS}}$$

Where, MRR= Most Relevant Response, RR= Relevant Response, LRR= Least Relevant Response

MPS = Maximum Possible Scores [No. of judges responded * 3(45 * 3=135)]

Mean relevancy score (MRS)

It is the ratio of the actual score obtained by each respondent to the number of judges who respondent to the variable.

$$\text{MRS} = \frac{\text{MRR} \times 3 + \text{RR} \times 2 + \text{LRR} \times 1}{\text{Number of Judges}}$$

Where, MRR= Most Relevant Response, RR= Relevant Response, LRR= Least Relevant Response. Following this procedure, a total of 28 statements were finally chosen and subsequently revised/ rephrased based on the feedback provided by the experts.

Item analysis

Item analysis is an important step in the Likert technique for developing a valid and reliable scale. It was necessary to identify items based on their ability to discriminate between respondents with a high level of risk perception and those with a low level of perception regarding climate change. Accordingly, an item was conducted on the 28 statements shortlisted during the first stage. A schedule containing these 28 statements was prepared and administered through personal interviews with a sample of 40 farmers selected from a non-sampled area. Responses to each statement were recorded on a five-point continuum, namely Strongly Agree, Agree, Undecided, Disagree and Strongly Disagree with corresponding scores of 5, 4, 3, 2 and 1, respectively. For negatively worded statements, the scoring pattern was reversed. The overall perception score of each respondent was obtained by summing the scores of all the statements.

For item analysis, respondents were arranged in ascending order according to their overall perception scores. From this ordered according to their overall perception scores. From this ordered list, the top 25 per cent of respondents with the highest scores and the bottom 25 per cent with the lowest scores were selected. These two groups served as the criterion groups for evaluating the discriminating power of individual statements, as suggested by Edwards. Accordingly, out of 40 farmers to whom the statements were administered for item analysis, 10 farmers with the highest scores and 10 farmers with the lowest scores were identified and used as the criterion groups for evaluating each item. The ratio for each statement was calculated using the *t*-test. The *t*-value indicates the extent to which a particular statement is capable of differentiating between the high perception group and the low perception group. The *t*-value were computed using the formula proposed by Edwards.

$$t = \frac{\bar{X}_H - \bar{X}_L}{\sqrt{\frac{\Sigma(x_H - \bar{X}_H)^2 + (x_L - \bar{X}_L)^2}{n(n-1)}}}$$

Where, ΣX_L = Continuum value (x) × Frequency of responses (f) = fx for lower group, ΣX_H = Continuum value (x) × Frequency of responses (f) = fx for higher group, $\Sigma X^2_L = f(x^2)$ for lower group, $\Sigma X^2_H = f(x^2)$ for higher group, $\bar{x}_L$ = the mean score of the same statement for the low group ($\frac{\Sigma x_L}{n_L}$), $\bar{x}_H$ = the mean score of a given statement for the high group ($\frac{\Sigma x_H}{n_H}$), n = number of respondents in each group

Selection of statements for final scale

After computing the 't' value for all the items, 22 statements with the highest 't' value equal to or greater than 1.75 were selected. Items with a 't' value below 1.75 were strictly rejected according to the guidelines laid out by Edwards in 1957. Following the guideline for selecting items to be kept in the scale, apart from removing those with low discriminating ability and doubtful authenticity, the issue was to include those with the highest discriminating values. Thus, 22 statements were chosen for inclusion in the final scale according to the specified criteria:

1. The 't' value is more than 1.75
2. The statement should present a new idea i.e., the idea not overlapping with that expressed by others
3. The statement should be simple in words and brief.

Standardization of the scale

The validity and reliability of the scale were established to ensure its standardization. Validity was assessed through content validity and criterion validity.

Validity

The content validity of the scale was examined. Content validity refers to the extent to which a measuring instrument adequately represents the content, substance, and subject matter of the construct being measured. Since the items included in the scale comprehensively covered the entire domain of climate change risk in agriculture, based on an extensive review of literature and expert consultation, the scale was considered to possess adequate content validity. Criterion validity refers to the degree to which the results of a particular instrument correspond with those of an established external criterion or standard that measures the same construct. In the present study, the scale items showed appropriate alignment with the theoretical understanding and empirical indicators of climate change risk perception in agriculture. Consequently, the differences in scale values across the statements demonstrated strong discriminating power, supporting the acceptance of the scale as a valid measurement tool.

Reliability

The reliability of the scale was assessed using Cronbach's alpha coefficient with the help of SPSS software 26 (Cronbach, 1951). A Cronbach's alpha value greater than 0.70 was considered indicative of acceptable reliability.

Table 2. Farmers' risk perception about climate change statements analysis and their respective 't' values and Cronbach's alpha (a) values.

