Original Research Article

Climate Change Knowledge Assessment for Farmers in Bundelkhand, Uttar Pradesh: Test Development and Validation

ABSTRACT

An assessment of climate change knowledge is important to understand farmers' knowledge. There are several tests available to measure it, but they are all dispersed, making the study tedious. The present study, conducted in 2022-23, aimed at developing a composite climate change knowledge test that would aid in the amalgamation of various aspects to holistically study climate change. Initially, items from diverse literature were collected and discussed with specialists. A total of 63 items were selected. At two levels, the knowledge item was judged and screened. For the first level of screening, 63 items were sent to 100 experts for review. 39 items were chosen for item analysis based on the opinions of 60 experts. These 39 items were distributed to 60 non-sample farmers for second-level screening. The difficulty and discrimination indexes were calculated using the item analysis score. Items with difficulty index of 0.40 to 0.80 and discrimination index of 0.25 and higher were chosen. Following that, 29 items were selected for the final climate change knowledge test for farmers. Finally, the split-half method reliability of the test was 0.85. The developed knowledge tool aids in identifying knowledge gaps and planning our future policy for better adaptation.

Keywords: Farmers, Bundelkhand region, Knowledge test, Climate change, Item analysis, Difficulty index, Discrimination index.

1. INTRODUCTION

Climate change has a direct impact on agriculture, non-agriculture, and natural resource sectors, which are all directly linked to the national economy, and it may also have a negative impact on human health (Anonymous, 2022). According to the Indian Meteorological Department, Ministry of Earth Science (2021), the decade 2011-2020 is the warmest on record, with a 0.34^0C increase in temperature above average. Agriculture in India accounts for approximately 42 per cent of total jobs and 60 per cent of geographical area (Ministry of Finance, 2019). Despite being a significant source of employment, its share of GDP has steadily declined over the last 55 years, falling from around 54 per cent in 1960-61 to 18.3 per cent in 2022 (PIB, 2023). Climate variability, poor infrastructure, a lack of knowledge, agricultural market mismanagement, farmer socioeconomic status, and agricultural-related technologies among farmers are all factors contributing to this transition (Swami and Parthasarathy, 2021). Climate variability has been changing dramatically in India over the last 30-40 years, with increasing monsoon and temperature variability exacerbating the decline in agricultural productivity (Sarkar et al., 2021). However, the World Bank (2018) estimates that rising temperatures and changing monsoon rainfall patterns caused by climate change could cost India 2.8 per cent of GDP and depress the living standards of nearly half of the country's population by 2050, based on observations of deteriorating socioeconomic standards caused by Climate Change, which are global alarms.

Uttar Pradesh is the most populous state, and it is divided geographically into four economic regions: Western, Central, Eastern, and Bundelkhand. Historically, Bundelkhand is more vulnerable to climate change (Singh, 2020). The main factors contributing to this region being the most vulnerable in the state are an increasing number of consecutive dry days, a depleting groundwater table, a low urbanization rate, a greater reliance on agriculture, and a low financial inclusion index (Directorate of Environment, 2022). Furthermore, a lack of non-farm employment opportunities reduces adaptive capacity; agriculture is the sole source of income; crop and income diversification is unlikely; the region's vulnerability to climate change is exacerbated by the region's high illiteracy rate (Singh & Singh, 2018; Jatav &Singh, 2023). The Bundelkhand region of Uttar Pradesh, which includes districts such as Chitrakut, Banda, Jhansi, Jalaun, Hamirpur, Mahoba, and Lalitpur, is the state's most vulnerable region in terms of climate-related risks (Directorate of Environment, 2020). Various standardized tools have been developed over time to assess farmers' knowledge of climate change, such as Tripathi and Mishra (2017), Vanasthi and Sahana (2017), and Das et al., (2020) etc. Existing assessment tools, on the other hand, may not adequately capture the specific knowledge requirements of farmers in the Bundelkhand region. As a result, assessing farmers' climate change knowledge is a critical step in addressing agricultural climate change challenges, particularly in the Bundelkhand region. Given the foregoing, the current study attempted to develop a knowledge test to assess farmers' knowledge on climate change while taking into consideration their adequate needs and requirements.

2. MATERIALS AND METHODS

In this study, we employed Bardhan & Bhardwaj (2022) established methodology to create a climate change knowledge test. The process involved item collection, selection, judgment, and analysis (difficulty and discrimination indices), ensuring reliability and validity, culminating in the final test item selection. Items were sourced from diverse literature, reflecting farmer knowledge, with 63 items initially selected and assessed by a panel of judges.

