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A Multi-Dimensional Scale for Quantifying Farmers' Adaptation Strategies to Climate Change

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HIGHLIGHTS

- A comprehensive 38-item scale was developed to measure farmers' adaptation strategies to climate change across eight major dimensions.
- All eight dimensions demonstrated strong internal consistency, with Cronbach's alpha values ranging from 0.795 to 0.861.
- The developed scale provides a reliable framework for assessing farmers' adaptation behaviour toward climate change.

ARTICLE INFO

Keywords: Climate change adaptation, Farmers' adaptation strategies, Scale development, Validation study, Climate-resilient agriculture.

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ABSTRACT

Climate change poses challenges to agricultural production and the livelihoods of communities, particularly in climate-sensitive regions. Although farmers adopt a range of adaptation practices, the absence of a standardized and validated measurement tool limits the systematic assessment of these strategies. Therefore, the study aimed to develop and validate a scale to measure farmers' adaptation strategies to climate change. The study was conducted in November-December 2025. An initial pool of 53 statements was generated through a literature review and expert consultation. After screening and refinement, 45 statements were subjected to expert judgment using a Likert summated rating approach to establish content validity. Statistical parameters, including Scale Value (S), Interquartile Range (Q), Relevancy Weightage (RW), Relevancy Percentage (RP), and Mean Relevancy Score (MRS) were used to evaluate and select items. Based on these criteria, 38 statements were finalised and organized into eight dimensions: crop adjustment and management, soil management and conservation, water management and conservation, nutrient management, livestock management, flood management, family resource/finance management, and labour use. The internal consistency of the scale was assessed using Cronbach's alpha, with values ranging from 0.795 to 0.861, indicating reliability across dimensions. The findings confirm that the instrument is valid and reliable for assessing farmers' adaptation strategies and informing climate-resilient policy.

INTRODUCTION

Climate change is a major global concern affecting socio-economic, socio-political, ecological, and environmental systems (Filho et al., 2021; Feliciano et al., 2022; Abbass et al., 2022). It is characterized by rising temperatures, irregular rainfall patterns, and an increased frequency of droughts, floods, and cyclones, with particularly severe implications for countries heavily dependent on agriculture (Dawid & Boka, 2025). Climate change is widely recognized as a critical challenge to agricultural production and rural livelihoods, and nations such as India are especially vulnerable due to their large agrarian population and mounting pressure on natural resources (Dupdal et al., 2021; Dupdal et al., 2022). In India, where a substantial share of the population relies on agriculture for livelihood, climate variability significantly affects productivity and limits farmers' capacity to cope with adverse weather conditions (Dawid & Boka, 2025). Bridging the knowledge gap through improvement in communication network has to go a long way in

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supporting farm level decisions and minimize the agricultural production and income loses in adverse climatic and weather conditions (Ravikumar et al., 2015).

Farmers typically respond to climate change through two broad approaches: adaptation and mitigation (Biswas & Rahman, 2023). Climate change adaptation involves implementing strategies that address shifting climatic conditions, including adopting appropriate measures and leveraging potential opportunities arising from climate variability (IPCC, 2022; IPCC, 2014; Biswas & Rahman, 2023). Such adaptation strategies are intended to strengthen the ability of individuals, households, and communities to manage climate risks, sustain livelihoods, and reduce vulnerability (Mucha et al., 2026). However, adaptation processes are influenced by diverse socio-economic and environmental factors that vary across regions (Debisa et al., 2025; Eshetu et al., 2021; Megabia et al., 2022). Consequently, adaptation remains a central policy pathway for addressing ongoing climate challenges.

Adaptation strategies play a crucial role in minimizing the negative impacts of climatic variability on agriculture. Effective adaptation measures enable farming communities to better withstand extreme weather events (Dawid & Boka, 2025). Research on climate adaptation continues to evolve, with new challenges and dimensions emerging, particularly in relation to farming communities (Ginbo et al., 2021; Iyer et al., 2022; Liu et al., 2020; Biswas & Rahman, 2023) and a lack of standardized scale to measure adaptation strategies to climate change. Addressing these gaps requires the development of scientifically robust tools capable of capturing the multidimensional nature of adaptation. Therefore, the present study was undertaken to develop and validate a scale for measuring farmers' adaptation strategies to climate change, to provide researchers and policymakers with a reliable framework for systematic assessment.

