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Design and validation of a scale for assessing farmers' climate resilience management

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Abstract
Scaling is the process of systematically assigning numerical values to varying degrees of attitudes, opinions, or other measurable concepts to facilitate comparison and analysis. This study aimed to construct a reliable and valid scale to measure the climate resilience management level of farmers. The scale was developed using the standard methodology suggested by Likert (1932), following a step-by-step procedure for scale construction and standardization. The key steps included the identification and selection of statements, collection and editing of items, selection of judges, relevancy testing, item analysis, and testing of reliability and validity. Initially, 44 statements were selected and sent to 150 experts for evaluation of their relevancy via email, Google Forms, and personal distribution. Based on responses from 92 experts received within the stipulated time, a total of 41 statements were shortlisted for item analysis. Statements with a relevancy weightage of ≥ 0.75 were considered for the item analysis, including the calculation of the "t" value. After analyzing the "t" values of all 41 statements, 36 statements with a "t" value of ≥ 1.75 were selected for reliability testing. The reliability of the scale was assessed using the test-retest method, yielding a reliability coefficient of 0.84. The validity of the scale was confirmed through content validity analysis. The final scale consists of 36 reliable and valid statements for measuring the climate resilience management level of farmers. It is structured on a three-point continuum: "Strongly Agree," "Partially Agree," and "Strongly Disagree." Positive statements were assigned weights of 3, 2, and 1, respectively, while the scoring was reversed for negative statements. This standardized scale provides a robust tool for assessing farmers' resilience management levels, facilitating targeted interventions and policy formulation.

Keywords: Climate resilience management, relevancy, item analysis, reliability and validity

Introduction
Climate change has emerged as a major challenge for the agricultural sector, particularly in vulnerable regions like Marathwada, Maharashtra, where farming remains the primary source of livelihood. The region's dependency on monsoon rainfall, coupled with frequent climatic uncertainties such as erratic rainfall, prolonged droughts, and rising temperatures, exacerbates the risks faced by farmers. These climate-induced stresses not only affect agricultural productivity but also pose significant economic and social challenges, limiting the capacity of farmers to adapt and sustain their livelihoods. In response to these challenges, the concept of climate resilience management has gained importance as a means to assess and enhance farmers' ability to withstand, adapt to, and recover from climate-related adversities. A systematic approach to measuring the climate resilience management level of farmers is essential for designing targeted interventions and policies. However, there is a lack of a standardized scale to quantify and evaluate this resilience comprehensively.
This study aims to develop a reliable and valid scale to measure the climate resilience management level of farmers. The proposed scale incorporates various dimensions of resilience, including information-seeking ability, agricultural resource management, risk management, and environmental protection measures. By establishing a structured framework for assessing resilience, this research seeks to provide valuable insights for policymakers, extension agencies, and other stakeholders in designing effective strategies to enhance farmers' adaptive capacity. The findings will contribute to sustainable agricultural development and strengthen the resilience of farming communities in climate-vulnerable regions.

Materials and Methods
The present study was conducted during 2023–24 in the Marathwada region of Maharashtra, India, to develop a scale and measure the climate resilience management level of farmers. The study area was selected purposively from the eight districts of the Marathwada region, focusing on three districts—Nanded, Dharashiv, and Hingoli—based on their significant climatic variability in terms of rainfall and temperature.

Results and Discussion

In order to measure the climate resilience management level of farmers a scale was developed by using summated rating scale suggested by Likert (1932) [3]. The details of the steps actually followed in developing and standardization of the scale are discussed as below.

1. Identification and selection of various components
2. Collection and editing of items
3. Relevancy test
4. Item analysis and calculation of "t" value
5. Testing reliability of the scale
6. Testing validity of the scale
7. Administration of scale

Identification and selection of various components:

Four components; Information Seeking Ability, Agricultural Resource Management, Risk Management, and Environmental Protection were identified and selected based on a review of the literature and discussions with experts in the context of climate resilience levels.

Collection and editing of items

Initially, 60 statements reflecting the climate resilience management level of farmers were formulated based on a review of relevant literature, articles, publications, and consultations with experts in the fields of Extension and Agriculture. These statements were then refined according to the criteria suggested by Thurstone (1946) [4], Likert (1932) [3], and Edward (1969) [1]. After the editing process, 44 statements were retained, as they were deemed clear, non-ambiguous, and non-factual.

