Original Research Article

Development and Validation of a Scale Measuring the Attitude of farmerstowards Climate Smart Agriculture

Abstract

The measurement of attitudes is a critical endeavour in the realm of social and psychological research, enabling a deeper understanding of human behaviours, preferences, and beliefs. Constructing a reliable and valid scale to assess attitudes requires a systematic approach that encompasses various stages, such as conceptualization, item generation, scale refinement, pilot testing, psychometric analysis, and validation. A summated (Likert) rating scale was used to develop the scale. A total of 60 statements, consisting of 45 positive and 15 negative statements, were framed, of which 22 statements (19 positive and 3 negative) were retained in the final scale. The reliability of the scale was calculated by using the split-half method. The validity of the scale was tested by experts' judgment. The psychometric properties of the scale include: Pearson product moment correlation between two sets was 0. 0.598; reliability of the test 0.748(P<0.01) and Cronbach = 0.759, which means the scale is consistent in measurement.This scale can be used to measure the attitude of students in similar situations outside the study area with suitable modifications.

Key words: Attitude, climate smart agriculture, Agricultural Practices, Reliability.

INTRODUCTION

Agriculture plays an essential role in India's food security, nutrition management, creation of employment, and livelihood security. Agriculture employs more than 50 percent of the Indian population, while agriculture and its affiliated sectors account for 15.4 percent of the Indian GDP (OECD 2017). Climate change has been accountable for 75% of extreme hot days and 18% of days with heavy rainfall worldwide, which can be explained by warming since the industrialrevolution (Fischer and Knutti 2015). Climate change may have a greater impact on developing countries' agricultural capacity than on the global average, reducing the production capacity of agricultural resources in many parts of the world (Alexandratos and Bruinsma 2012).Countries use a wide range of context-specific climate-smart agriculture technologies and techniques to solve the difficulties in order to fulfill their climate change and food security goals. Climate smart agriculture (CSA) is a key and relatively new term in the present issue on climate change mitigation and adaptation (FAO 2017; IPCC 2019). The CSA concept was first described in a November 2009 FAO study titled "Food Security and Agricultural Mitigation in Developing Countries: Options for Capturing Synergies," which was revealed in November of that year at the Barcelona Climate Change workshop. At the 2010 Hague Conference on Food Security, Agriculture, and Climate Change, the United Nations Food and Agriculture Organization (FAO) established the term climate smart agriculture.Climate smart agriculture (CSA) was created with a strong focus on both current and future food security, including adaptation to climate change. CSA comprises techniques and developments that have the potential to achieve the "triple-win" of enhancing food security and family incomes, as well as adapting to and mitigating climate change (Campbell *et al.* 2014). CSA is committed to achieving internationally agreed-upon goals such as the SDGs and the Paris Agreement. CSA strives to achieve three key goals: increasing agricultural output and family incomes in a sustainable manner; adapting and creating flexibility or resistance to climate change; and decreasing and eliminating ozone-depleting compounds whenever possible (FAO 2021).

The usage or adoption behavior of any technology is mainly affected by people's attitudes towards it. Attitude can be defined as the degree of positive or negative effects associated with a psychological object (Thurstone 1929). The objective of the present study was to conceptualize climate smart agriculture (CSA) in the Central Plain zone of Uttar Pradesh. Measuring farmers' attitudes towards climate smart agriculture (CSA) will provide input to policymakers with information for desirable changes in the existing position of smart practices. Under many circumstances, researchers are unable to find an adequate scale to measure an important concept. In this type of situation, it is essential to develop a new scale that serves the purpose of this study. Considering the aforementioned circumstances, an attempt has been made to develop a scale that measures the attitudes of farmers towards climate smart agriculture in Uttar Pradesh.

MATERIALS AND METHODS

In this context, a schedule was developed to assess farmers' attitudes toward climate smart agriculture. Attitude is a predisposition or tendency to respond positively or negatively to a certain idea, object, person, or condition. The response may also be directed at psychological items, such as smart practices, and farmers' level of favorable or adverse sensations may be determined. To develop the attitude scale, the Likert method of the summated rating scale (1932) was used, as it offers possibilities to select statements based on their discriminative power. The methodological procedures for Likert's methods of the summated rating scale (1932) for measuring the attitude of farmers towards climate smart agricultural practices are discussed below. Similar methods were employed by Mukherjee *et al.* (2018).