METHODOLOGY

The scale was developed through an extensive literature review and expert consultation. The statements were formulated under eight major dimensions like Crop adjustment/management, Soil Management/conservation, Water management/conservation, Nutrient management, Livestock Management, Flood Management, Family Management and Labour Use. The Likert summated rating scale method (Likert, 1932) was adopted to develop a scale for measuring adaptation strategies. The dimensions included crop management practices such as mixed cropping, drought- and disease-resistant varieties, crop rotation, short-duration crops, adjusted planting dates and crop insurance. Soil and water conservation involved mulching, cover crops, reduced tillage, bunds, supplemental irrigation, drip and sprinkler systems, and ridges and furrows. Nutrient management emphasized bio-fertilizers, integrated nutrient management and farmyard manure use. Livestock management covered animal healthcare, vaccination, grazing management, feed supplementation, manure management and insurance. Flood management included structural and non-structural measures like barriers, drainage improvement and hazard insurance. Family resource and labour management focused on reducing expenditures, borrowing food grains, increasing family labour participation and adopting labour-saving implements. The study scale was structured using close-ended questionnaire, which was formed using keywords or concepts regarding adaptation strategies to climate change. Initially, 53 statements were developed to represent the eight dimensions. After refinement and editing for clarity and redundancy, 45 statements were retained. These statements were subsequently subjected to expert judgment for content validation. The statements were shared with 100 experts based on their expertise in climate change, agriculture, KVK and extension scientists all over the country to rate the scale based on the relevance each statement on a five-point Likert scale ranging from (score 1) "Not relevant" to (score 5) "Most relevant". To evaluate the relevancy of each statement, statistical measures like Scale Value (S), Inter-Quartile Range (Q), Relevancy Weightage (RW), Relevancy Percentage (RP) and Mean Relevancy Weightage (MRW) were used and the responses received from 50 judges were used for the final analysis. Statements were included if their median scores were higher than the interquartile range, whereas statements considered less relevant or with more variation were excluded. This process led to the selection of 38 statements across eight dimensions. To reduce the biases a pre-test was conducted with 50 respondents to measure the internal consistency of scale in the non-sample area during November-December 2025, the reliability of the scale was tested by using Cronbach's alpha coefficient through IBM SPSS statistics 27.0.1 (Cronbach, 1951). A Cronbach's alpha value of greater than 0.70 was considered acceptable. In this study, the majority of the dimensions showed high reliability, with alpha values exceeding 0.80, confirming strong internal consistency of the scale.

RESULTS

The development of scale for adaptation strategies to climate change involved screening of 45 statements using expert judgment statistical analysis to ensure validity, relevancy and consistency of statements. A total of fifty experts rated the statements from 1 to 5 based on their relevance and parameters like scale value (S), Inter-Quartile Range (Q), Relevancy Weightage (RW), Relevancy Percentage (RP), and Mean Relevancy Weightage (MRW) were calculated. Based on these statistics 38 statements were finalized and grouped under eight core dimensions such as Crop adjustment/management, Soil Management/conservation, Water management/conservation, Nutrient management, Livestock Management, Flood Management, Family Management and Labour Use. In livestock management Rotational grazing is the moving the livestock through the paddocks on fixed schedule whereas altered pasture grazing is the movement of livestock from paddock to paddock adjusted based on the grass growth rate, weather conditions etc. Six of the eight dimensions showed strong internal consistency, with Cronbach's alpha values exceeding 0.80. For livestock management, alpha value is 0.861, crop adjustment 0.860, flood management 0.856, soil management 0.844, family management 0.834, water management 0.813, nutrient management 0.807 and Labour use 0.795 showed alpha value between 0.70 to 0.80. The results are in line with standard scale development practices reported by Shitu et al. (2018), Chandra et al. (2024) & Arulmanikandan et al. (2025), who emphasised the role of expert validation in instrument construction. Overall, the scale demonstrated good reliability ($\alpha > 0.75$ across dimensions), confirming that the retained 38 indicators are internally

Table 1. Final Selection of Statements in the Adaptation strategies to climate change

