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Development of knowledge test to measure the knowledge level of farmers on interventions of the NICRA project for climate change adaptation

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Abstract

The study focused on climate change adaptation under the Technology Demonstration Component (TDC) of the NICRA project and attempted to construct a knowledge test to measure the knowledge level of farmers. Items about climate-smart interventions under the NICRA project were collected from relevant literature and through consultation with scientists. The study was conducted in the Kathua district of Jammu region for item analysis. Item analysis provided a difficulty index and item discrimination index. One mark for each correct and zero mark for each wrong answer was assigned. Finally, the reliability of the test using split half method was found to be highly reliable. Content validly was assessed by CVR (Content validity Ratio), CVI (Content Validity Index), and Kappa statistic. The item content validity index (I-CVI) ranged from 0.63 to 1.0, the I-CVI value above 0.78 was considered fit for the instrument. The instrument was assessed with high content validity. A total of 18 statements were finally retained which contains 4 multiple choice response, 3 alternate response, 3 identifications from photographs, and 8 open response items.

Keywords: Content validity, item analysis, knowledge test, reliability, spearman-brown prophecy, split half test

Introduction

Climate change is causing an increase in the number and intensity of extreme weather occurrences. Agriculture and climate change are mutually dependent. The agriculture sector is given high priority status in most developing nations due to its cardinal contribution to their country's economic growth (Pradhan *et al.*, 2021) [7]. Appropriate extension interventions can reduce the climate change effect considerably and help the farmers to maintain the productivity in the midst of extreme climate variations (Ponnusamy *et al.*, 2019) [6]. National Initiative on Climate Resilient Agriculture (NICRA) is the pilot project launched by the Indian Council of Agricultural Research (ICAR), that correlates climate variability and its impact on agricultural processes and aims at the development in agricultural strategies based on variability of temperature, humidity, dry land and other adverse condition (Tajpara *et al.*, 2020) [8]. The concentrated application of watershed development, new crop technologies, livestock improvements and institutional innovations would catalyse a process of focused learning, training and validation that, together, could build climate-resilience. By creating models of best practices at a village level, the NICRA project further sought to provide the foundations for scaling out successful technologies via networks of trained agricultural extension officers as a means to establish climate resilience across rural India (Taylor and Bhasme, 2021) [9].

Jammu and Kashmir are experiencing the major effects of climate change on local weather in the form of diminishing and reducing glaciers, catastrophic flooding, decreasing winter time and snow, and increasing summer length and temperature (Mahdi *et al.*, 2018) [4]. The annual temperature is also likely to increase by 2030. (Parvaze *et al.*, 2017) [5]. Therefore, to provide mitigation and adaptation strategies to farmers, Krishi Vigyan Kendra, Kathua under the administrative control of Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu (J&K) has implemented climate resilient technologies under the National Innovations in Climate Resilient Agriculture (NICRA) project, sponsored by Indian Council of Agricultural Research, New Delhi. KVK Kathua adopted villages under the NICRA project and implemented several measures such as in-situ moisture conservation, the introduction of short-duration and drought-resistant varieties, etc. to build confidence among farmers related to farming.

The main objective is to develop the knowledge test to identify the knowledge level of farmers regarding the climate-smart interventions provided under the Technology Demonstration Component of the NICRA project.

Methodology

Considering the importance of climate-smart technologies in enhancing productivity, a knowledge test was developed by employing the following methodology, and standardization of test items was made as given below:

a) Conceptual definition of knowledge

Knowledge is defined as "Behaviour and test situations which emphasize the remembering, either by recognition or recall of idea, material or phenomenon" (Bloom, 1956) [2].

b) Operational definition of knowledge

Recalling and remembering the principles and theories of climate smart scientific interventions by the farmers.

c) Content area of the test

The content area was divided into four parts based on the four components of the Technology Demonstration Component of the NICRA project i.e. Natural resource management, Crop production, Livestock production, and Institutional interventions.

d) Layout of the test

It involves the types of items and no. of items. In the study, 4 types of items were framed i.e.: multiple choice response, alternate response, identification from photographs, and open response.

e) Collection of test items

The test items were collected based on the annual report of NICRA and relevant literature.

f) Item analysis

The item analysis usually yields two kinds of information, item difficulty and item discrimination. The index of item difficulty reveals how difficult an item is. The index of discrimination indicates the extent to which an item discriminates well-informed individuals from poorly informed ones.

g) Standardization of test

Standardization of tests is done with reliability and content validity.