Defining the construct:A construct is a concept that has been deliberately and consciously invented or adopted for a specific scientific purpose, filled with added meaning (Kerlinger 1973). A proposed attribute of a person that cannot be measured directly, but can be inferred through various indicators or manifest variables is known as the construct. In this study, the focus was on assessing the attitudes of farmers towards climate-smart agriculture.

Collection and items: Statements that comprise the attitude scale are known as items. To develop a scale, start by compiling a list of statements from various sources, such as books, bulletins, newspaper articles, journals, and consulting experts and researchers in the field. A tentative list of 60 statements consisting of 45 positive and 15 negative statements was drafted, keeping in mind the applicability or items suited to the area of the study.

Editing of statements: The statements were carefully edited according to the criteria given by Likert (1932) and Edwards (1957). The utmost care was taken in the editing of statements so that it could measure what is intended to measure. Statements that were ambiguous, irrelevant, or not suited to the suggested criteria were discarded. Of these 60 statements, 15 statements were eliminated. The remaining 45 statements (33 positive and 12 negative) were included in the proforma. These statements were framed such that they expressed positive or negative attitudes.

RESULTS AND DISCUSSION

Relevancy test of statements:The collected statements were scrutinized by a panel of experts to determine their relevancy and screening for inclusion in the final scale. Finally, 45 statements on a three-point continuum, viz., Highly relevant, Relevant and Least relevant with scores of 3, 2, and 1, respectively, and reverse scoring for the negative statements were sent by Google form survey and individually handed over to a total of 80 judges. These judges comprised scientists from SAUs, ICAR Research Institutions, Subject Matter Specialists from KVKs, Agriculture officers, and experts in the field of extension education professionals.Everyone was requested to critically examine and evaluate each statement for its relevance and to make any necessary changes, additions, or deletions of statements, if desired. A total of 39 experts or judges' responses out of 80 were considered for the analysis of relevance weight and mean relevance score. After the analysis, the statements were rewritten in light of the criticism and comments of the experts. The Relevancy Weightage (RW) and Mean Relevancy Score (MRS) for each given indicator were calculated independently using the following formula:

$$\text{Relevancy Weightage (RW)} = \frac{(\text{Highly relevant X 3}) + (\text{Relevant X 2}) + (\text{Least Relevant X 1})}{\text{Maximum Possible Score}}$$

$$\text{Mean Relevancy Score (MRS)} = \frac{(\text{Highly relevant X 3}) + (\text{Relevant X 2}) + (\text{Least Relevant X 1})}{\text{Number of judges}}$$

The calculated value of RW was in the range of 0.487–0.923. Statements with a relevancy weightage of more than 0.74 were selected. The calculated value of MRS was found to be in the range of 1.461 to 2.717, and MRS ≥ 2.25 or more was selected for item analysis. Consequently, 31 statements were selected for item analysis.

Table 1: Statements with calculated RV and MRS Values

S.No.	Statements	RV	MRS
1.	Climate-smart farming aids in the fight against climate change.	0.829	2.487
2.	Agro-Advisory does not provide weather-related information.	0.589	1.769
3.	Awareness of meteorological events allows farmers to	0.923	2.769

	produce more suitable crops.		
4.	Adaptation measures include growing drought-resistant varieties, expanding the crop selection, spraying more pesticides, and adding fertilizer.	0.752	2.256
5.	Changes in weather conditions under climate change affect farmer choices and outcomes.	0.811	2.435
6.	Climate Smart Agricultural practices increases the soil erosion.	0.641	1.92
7.	Climate change adaptation is made possible through the creation of new varieties of crops and production techniques.	0.871	2.615
8.	Climate-smart agriculture contributes to better resource management and enhancement.	0.905	2.717
9.	Crop insurance can be a good way to cope with increased risk.	0.863	2.589
10.	Farmers are not able to use weather forecasts to manage crops.	0.658	1.974
11.	Climate change is predicted by past experiences.	0.752	2.256
12.	Crop residues added to the soil have a negative impact on its properties.	0.487	1.461
13.	Climate Smart Agriculture ensures sustainable agriculture.	0.743	2.230
14.	Diversification of crops and varietals can be a successful adaptation strategy in response to Smart Agricultural practices.	0.854	2.564
15.	Climate Smart Agriculture technologies and practices may take a long time to reap the benefits.	0.743	2.230
16.	Climate Smart Agricultural practices increase the production cost of vegetables.	0.666	2.00
17.	Drip irrigation systems are expensive to install.	0.794	2.384
18.	Climate Smart Agriculture positively influences the quality	0.794	2.384

