Research Tool

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A Tool to Measure Livelihood Vulnerability of Climate-Sensitive Farming Communities

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HIGHLIGHTS

- A Livelihood Vulnerability Scale was developed based on the IPCC framework, covering exposure, sensitivity, and adaptive capacity.
- The Cronbach's alpha value was 0.90, indicating high internal consistency across all dimensions.
- The developed scale is a reliable tool for assessing climate-related livelihood vulnerability among farming communities.

ARTICLE INFO

Keywords: Livelihood vulnerability, Climate change, IPCC framework, Adaptive capacity, Sensitivity, Exposure.

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ABSTRACT

Climate change is one of the major concerns for rural livelihoods, particularly for families dependent on agriculture. Understanding livelihood vulnerability to climate change is essential for developing adaptive strategies. The present study, conducted in March 2025, aimed to develop a scale for livelihood vulnerability by incorporating three dimensions: exposure, sensitivity, and adaptive capacity. From an initial pool of 53 statements, 36 were finalized after expert validation and statistical screening. The Likert methodology was used to assess the statements. Content validity was established through expert review, and internal consistency of the scale was assessed by using Cronbach's alpha (0.90), indicating high reliability. The final scale offers a comprehensive, reliable tool for assessing livelihood vulnerability to climate change and can be used for research, policy formulation, and relevant interventions in climate-sensitive regions.

INTRODUCTION

Climate change is one of the most pressing global challenges, manifesting through shifting rainfall patterns, rising temperatures, increased frequency of natural disasters, and adverse effects on food systems and human health (Krishnan et al., 2020; Hussain & Hoque, 2022; Saxena et al., 2022; Vijayabhinandana et al., 2022). In India, with its diverse climatic conditions and heavy reliance on agriculture, the impact of climate change is particularly pronounced (Sonwani et al., 2021; Hussain et al., 2024). Studies have indicated a decline in monsoon rainfall and an increase in the intensity and frequency of extreme weather events such as floods, droughts, and cyclones (Kumar & Saxena, 2021; Kumar & Saxena, 2024).

According to the Intergovernmental Panel on Climate Change (IPCC), global temperatures are projected to rise by 1.5°C, further intensifying climate-related threats (Parmesan et al., 2022; WMO, 2022). The IPCC defines vulnerability as "the degree to which a system is susceptible to and unable to cope with the adverse effects of climate change, including extreme events" (IPCC, 2007). This vulnerability is conceptualized across three dimensions: exposure, sensitivity, and adaptive capacity. India's position as the 7th most vulnerable country in the Global Climate Risk Index (Eckstein et al., 2021) highlights the urgency of assessing and addressing livelihood vulnerability at the grassroots level.

Agriculture, a key sector for rural livelihoods in India and particularly in states like Karnataka, is increasingly at risk. More than 50 per cent of the population depends on agriculture, and over 80 per cent of farms are rainfed (Reddy et al., 2023). The rising temperature and irregular monsoons are not only affecting crop

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productivity and traditional agricultural practices but also increasing the prevalence of pests, diseases, and food insecurity (Ashoka et al., 2022). These changes pose serious challenges to the livelihood security of farming communities.

Despite numerous vulnerability studies, there remains a lack of standardized, reliable, and context-specific tools to assess livelihood vulnerability, especially tailored to climate-sensitive farming communities. Addressing this gap requires the development of a scientifically validated tool that incorporates multiple dimensions of vulnerability. Therefore, the present study was undertaken to develop and validate a Livelihood Vulnerability Scale based on the IPCC framework, aiming to provide policymakers, researchers, and practitioners with a reliable tool to assess and address the vulnerability of farmers to climate change.

METHODOLOGY

The Intergovernmental Panel on Climate Change (IPCC) defines vulnerability as a function of three components: exposure, sensitivity, and adaptive capacity. The Livelihood Vulnerability Index is a widely accepted tool used to assess how susceptible a household or community is to various stressors such as climate change, natural disasters, and socio-economic shocks. In the present study, the Likert summated rating scale method (Likert, 1932) was adopted to develop a scale for measuring livelihood vulnerability. Based on a thorough review of literature and consultations with subject-matter experts, relevant indicators were identified and categorized under three key dimensions: exposure, sensitivity, and adaptive capacity.