Collection of test items

An item pool of questions was prepared by reviewing literature such as books, research papers, annual report of the NICRA project and conducting discussions with field extension personnel. The items were collected concerning the technology demonstration component of the NICRA project.

Item analysis

The initially prepared 30 items on climate smart interventions under the Technology Demonstration Component of the NICRA project were administered to a group of 24 respondents before the preparation of the final schedule on non-sampled respondents from Said, Sohal, Loukhali, and Badholi villages of Kathua district of Jammu and Kashmir.

Each statement had two response categories either correct or wrong. Each correct answer was given a '1' score while the wrong answer was awarded a '0' mark. Thus, the total score secured by all individual respondents on 30 items for correct answers was the knowledge score. The scores obtained by 24 respondents were arranged in descending order and divided into six groups i.e. 4 respondents in each group. The groups were named as G1, G2, G3, G4, G5 and G6. The range of scores obtained by the respondents of six groups was as follows:

Table 1: Range of scores obtained by the respondents (n=24)

Group	Score range	No. of respondents
G1	25-23	4
G2	22-21	4
G3	20-17	4
G4	17-14	4
G5	13-11	4
G6	09-07	4

For item analysis, the middle two groups G3 and G4 were eliminated keeping four extreme groups with high and low scores. The data of the correct response for all the items in respect of these four groups were tabulated for calculating the difficulty and discrimination indices.

Calculation of difficulty index

The difficulty index of an item was defined as the proportion of respondents giving correct answers to that particular item. This was calculated by the formula:

$Pi = ni/Ni \times 100$

Pi = Difficulty index in % of the i^{th} item
ni = Total number of respondents giving the correct answer
Ni = Total number of respondents to whom the i^{th} item was administered

For example, in the first item given in Table 2, 08 respondents (ni) gave the correct answer and this schedule was administered to 24 respondents.

Thus, the difficulty index was calculated as $Pi = ni/Ni \times 100 = 08/24 \times 100 = 33.33$.

Calculation of discrimination index

The formula for the item discrimination index was calculated as given below. $(S1+S2) - (S5 + S6) / N/3 = E_{1/3}$. G1, G2, G5, and G6 indicated frequencies of correct answers given for the respective subgroup of respondents for an item in the test. In the first item given in Table 2, 1 respondent in the first group G1 were able to give the correct answer while 1 respondent answered it correctly in the second group G2. In the low groups, G5 and G6, 2 and 1 respondents respectively gave the correct answer. Thus, the discrimination index was calculated as $E_{1/3} = (S1+S2) - (S5 + S6) / N/3 = (1 + 1) - (2+ 1) = 24/3 = -0.125$.