Relevancy of the statements

Not all collected statements are equally relevant for measuring the climate resilience management level of farmers. After careful editing, 44 statements were retained and subsequently evaluated for their relevance. These statements were sent to 150 experts in the fields of extension education and agricultural development, including Heads of Departments, Professors, Subject Matter Specialists from KVKs, Senior Scientists from Research Stations, and Agriculture Officers and Assistants. The experts were requested to provide their judgments on each statement using a three-point continuum: 'Most Relevant' (MR), 'Relevant' (R), and 'Not Relevant' (NR), assigned scores of 3, 2, and 1, respectively. Additionally, the judges were encouraged to suggest any new items they deemed appropriate for inclusion in the scale. A total of 92 judges responded and returned the duly completed schedules. Based on their responses, the relevancy weightage, relevancy percentage, and mean relevancy score for each statement were calculated using formulas provided by Edward (1969) [1].

1. Relevancy weightage (RW)

$$\mathbf{RW} = \frac{MRR\times3+RR\times2+NRR\times1}{MOS\ (3\ X\ 92=276)}$$

Where,
RW = Relevancy Weightage
MRR = Most Relevant Response
RR = Relevant Response
NR = Not Relevant Response
MOS = Maximum Obtainable Score

2. Relevancy percentage (RP)

$$\mathbf{RP} = \frac{MRR\times3+RR\times2+NRR\times1}{MOS\ (3\ X\ 92=276)} \times 100$$

3. Mean Relevancy Score (MRS)

$$\mathbf{MRS} = \frac{MRR\times3+RR\times2+NRR\times1}{\text{Number of judges (92)}}$$

Using these three criteria, the statements were evaluated for their relevance. Items with a relevancy weightage greater than 0.75, a relevancy percentage more than 75 per cent, and a mean relevancy score above 2.27 were selected for inclusion in the item analysis. As a result, 41 statements were retained after the relevancy test.

Calculation of 't' value (Item analysis)

A total of 41 statements were retained after the relevancy test and subjected to item analysis to determine their relevance in assessing the climate resilience management level of farmers in the Marathwada region. For this purpose, 40 respondents were selected from non-sampling area. The respondents were asked to express their opinions on each statement using a three-point continuum ranging from "strongly agree" to "strongly disagree." For positive statements, the scoring pattern assigned weights of 3 to "strongly agree," 2 to "partially agree," and 1 to "strongly disagree." For negative statements, the scoring pattern was reversed. Based on the total scores, respondents were arranged in descending order. The top 25 per cent of respondents, with the highest total scores, were categorized as the high group, while the bottom 25 per cent, with the lowest scores, formed the low group. These two groups served as criterion groups for evaluating individual statements, following the methodology suggested by Edward (1969) [1]. Thus, from the 40 respondents, the 10 with the highest scores and the 10 with the lowest scores were identified as criterion groups to assess the individual items.

The critical ratio (i.e., the 't' value), which measures the extent to which a given statement differentiates between the high and low respondent groups, was calculated using the formula proposed by Edward (1969) [1].

$$t = \frac{X_H - X_L}{\sqrt{\frac{\Sigma(X_H-\bar{x}_H)^2+(X_L-\bar{x}_L{}^2)}{n(n-1)}}}$$

Where,

$(X_H - \bar{X}_H)^2 = X_H^2 - (\bar{X}_H)^2$

$(X_L - \bar{X}_L)^2 = X_L^2 - (\bar{X}_L)^2$

$\bar{X}_H$ = mean score on given statement of the high group

$\overline{X}_L$ = mean score on given statement of the low group
X_H= summation of scores on given statement for high group
X_L= summation of scores on given statement for low group
$\sum X_H^2$ = sum of the squares of individual score on given statement for high group
$\sum X_L^2$ = sum of the squares of individual score on given statement for low group
n = number of respondents in each group

After calculating the 't' value for all 41 statements, those with a 't' value equal to or greater than 1.75 were selected for inclusion in the final scale.

As a result, a total of 36 statements with 't' values of 1.75 or higher were retained for the final scale, while statements with 't' values below 1.75 were excluded.

Reliability of Scale

i) Test-Retest Method

The final set of 36 statements, representing the climate resilience management level, was administered on a three-point continuum to a new group of 40 respondents who were not part of the actual sample. After 15 days, the scale was re-administered to the same respondents, resulting in two sets of scores.

The correlation coefficient ('r') between the two sets of scores was calculated and found to be 0.84, which was significant at the 0.01 probability level. This result indicates that the scale is highly reliable, demonstrating stability and dependability in its measurements.