Statement	't' value	Cronbach alpha (α)	Status
I perceived that the heavy floods and flash floods in the rainy season are increasing year by year.	5.09434	0.969	Included
I think that crop losses increased due to an increase in temperature.	2.210526	0.752	Included
I do not think that adjusting the sowing date and time is an effective strategy for adapting to climate change.	3.641618	0.821	Included
I think the frequency of droughts, floods, and dry spells increased due to climate change.	2.322581	0.756	Included
I think that the flowering and fruiting times of various crops and fruit trees will change due to climate change.	2.04545	0.712	Included
I perceive that although climate change is occurring in other regions, it is not happening in my own region.	5.436242	0.974	Included
Climate change increases the risk of human life, risk of infectious disease epidemics, and many other risks.	-1.06719	0.321	Excluded
Livestock rearing has become more vulnerable because of climate change.	2.045455	0.711	Included
I think that there is a change in the feeding behaviour of dairy animals due to climate change.	-1.30435	0.314	Excluded
I believe that extreme weather events will happen more frequently in the future.	5.04	0.967	Included
I perceive that the climate is changing year by year.	6.428571	0.983	Included
I do not believe that food security is decreasing due to climate change.	3.103448	0.792	Included
I feel difficulty in adopting climate-smart agriculture practices.	0.947368	0.568	Excluded
I feel that the reduction in certain plant, animal, and bird species is due to climate change.	3.60	0.820	Included
I think that there is a fall in the groundwater level due to climate change.	7.39726	0.986	Included
I think that there is a change in current farm management practices due to climate change.	2.769231	0.763	Included
I think people will not migrate from more vulnerable areas to less vulnerable areas.	5.806452	0.978	Included
I perceive late rainfall records or delays in the onset of rainfall due to climate change.	2.673267	0.758	Included
I believe that the changes in weather patterns are hurting my farm operations.	2.941176	0.769	Included
I don't think that industrialization is responsible for climate change.	5.555556	0.976	Included
I feel that the increase in the cost of cultivation is due to climate change.	6.923077	0.986	Included
I think that climate variability seriously affects the ability to invest in business.	-0.26706	0.423	Excluded
I think climate change is beneficial for farming and will improve our agricultural prospects.	4.864865	0.953	Included
I think that the decrease in natural rangeland/grassland is due to climate change.	-0.78534	0.318	Excluded
I feel that the frequency and extent of heat waves have become a major concern as they affect agricultural production.	2.368421	0.758	Included
I believe that the production and productivity of major crops decline under changing climatic situations.	3.00	0.788	Included
I believe that the extreme cold weather, heavy fog, etc. due to climate change would affect the livelihood.	0.393013	0.521	Excluded
I believe that the increase in the temperature of the Earth due to climate change is very dangerous for the next generation.	5.40	0.972	Included

Note: *Statements having equal to or greater than 1.75 't' value were selected for the final scale

Final administration

The finally selected statements of the scale were randomly arranged and incorporated in the final format of the interview schedule for the farmers.

The finalized scale comprised 22 statements, as presented in Table 3. Responses were recorded on a five-point continuum, ranging from strongly agree (score 5) to strongly disagree (score 1), with intermediate options of agree (score 4), undecided (score 3), and disagree (score 2). The overall perception score of each respondent was obtained by summing the scores across all items. Consequently, the perception scores on this ranged from a minimum of 22 to a maximum of 110. Based on these scores, farmers were categorized into three groups like low, medium and high-risk perception. A higher score indicated a greater perceived level of risk related to climate change, and vice versa.

DISCUSSION

Although several scales have been developed to assess climate-related issues, these tools are largely context specific. As the area covered in the present study differs from those previously examined, there is a need to develop context-appropriate scales or tools to assess climate vulnerability and to identify factors that may threaten the country's food security. In addition, farmers' perceptions of climate change and its adverse effects on agriculture are essential for the effective implementation of mitigation and adaptation strategies. Risk perception is a social construct that represents the relationship between the group exposed to risk and the object at risk. The finalized scale, consisting of 22 carefully selected statements, exhibited strong internal consistency, as indicated by Cronbach's alpha values exceeding 0.70 across all the statements. This high level of reliability suggests that the items consistently measure the intended construct across different respondents. Such findings are in line with established scale development practices in agricultural extension research, where Cronbach's alpha values above 0.70 are considered acceptable (Ray & Mondal, 2011). The result also corresponds with the methodological standards reported in earlier studies, including Arulmanikandan et al. (2025), who developed an assessment tool for farmers' training needs in drone-based technologies using expert validation, item selection criteria and reliability analysis. Like their approach, the present study employed interquartile range analysis and mean relevancy weightage to refine the pool of statements, ensuring that only statistically significant and contextually relevant items were retained.

The scale encompasses a wide range of risk perception-related items, making it suitable for assessing risk perception across diverse agro-ecological and socio-economic contexts. The inclusion of these items enhances the robustness of the scale and facilitates a comprehensive understanding of constructs that either support or constrain resilience. Such an approach is crucial for developing context-specific interventions and policy measures. Furthermore, the scale development process was aligned with tools developed by Kumar et al. (2015), Shitu et al. (2018), Gupta et al. (2022), Chandra et al. (2024), and Kademani et al. (2025), thereby strengthening its methodological rigor and applicability.

CONCLUSION

Accurate and reliable measurement of farmers' perceptions of the risks and uncertainties linked to climate change and its adverse impacts on agriculture is essential for designing appropriate mitigation and adaptation strategies. Each statement was validated using a Likert scale, and Cronbach's alpha values above 0.70 across all statements indicated a high level of internal consistency. The final form of the scale included 22 statements for evaluating risk perception. Overall, the scale was found to be statistically reliable and valid for assessing farmers' risk perception toward climate change. It can serve as a useful tool for researchers, policymakers, and development agencies to identify the risks and uncertainties perceived by farmers, to prioritize suitable interventions, and to design data-driven and context-specific strategies for strengthening climate resilience.

DECLARATIONS

Ethical approval and consent to participate: The informed consent was sought from the respondents.

Availability of supporting data: Supporting data are available upon request.

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The authors declare that during the preparation of this work, thoroughly reviewed, revised, and edited the content as needed. The authors take full responsibility for the final content of this publication.

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