S.No.	Statements	Scale value (S)	Inter quartile range (Q)	RW	RP	MRS	Cronbach alpha value
A.	**Crop adjustment/management**						
1	Mixed cropping	1.76	1.03	0.84	84.40	4.22	
2	Drought-tolerant varieties	1.69	1.40	0.82	81.60	4.08	
3	Insects/diseases resistant varieties	1.33	1.12	0.88	88.40	4.42	
4	Less water-intensive crop	1.55	1.15	0.86	86.00	4.30	0.860
5	Crop rotation	1.39	1.23	0.88	88.00	4.40	
6	Cultivating short-duration crops and varieties	1.54	1.00	0.90	89.60	4.48	
7	Change in crop variety (HYV)	1.60	1.18	0.84	84.00	4.20	
8	Adjusting planting dates	1.21	0.85	0.92	91.60	4.58	
9	Crop insurance	1.24	0.90	0.91	91.20	4.56	
B.	**Soil Management/conservation**						
10	Mulching	1.46	1.07	0.89	89.20	4.46	
11	Cover crops	1.83	0.92	0.84	84.00	4.20	0.844
12	Reduced tillage/Zero tillage	1.88	1.03	0.82	82.40	4.12	
13	Construction of bunds to conserve moisture	1.33	1.02	0.91	90.80	4.54	
C.	**Water management/conservation**						
14	Supplemental irrigation through ground water	1.61	0.99	0.89	88.80	4.44	
15	Use of drip irrigation	1.24	0.85	0.94	93.60	4.68	0.813
16	Use of sprinkle irrigation	1.39	1.11	0.89	89.20	4.46	
17	Adopting ridges and furrows for crop cultivation	1.43	1.15	0.88	88.40	4.42	
D.	**Nutrient management**						
18	Bio fertilizer	1.19	0.82	0.92	92.40	4.62	
19	Integrated nutrient management	1.21	0.81	0.94	94.00	4.70	0.807
20	Improve/increase farmyard manure use	1.18	0.71	0.94	94.00	4.70	
E.	**Livestock Management**						
21	Manure management	1.19	0.78	0.93	92.80	4.64	
22	Rotational grazing	2.17	1.82	0.78	78.00	3.90	0.861
23	Better animal health management including surveillance and veterinary services	1.50	1.28	0.85	85.20	4.26	
24	Regular vaccination	1.50	1.16	0.85	85.20	4.26	
25	Extra concentrate minerals supplementation and feed additives to livestock	1.31	1.10	0.90	90.00	4.50	
26	Livestock insurance	1.24	0.90	0.92	92.40	4.62	
27	Altered pasture rotation	1.80	1.27	0.82	82.40	4.12	
F.	**Flood Management**						
28	Construction of Stone breakwater	1.67	1.12	0.86	86.00	4.30	
29	Use of Sandbags for flood protection	1.62	1.05	0.88	87.60	4.38	
30	Use of Hazard insurance	1.50	1.13	0.87	87.20	4.36	0.856
31	Establishing Improved drainage facilities	1.24	1.22	0.87	87.20	4.36	
32	Use of Indigenous options such as walls of wood, stone or coconut leaf and afforestation to overcome flood effects	1.82	1.08	0.84	83.60	4.18	
G.	**Family Resource/ Finance Management**						
33	Reducing expenditure for social functions and festivals	1.97	1.70	0.75	74.80	3.74	
34	Reducing spending on costly food items	2.00	2.01	0.74	74.40	3.72	0.834
35	Borrowing food grains from relatives	2.68	1.78	0.68	67.60	3.38	
H.	**Labour Use**	0.795					
36	Reducing the number of labourers employed on farm	2.14	2.05	0.74	74.00	3.70	
37	Increase the number of family labourers to avoid waged labourers	2.00	1.23	0.78	78.40	3.92	0.795
38	Adoption of labour-saving implements for cultivation	1.26	0.89	0.93	93.20	4.66	

Note: RW= Relevancy Weightage, RP= Relevancy Percentage, MRW= Mean Relevancy Weightage