Content validity

According to Kerlinger (1976) [2], content validity refers to the representativeness or adequacy of the content, substance, matter, and topics of a measuring instrument. The content validity of the scale was established in two ways. First, the inclusion of various main and sub-items in the scale was based on a thorough review of available literature from various studies. Second, the opinions of a panel of 92 experts in the fields of Extension Education and Agriculture were sought to determine the relevance of the suggested items for inclusion in the scale.

Administration of scale

The final scale, consisting of 36 statements (presented in Table I), was administered on a three-point continuum ranging from "strongly agree" to "strongly disagree." The scoring pattern assigned weights of 3, 2, and 1 to "strongly agree," "partially agree," and "strongly disagree" responses, respectively, for positive statements, while the scoring was reversed for negative statements. The climate resilience management score for each respondent was calculated by summing the scores of all statements included in the scale. Respondents were then categorized into three groups; low, medium, and high based on the mean and standard deviation criteria.

Table I: List of total statements selected for final scale

Sr. No.	Statements	SA	PA	SD
A	**Information Seeking Ability**			
1	Regularly consult with agricultural extension workers or experts learn about the best climate resilient practices			
2	Actively participates in workshops or training sessions related to climate change adaptations			
3	Regularly communicate with other farmers to exchange knowledge and experience			
4	Uses Agricultural publications or newsletters to stay updated on advancements in climate resilient farming			
5	Utilize online resources/social media to gather information on climate smart agriculture			
6	I use ICT tools such as radio, TV to access information on climate resilient practices, weather updates & Market prices			
7(-)	Mostly depend on indigenous technical knowledge and traditional farming practices			
8	Visit the research stations, KVK's or State agricultural universities to know about new climate smart practices			
9	Received messages under the "Gramin Krishi Mausam Seva" to stay updated about upcoming weather conditions			
B	**Agricultural Resource Management**			
1	Performs soil tests regularly to optimize nutrient management			
2	Use drought resistant crop varieties to survive under water stressed conditions			
3	Use bio fertilizers for seed treatment to enhance soil fertility, improve nutrient uptake and increase tolerance to environmental stresses			
4	Employ conservation tillage practices to minimize soil disturbance			
5	Effectively manage water resources through drip or sprinkler irrigation			
6	Follows Crop rotations to maintain soil health and prevent pest and disease outbreaks			
7	Follows mixed or intercropping to maximize land use efficiency and reduce the risk of crop failure			
8	Follows organic carbon sequestration practices such as agro forestry / Crop residue retention			
9	Use Mulch to retain soil moisture and prevent weed infestation			
10	Recharges the well/ Borewells to ensure availability of water throughout the years			
C	**Risk Management**			
1	Use improved variety seeds for sowing to enhance climate resilience and boost yields			
2	Sowing is done only after checking the germination capacity of the seeds			
3	Manages farming operations according to weather forecast			
4	To mitigate the risk of losses due to climate change, I diversified my crops			
5	Insured my crop under crop insurance scheme to protect against weather related risks			
6	Adheres to contingency crop planning to reduce the risk of aberrant weather conditions			
7	Engage in water conservation practices to ensure sufficient water availability for my farm			
8	Prefers investing in resilient farming infrastructure & equipment			

9	Diversified my source of income beyond farming like sericulture\ dairy\ poultry\ goatry			
10	Take measures to protect my livestock from heat stress during periods of extreme heat			
11	I use BBF planting as a strategy to adapt to changing rainfall patterns & extreme weather events			
D	**Environment Protection**			
1	Adopt integrated pest management techniques to minimize the need for chemical pesticide			
2	Implements practices such as contour ploughing to reduce soil erosion			
3(-)	I rarely use organic fertilizers and compost in farming			
4	Optimal use of chemical pesticides to ensure a population of beneficial insects			
5	Priorities the use of renewable energy sources such as solar power on farm			
6	Participates in tree planting initiatives to enhance biodiversity & combat climate change			

SA- Strongly Agree, PA- Partially Agree, SD- Strongly Disagree

Conclusion

The climate resilience management scale, consisting of 36 statements, was effectively used to assess the resilience levels of farmers. The three-point continuum provided a structured approach to gauge farmers' agreement with various resilience-related aspects. By assigning appropriate weights to positive and negative statements, the scoring method ensured a balanced evaluation. The final climate resilience management score for each respondent was derived by summing the individual statement scores. Based on the mean and standard deviation criteria, farmers were categorized into three groups: low, medium, and high resilience levels. This classification helped in understanding the distribution of resilience levels among farmers and identifying areas where targeted interventions may be necessary to enhance their adaptive capacity against climate change challenges.

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