Table 2: Item analysis of the test

Item No.	Interventions	Difficulty index	Discrimination index
	Natural Resource Management Interventions		
1	What is a conservation furrow method? *	37.50	-0.125
2	Mulching serves which of the following purpose?	62.50	0.375
3	What is the critical input for summer deep ploughing? *	75.00	0.125
4	Which of the following method is for cultivation in the slopy area.	37.50	0.750
5	What is the critical input for conservation tillage? *	0	0
6	Tillage affects which of the following?	33.33	0.750
7	Mention the crops for strengthening farm bunds	62.50	0.50
8	Describe minimum tillage	70.83	0.50
9	By which of the following methods, run-off water can be stored?	54.17	0.375
	Crop Production Interventions		
10	Which of the following crop is a drought tolerant variety	75.00	0.750
11	Which of the following is good for dry spell management? *	95.83	0.125
12	What are the integrated pest management techniques?	70.83	0.50
13	How is vermicompost made?	75.00	0.375
14	Why is crop diversification important?	70.83	0.375
15	Mention the category of fertilizer in which vermicompost is categorised?	58.33	0.875
16	Sticky trap (photograph)	54.17	0.375
17	Which of the following is a short duration variety of Paddy?	58.33	0.750
	Livestock interventions		
18	What are the fodder/feed storage methods?	54.17	0.875
19	UMMB (Urea Mollasses Mineral Block) bricks (photograph)	70.83	0.375
20	What are the steps in silage making?	66.67	0.50
21	How to assess the quality of fodder before feeding it to livestock?	66.67	0.375
22	Which of the following is good for deworming of livestock?	62.50	0.625
23	Why vaccination in livestock is necessary?	75.00	0.375
	Institutional interventions		
24	What is a certified seed?	75.00	0.50
25	What is a custom hiring centre (CHC)?	75.00	0.375
26	what is a seed production system? *	0	0
27	Seed production system recognizes how many generation systems? *	12.50	0.375
28	The colour of tag stitched on bag of certified seeds is *	0	0
29	Golden yellow tag is given to the breeder seed *	70.83	0.250
30	Seed drill (photograph)	37.50	0.625

Total item selected after item analysis

All important components of the TDC component of the NICRA project have been covered. The items were prepared in such a way that no important component was left out. Out of 30 items, 22 items were selected on the basis of difficulty index and discrimination index. Items with difficulty index scores ranging from 30 to 80 were selected for the knowledge test. Further, the items with a discrimination index score ranging from 0.30 to 0.80 were selected for the knowledge test. Finally, the item number 2, 4, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 30 were selected based on their respective difficulty index and discrimination indices.

Reliability of the Test

The reliability of the knowledge test was measured with the help of the split-half method. All the 22 items were divided into two halves with one set containing the odd items and the other set containing the even items. A single administration of the two sets of items to a sample of respondents, yields two sets of score. A positive and significant correlation between the two sets of scores indicate that the test is reliable. The formula used is as following:

$$r = [n(\Sigma xy) - \Sigma x \Sigma y] / \sqrt{[n(\Sigma x^2) - (\Sigma x)^2][n(\Sigma y^2) - (\Sigma y)^2]}$$

The co-efficient of correlation between two sets of scores was calculated and was found to be 0.76.

The reliability coefficient of the full test was worked out by using the Spearman-Brown formula:

r(full)= 2 r(half) / 1 + r(half), where r(full) = reliability coefficient of total test

It was found to be 0.86 indicating that the knowledge test is highly reliable.

Content Validity of the test

Content validity is performed in two steps: Content Validity Ratio (CVR) and Content Validity Index (CVI). Content Validity Ratio (CVR) according to the Lawshe is computed to specify whether an item is necessary for operating a construct in a set of items or not. For this, experts were selected based on their expertise and experience in the area of agricultural extension and climate change adaptation. The experts were asked to assign the items as "*essential" and "not essential"*. The formula for the computation of CVR:

CVR = (Ne – N / 2) / (N / 2), where, Ne is the number of experts indicating "essential" and N is the total number of experts.

The minimum critical values for CVR (Lawshe, 1975) [3]:

Number of judges	Minimum value
5	0.99
6	0.99
7	0.99
8	0.75
9	0.78
10	0.62

Since, 8 experts were involved to assess the validity of the test, the minimum value to retain an item is 0.75. The value of CVR values ranged from 0.25 to 1.00, however, the items having the value 0.75 and above were retained. Out of 22 statements, only 19 statements were retained. The item number 8, 15, and 24 were eliminated.