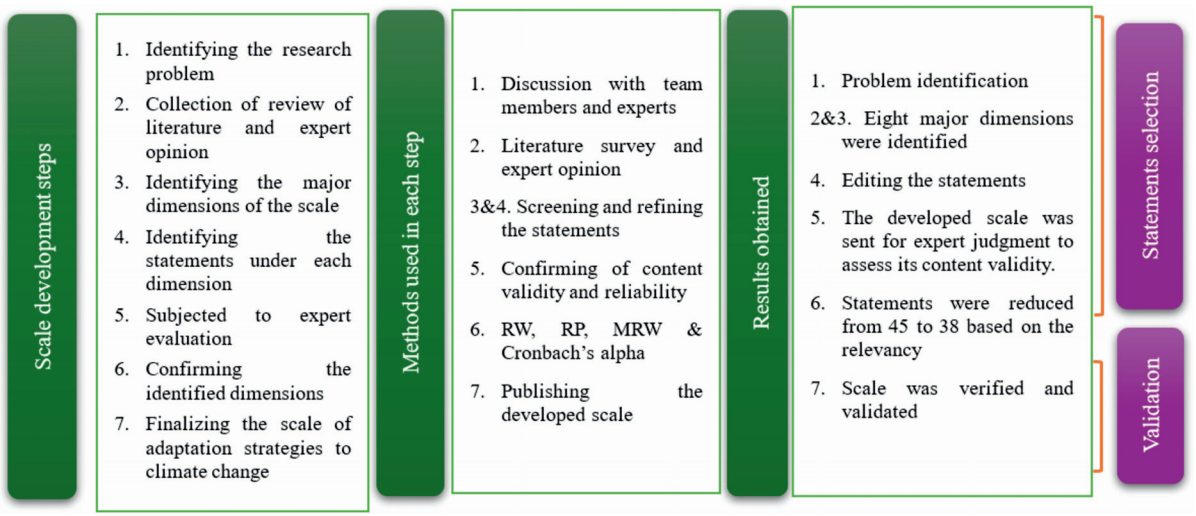

Figure 1. The process of developing adaptation strategies to climate change scale

consistent and suitable for measuring farmers' adaptation strategies to climate change.

DISCUSSION

The study evaluates the reliability and validity of the scale. In the present study Likert scale was employed to reduce ambiguity and make the statement easy to understand. After evaluation, the final scale consisting of 38 statements demonstrated good internal consistency, with Cronbach's alpha values exceeding 0.80 across all dimensions. The high reliability of the scale indicates that it consistently measures the intended construct across respondents; in agricultural extension research, a Cronbach's alpha value greater than 0.70 is generally considered acceptable (Ray & Mondal, 2011). The findings further indicated that the developed scale possesses strong content validity and dimensional consistency, as reflected in the Relevancy Weightage (RW) and Mean Relevancy Score (MRS), suggesting that experts perceived the statements as appropriate for assessing farmers' adaptation strategies to climate change.

Experts were asked to evaluate the relevance of each statement in relation to the study objectives. A total of 100 judges were contacted and the scale was circulated to them, of whom 50 (50%) responded. The responses were used to compute the MRS, while the Scale Value (S) and Interquartile Range (Q) guided the statement selection process. Statements with an S value greater than the Q value and a mean relevancy score above 0.70 were retained. Although the Mean Relevancy Scores for the Family Management dimension was comparatively lower than those of other domains, the Cronbach's alpha value (0.834) remained high, indicating strong internal consistency despite moderate perceived relevance. Similar methodological approaches have been used to establish validity and reliability in earlier studies (Kumar et al., 2015; Kumar et al., 2016; Shitu et al., 2018; Ashoka et al., 2022; Gupta et al., 2022; Vijayan et al., 2023; Chandra et al., 2024).

CONCLUSION

The developed scale demonstrated strong statistical validity and reliability for evaluating farmers' adaptation strategies to climate change. The final scale consists of 38 statements categorized under eight main dimensions i.e., Crop adjustment/management, Soil Management/conservation, Water management/conservation, Nutrient management, Livestock Management, Flood Management, Family Management and Labour Use. Likert scale was used to validate each statement. Cronbach's alpha value was (> 0.70) across all the eight dimensions representing the internal consistency of the dimensions. This scale provides researchers, extension professionals, and policymakers with a scientifically validated instrument to assess adaptation behaviour, identify gaps in resilience, and design targeted interventions for climate-resilient agriculture.

DECLARATION

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

Competing interests: No competing interests were declared.

Conflict of interest: No conflicts of interest among the authors.

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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