A total of 100 experts were consulted for the first level of screening to assess the relevance of the 63 items. A total of 60 experts responded using the mailed questionnaire technique with Google Forms. Item relevance was graded on a three-point scale, with three being the most relevant (3) and one being the least relevant (1). Finally, 39 items with an average relevancy rating of two or higher were chosen for the second round of evaluation. The second round was decided by 60 non-sample farmers from Gurdaha village in Hamirpur district. The difficulty index is defined as the proportion of farmers who correctly answer that specific item. The difficulty index can be calculated using the formula below:

$$Pi = R/N$$

Where 'Pi' = Difficulty index, 'R' = Number of farmers who responded correct answer, and, N = Total number of farmers (60).

The discrimination index is the ability of the item that is used to differentiate between superior and inferior items (Pratiksha and Sharma, 2023). After computing the respondents' scores, the scores were arranged in descending order using this method. The respondents were then divided into six equal groups of ten, and their total scores were used to sort them. Because test items were to be analyzed, the two medium groups were excluded from the analysis (Johnson et al., 2023). The discrimination index was calculated using only four groups: upper and lower. Table 1 shows the distribution of scores obtained by respondents from six groups.

Table 1: The scores of respondents ranged from G1= Group 1 to G6 = Group 6.

Group Number	G1	G2	G3	G4	G5	G6
Range of score	31-36	28-30	25-27	22-24	20-21	16-19

The index of discrimination can be measured by following the formula given by Mehta (1958):

$$E^{1/3} = \frac{(S1 + S2) - (S5 + S6)}{N/3}$$

Where, ‘S1’, ‘S2’, ‘S5’, and ‘S6’ were the frequencies of the correct answer in ‘G1’, ‘G2’, ‘G5’, and ‘G6’, N =Total number of farmers in the item analysis sample group.

3. RESULTS AND DISCUSSION

3.1 Finalization of items for the test

The Items selected for the knowledge test with difficulty index values ranging from 0.40 to 0.80 were retained; the underlying assumption was that difficulty was proportional to an individual's level of knowledge on the subject (Coombs, 1950). That is, items that were too easy or too difficult based on the extreme values of the difficulty index, where less than 0.40 indicated too easy and greater than 0.80 indicated too difficult, were removed. After calculating the difficulty index, the items with the discrimination index score of 0.25 or higher were retained. As a result, only 29 items of the 39 items initially chosen for the knowledge test were incorporated into the interview schedule for administration to the actual respondents, as shown in Table 2.

3.1.1 Reliability and validity test

Reliability is the accuracy or precision of a measuring instrument (Kerlinger, 2007). For calculating reliability of the test, split-half method was used to compute the test's reliability coefficient value. The benefit is that all data for computing reliability was obtained on a single occasion, which assisted in eliminating variations caused by two different testing scenarios (Garret, 2007). Each item was arranged at random before being divided into two equal halves with odd and even numbers of items. The co-efficient of correlation between two sets of scores was computed using and the "r" value of 0.85 was found to be significant at the 1% level of significance, indicating that the knowledge test was highly reliable (Table 3).

Good item validity is a guarantee of test validity, so the test was deemed valid (Sarkar et al., 2014). Guilford (1954) defined the empirical type of validity as intrinsic validity by taking the square root of the calculated reliability coefficient. The content validity of the knowledge test was ensured by a thorough discussion with a member of the advisory committee. The test validity was 0.92, indicating that the knowledge test was quite valid for the study. The reliability and validity test has significantly improved the consistency and objectivity of the test, indicating its potential.

Table 2: Difficulty index and Discrimination power index of test items.

S. No.	Items	P_i	$E^{1/3}$
Farmers' knowledge of climate change			
1.	Climate change means change in rainfall, temperature, humidity and other weather parameter over a longer period of time.	0.53	0.33
2.	Have you ever experienced changes in the livelihood patterns of farmers because of changing climate conditions?	0.66	0.30
3.	Does the burning of fossil fuels cause climate change?	0.86 (x)	0.10 (x)
4.	Do you know that crop residue burning in fields contributes to	0.60	0.36

	climate change?		
5.	Is the groundwater availability affected because of poor distribution of rainfall?	0.55	0.30
6.	Is climate change both natural and man-made?	0.95 (x)	0.13 (x)
Climate change extreme events knowledge			
Rainfall			
7.	Do you feel that there is a shift in the onset of monsoon over the years?	0.96 (x)	0.23 (x)
8.	Do you think the changes in rainfall patterns due to climate change have reduced crop production?	0.83 (x)	0.13 (x)
9.	Has the evaporation rate increased due to climate change?	0.58	0.26
10.	Do unfavorable climate change affect crop period?	0.75	0.33
11.	Do you think climate change has brought a change in cropping patterns?	0.55	0.33
Temperature			
12.	Does rising temperature have an impact on soil health?	0.55	0.40
13.	Is climate change a major cause of increased pest incidents?	0.62	0.36
14.	Do you think climate change has hardened the seed bed?	0.65	0.30
Relative-humidity			
15.	Has increased relative humidity increased the occurrence of new diseases on crops?	0.63	0.40
16.	Do you think more post harvest losses occurred due to excessive relative humidity?	0.52	0.40
17.	Is there an increase in weed infestation due to relative humidity?	0.68	0.33
18.	Is there a reduction in the production of crops due to relative humidity?	0.25 (x)	0.23 (x)
19.	Do you know that relative humidity is highest in the month of July-August?	0.88 (x)	0.10 (x)