The scale indicators were categorized as follows: exposure included climatic events such as floods, droughts, and cyclones experienced over recent years; sensitivity focused on aspects like water access, food security, and health conditions; and adaptive capacity was evaluated using indicators such as socio-demographic characteristics, livelihood strategies, social networks, access to services, use of technology, and natural resource availability. Initially, 70 statements were generated to represent these components. After careful editing and refinement, 53 statements were retained and subjected to expert judgment. These statements were shared with 110 experts, both electronically and in person, along with instructions to rate the relevance of each item on a five-point continuum ranging from "not relevant" (score 1) to "most relevant" (score 5).

To evaluate the relevance of each statement, the following statistical measures were applied, namely, Relevancy Weightage (RW), Relevancy Percentage (RP), Mean Relevancy Weightage (MRW), Scale Value (S), and Inter-Quartile Range (Q). Responses received from 50 experts were used for the final analysis. Statements were selected for inclusion if their median value exceeded the inter-quartile range, while those with lower relevance or greater variability were excluded. This process led to the selection of 36 statements across the three dimensions.

To ensure content validity, all statements were derived from literature and refined through expert feedback. Reliability of the scale was tested using Cronbach's alpha coefficient through SPSS software (Cronbach, 1951). A Cronbach's alpha value of more than 0.70 was considered acceptable. In this study, all three dimensions showed very high reliability, with alpha values exceeding 0.90, confirming strong internal consistency of the scale.

RESULTS

The development of the Livelihood Vulnerability Scale involved a rigorous screening of 53 initial statements using expert judgment and statistical analysis to ensure relevance, clarity, and consistency. Fifty experts rated the items, and key parameters such as Scale Value (S), Inter-Quartile Range (Q), Relevancy Weightage (RW), Relevancy Percentage (RP), and Mean Relevancy Weightage (MRW) were calculated. Based on these metrics, 36 statements were finalized and grouped under three core dimensions: exposure, sensitivity, and adaptive capacity.

The exposure dimension comprised eight statements capturing the frequency and impact of climate-related events like floods, droughts, and variability in rainfall patterns. The sensitivity component included eleven statements addressing access to water, food security, and health services. The adaptive capacity dimension consisted of seventeen statements covering socio-demographic factors, livelihood diversification, access to technology, climate-related information, and institutional support systems. Each dimension demonstrated strong internal consistency, with Cronbach's alpha values of 0.985 for both exposure and sensitivity, and 0.991 for adaptive capacity, indicating excellent reliability.

Content validity was established through a comprehensive literature review and consultation with experts in climate change and rural development. This methodology aligns with standard scale development practices reported by Shitu et al., (2018); Chandra et al., (2024) & Arulmanikandan et al., (2025), who emphasized the role of expert validation in instrument construction. Cronbach's alpha, a widely accepted measure of internal consistency in extension research (Ray & Mondal, 2011; Arulmanikandan et al., 2025), was used to assess reliability. The consistently high alpha values across all dimensions confirm that the scale is both statistically robust and suitable for assessing livelihood vulnerability among climate-sensitive farming communities.

DISCUSSION

The final scale, comprising 36 carefully selected statements, demonstrated high internal consistency, as reflected by Cronbach's alpha values exceeding 0.90 for all three dimensions. The high reliability of the scale indicates that the items consistently measure the intended construct across different respondents. This is consistent with established practices in scale development within agricultural extension research, where Cronbach's alpha values above 0.70 are considered acceptable (Ray & Mondal, 2011). The results also align with the methodological standards demonstrated in previous studies such as Arulmanikandan et al., (2025), who developed a tool to assess farmers' training needs in drone-based technologies using expert validation, item selection criteria, and reliability analysis. Similar to their approach, our study applied inter-quartile range analysis and mean relevancy weightage to refine the statement pool, ensuring that only statistically significant and contextually relevant items were retained.

While the IPCC framework provides a robust theoretical foundation, the scale's practical strength lies in its ability to capture

Table 1. Item-wise Statistical Indicators for Final Selection of Statements in the Livelihood Vulnerability Scale