Table 3: Content Validity Ratio of the items constituting the test

Item No.	CVR
2	1
4	0.75
6	0.75
7	0.75
8	0.5
9	0.75
10	1
12	1
13	0.75
14	0.75
15	0.5
16	0.75
17	0.75
18	0.75
19	1
20	1
21	1
22	0.75
23	1
24	0.25
25	1
30	1

I-CVI (Item Content Validity Index)

For CVI, the panel of experts was asked to rate each scale item in terms of its relevance to the underlying construct. A 4-point scale was used to avoid a neutral point. The four points used along the item rating continuum were 1 = *not relevant*, 2 = *somewhat relevant*, 3 = *quite relevant*, and 4 = *highly relevant*.

The formula of I-CVI for each item

I-CVI = (number of experts giving a rating of 3 or 4) / (total number of experts)

The item content validity index (I-CVI) ranged from 0.63 to 1.0, the I-CVI value above 0.78 was considered fit or the instrument. Out of 19 statements, 18 were retained. Item number 14 was eliminated.

S-CVI (Scale Content Validity Index)

Scale-Content Validity Index (S-CVI) determines the stability of the scale/test as a whole. Formula of S-CVI is given below:

$S\text{-CVI} = \Sigma (\text{I-CVI}) / n$

Where, I-CVI is item content validity index and n is the total number of items

A commonly used threshold for an acceptable level of content validity is an S-CVI of 0.80 or higher. In the study, the scale content validity index (S-CVI) was wound to be 0.92. The instrument was assessed with high content validity. A total of 18 statements were finally retained.

Kappa statistic

It is a consensus index of interrater agreement that supplements CVI to ensure that the agreement among experts is beyond chance. Computation of Kappa Statistic requires the calculation of probability of chance agreement, that is, $Pc = [N! / A! (N – A)!] \times 0.5N$. In this formula, N = number of experts in the panel, and A = number of experts in the panel who agree that the item is relevant. Kappa statistic is then calculated as $K = (\text{I-CVI} – Pc) / (1 – Pc)$. Evaluation criteria for Kappa are that values above 0.74 is considered excellent, between 0.6 and 0.74 is considered good, and the ones between 0.4 and 0.59 is considered fair (Ansari and Khan, 2023) [1]. In the study, the Kappa was found to be 0.87-1.00 which is considered to be excellent.

Table 4: Content Validity Index and Kappa of the test

Item No.	I-CVI	Pc	K
2	1	0.00391	1
4	0.88	0.000001326	0.87
6	0.88	0.000001326	0.87
7	0.88	0.000001326	0.87
9	0.88	0.000001326	0.87
10	1	0.00391	1
12	1	0.00391	1
13	0.88	0.000001326	0.87
14	0.63	0.000005474	0.62
16	0.88	0.000001326	0.87
17	0.88	0.000001326	0.87
18	0.88	0.000001326	0.87
19	1	0.00391	1
20	1	0.00391	1
21	1	0.00391	1
22	0.88	0.000001326	0.87
23	0.88	0.00391	1
25	1	0.00391	1
30	1	0.00391	1
	S-CVI = 0.92		

The finally selected knowledge test items comprised eighteen (18) test items which contains four (4) multiple choice response, three (3) alternate response, three (3) identification from photographs, and eight (8) open response items.

Conclusion

In the present study, a knowledge test on the TDC of NICRA is developed and standardized. Item analysis provided a difficulty index and item discrimination index. Items with difficulty index scores from 30 to 80 and discrimination index scores from 0.30 to 0.80 were selected for the knowledge test. Additionally, the reliability of the test using the split-half method was found to be 0.76. The reliability coefficient of the full test was worked out by using the Spearman-Brown formula and was found to be

0.86 indicating that the knowledge test is highly reliable. Content validly was assessed by CVR (Content validity Ratio), CVI (Content Validity Index), and Kappa statistic. The item content validity index (I-CVI) ranged from 0.63 to 1.0, the I-CVI value above 0.78 was considered fit for the instrument. The scale content validity index (S-CVI) was 0.92. The instrument was assessed with high content validity. A total of 18 statements were finally retained. Overall, the test was highly reliable and valid.

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