Drought			
20.	Does the use of pond water by low lift pump helps to reduce the risk of drought?	0.56	0.30
21.	Do you think lack of sufficient rainfall due to climate change decreased the amounts of available groundwater?	0.62	0.30
22.	Do you think general health condition of livestock adversely affected due to decreased in potable water availability?	0.66	0.36
23.	Do you think extended heat stress caused drop in milk productivity?	0.75	0.33
Other climate events			
24.	Do you know about weather forecasting, monitoring and early warning systems with regard to climate variability?	0.53	0.40
25.	Does climate change increase food insecurity?	0.56	0.30
26.	Does climate change create hazards to human health?	0.90 (x)	0.06 (x)
27.	Do you know about the various government schemes and subsidies related to climate change in agriculture?	0.56	0.30
Adaptation strategies			
28.	Change in cropping pattern	0.93 (x)	0.20 (x)
29.	Switch to drought and flood-tolerant varieties	0.73	0.30
30.	Crop weather insurance	0.52	0.40
31.	Intercropping or mixed cropping	0.65	0.33
32.	Integrated crop-livestock management	0.93 (x)	0.03 (x)
33.	Switch to non-farm activity	0.68	0.30
34.	Delay/Early maturing variety	0.73	0.30
35.	Taking soil and water conservation measures	0.75	0.30
36.	Use short growth period crop	0.93 (x)	0.13 (x)
37.	Crop-water demand management and watershed management	0.66	0.36
38.	Diversification of income generating activities like dairy, poultry,	0.68	0.30

	sericulture and so on		
39.	Use of drip and sprinkle irrigation system for increasing water use efficiency	0.68	0.30

Table 3: Correlation coefficient value in Split-half method.

		Odd item	Even item
Odd item	Pearson correlation sign. (2-tailed)	.001	.085**
	N	40	
Even item	Pearson correlation sign. (2-tailed)	.085**	.001
	N	40	

Subsequently, Beevi et al., (2022) & Chandhana et al., (2022) used a similar procedure to develop a knowledge test to assess the rainfed farmers' knowledge on natural resource management practices and measure the farmers' knowledge level on sunflower cultivation. Likewise, Jha et al. (2012) studied the farmers' information and knowledge needs for climate change adaptation. Similarly, Sarkar et al., (2014) also studies knowledge level of farmers about climate change in arid ecosystem in India with the help of knowledge test by considering most of the areas related to climate change.

In the present research, we have constructed a comprehensive climate change knowledge test comprised of 29 items. This test is particularly relevant in light of the substantial climatic shifts experienced by farmers in the Bundelkhand region, which are having detrimental effects on their agricultural practices. These changes encompass reduced rainfall, elevated temperatures, alterations in relative humidity, and frequent occurrences of drought, among other climate events. The implementation of a scientifically designed knowledge test offers a promising avenue to pinpoint the existing gaps in understanding and knowledge regarding climate change. It is essential that we employ such a tool to inform our future policy decisions, enabling us to better strategize for effective adaptation measures. Moreover, a sound knowledge base serves as a foundation for fostering a positive attitude, honing problem-solving skills, and cultivating a value orientation that is conducive to addressing climate change challenges constructively. Thus, the standardized items within this knowledge test hold the potential to provide a comprehensive and well-rounded perspective on the climate change issues faced by farmers in the region.

4. CONCLUSION

In conclusion, this study has successfully created and standardized a climate change knowledge test tailored for farmers. This comprehensive test evaluates their understanding of climate change, extreme weather events, and adaptation strategies. The study has also outlined the systematic process for constructing and validating this standardized knowledge test. In light of the critical importance of climate change knowledge, extreme weather events, and adaptation strategies in the Bundelkhand region, this tool holds significant potential. It can be a valuable resource for researchers, policymakers, and concerned organizations seeking to enhance farmers' comprehension of climate change, ultimately facilitating their capacity to adapt. Furthermore, bolstering farmers' knowledge can foster a positive mindset and enhance their problem-solving capabilities in addressing climate change challenges.

CONSENT

The prior consent of the respondents was taken with due care and confidentiality.

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