S.No.	Statement (S)	Scale value (S)	Inter-quartile range (Q)	RW	RP	MRS	Cronbach alpha (α)
	I. Exposure						
	a. Climate shock						
1	Number of flood events occurred over the past three years	1.68	0.15	0.84	84.4	4.22	0.985
2	Incident of floods during crop growth periods (Early / Mid/ Late)	2.42	1.24	0.86	86.4	4.32	
3	Flood has caused damage to my physical assets (farmland and buildings)	2.00	1.25	0.88	88.0	4.4	
4	Experienced the incidents of drought events over the past three years	2.75	0.81	0.83	83.2	4.16	
5	Droughts have occurred during crop growth periods (Early / Mid/ Late)	2.54	1.20	0.85	85.2	4.26	
	b. Climate variability						
6	Experienced the changes in the onset and withdrawal of rainfall	2.78	1.09	0.88	88.00	4.4	
7	Presence of high temperature and unusual dryness	2.54	1.13	0.85	84.80	4.24	
8	Observed the uneven distribution of rainfall during rainy season	1.88	0.59	0.86	85.60	4.28	
	II. Sensitivity						
	a. Water						
9	Usage of natural water source by you	2.50	1.09	0.88	88.00	4.16	
10	Access to consistent water supply	2.81	0.32	0.85	85.00	4.38	
11	Distance travelled by you to reach potable water source	2.63	0.61	0.86	85.60	3.96	0.985
	b. Food						
12	Dependency on family farm for food	1.89	0.55	0.83	83.20	4.16	
13	Struggle to find food (in months) by you	2.68	0.50	0.78	77.60	3.88	
14	Number of crops grown on your farm	2.94	0.40	0.85	85.20	4.26	
15	Saving crops for home consumption	2.25	2.49	0.89	89.20	4.46	
	c. Health						
16	Proximity to medical facility	2.04	1.73	0.87	87.2	4.36	
17	Members with a chronic illness	2.54	1.81	0.82	81.60	4.08	
18	Illness due to flooding	1.86	1.31	0.74	73.60	3.68	
19	Access or own a latrine on their premise	2.12	0.56	0.80	79.60	3.98	
	III. Adaptive capacity						0.991
	a. Socio demographic profile						
20	Age of Household head	2.75	1.37	0.81	81.20	4.06	
21	Education of Household head	1.86	0.46	0.86	85.60	4.28	
22	Family Size	2.75	1.37	0.88	88.00	4.4	
23	Land holdings	1.86	0.46	0.90	90.40	4.52	
24	Out migration	1.69	0.70	0.84	84.40	4.22	
	b. Livelihood strategies						
25	Dependence on agriculture as their primary source of income	1.47	1.37	0.86	86.40	4.32	
26	Agriculture livelihood diversification	2.42	2.22	0.88	88.40	4.42	
27	Dependence on forest products as a source of supplemental income	3.16	2.69	0.87	86.80	4.34	
	c. Social network						
28	Membership in community-based or social organization	1.70	1.02	0.80	79.60	3.98	
29	Access to telecommunications services (telephone, mobile phone, and email)	2.50	1.06	0.87	87.20	4.36	
30	Climate change awareness	1.80	0.50	0.87	86.80	4.34	
31	Use of weather forecasting for farming decisions	2.42	1.29	0.86	86.00	4.28	
32	Trainings on climate change	1.94	0.60	0.89	89.20	4.46	
	d. Technology adoption and services						
33	Use of pesticides and fertilizers	2.42	1.24	0.84	84.0	4.2	
34	Use of climate-resilient varieties of seed	2.42	1.15	0.91	91.20	4.56	
35	Distance to market (km)	1.70	1.60	0.91	91.20	4.56	
36	Access to Climate information	1.76	0.30	0.88	88.40	4.42	

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

localized aspects of vulnerability, such as climate variability, food insecurity, and access to services—factors particularly relevant for climate-sensitive farming communities. The scale incorporates diverse livelihood-related indicators, which makes it suitable for assessing vulnerabilities in various agro-ecological and socio-economic contexts. The inclusion of adaptive capacity indicators such as access to climate information, education, market linkage, and training further strengthens the scale, enabling a comprehensive understanding of the factors that support or hinder resilience. This approach is essential for designing context-specific interventions and policies. Furthermore, by aligning our scale development with recent tools developed by Chandra et al., (2024).

CONCLUSION

The scale was statistically reliable and valid for evaluating the livelihood vulnerability among the farmers for climate change. The final scale consists of 36 statements categorised under three main indicators i.e., exposure, sensitivity and adaptive capacity. Likert scale was used to validate each statement. Cronbach's alpha value was (> 0.90) across all the three indicators representing the internal consistency of the scale. This scale helps to guide the researchers, policymakers and development agencies in identifying vulnerable groups, prioritizing interventions and formulating strategies for climate resilience that are data-driven and contextually relevant.

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DECLARATIONS

Ethics approval and informed consent: The experts to judge the items were well informed regarding the purpose and only the responses of the judges who consented have been included for analysis purpose.

Conflict of interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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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