	of agricultural products.		
19.	Early weather knowledge aids in reducing the risk associated with crop cultivation.	0.854	2.564
20.	The price of cultivation rises due to integrated pest management	0.675	2.025
21.	Effective use of pesticides is made easier by integrated pest management.	0.811	2.435
22.	Improved communication and localized extension services enhance the adoption of smart farming practices	0.820	2.461
23.	Important CSA practices are developed for location-specific solutions.	0.752	2.256
24.	Labour costs are increased through CSA techniques.	0.632	1.897
25.	Information regarding weather forecasts can be obtained through a mobile weather app.	0.786	2.358
26.	Natural resources are preserved through climate-smart agriculture.	0.760	2.282
27.	Proper land use management and pest control management are improved due to CSA.	0.666	2.00
28.	Nutrient application at specific locations is costly.	0.743	2.230
29.	Rural women are more susceptible to the effects of climate change because they have less access to and control over resources.	0.683	2.051
30.	Solar energy use in agricultural operations reduces negative environmental impacts.	0.777	2.333
31.	The availability of nitrogen in the soil cannot be increased when legumes are grown.	0.837	2.512
32.	Temperature and rainfall variations will impact pest occurrence and virulence on main crops.	0.794	2.384
33.	The cost of cultivation is increased by mulching.	0.623	1.871

34.	The development of CSA tech1logies requires the involvement of the public and private sectors as well as development partners.	0.760	2.282
35.	The effects of climate change on agriculture vary over time and space.	0.752	2.256
36.	The use of CSA methods helps to maintain an optimal level of irrigation.	0.709	2.128
37.	The practice of multiple cropping increases farmer risk.	0.589	1.769
38.	There isno need to increase youth participation in CSA.	0.803	2.410
39.	Traditional varieties of crops are more resilient to climatic change and environmental stress because they are better matched to local conditions.	0.794	2.384
40.	The use of a drip irrigation system helps conserve water.	0.794	2.384
41.	Income insecurity comes from agricultural diversification.	0.692	2.076
42.	Traditional varieties of crops cost little and are easy to obtain.	0.760	2.282
43.	Indigenous Indian cattle breeds have more resilient to regional threats like parasites and disease, and heat stress.	0.837	2.512
44.	Small and marginal farmers are not considered as the vulnerable community to the effects of climate change	0.777	2.333
45.	Solarisation promotes soil-borne diseases.	0.487	1.461

Item analysis (calculation of 't' value):The objective of an item analysis is to find items that form an internally consistent scale and to eliminate those that do not (Spector 1992). Item analysis provides information on how well each item relates to the other items in the analysis. The selected 31 statements were administered to 40 farmers from different villages in non-sample areas. These respondents were asked to rate their degree of favorableness/unfavorableness on five-point continuums with each statement: Strongly agree, Agree, Undecided, Disagree, and Strongly disagree with scores of 5,4,3,2 and 1, respectively, for positive statements and reverse scoring for each negative statement. The total score for each respondent was computed by summing the scores of all statements. For each respondent, the maximum attainable score for 31 statements was 155 and the minimum was 31. The total individual scores of the respondents were arranged in descending order. The upper and lower 25% of the judges, that is, 10 non-sample area farmers with the highest total score and 10 non-sample area farmers with the lowest total score, were selected. The critical ratio, which is the t-value, is a measure of the extent to which a given statement differentiates between the high and low groups of respondents for each statement, and was calculated using the formula given by Edwards (1957).

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

Where, $\sum(X_H - \bar{X}_H)^2 = \sum(X_H)^2 - \frac{(\sum X_H)^2}{n}$ and $\sum(X_L - \bar{X}_L)^2 = \sum(X_L)^2 - \frac{(\sum X_L)^2}{n}$

t = t value of particular statement

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

$\bar{X}_L$= Mean score on given statement of the low group

$\Sigma(X_H)^2$= Sum of squares of the individual score on a given statement for high group

-$\Sigma(X_L)^2$= Sum of squares of the individual score on a given statement for low group

ΣX_H =Summation of scores on given statement for high group

ΣX_L = Summation of scores on given statement for low group

n= Number of respondents in each group

$\sum$ = Summation

Table 2: Calculation of 't' value for evaluating the difference in the mean response to an attitude statement by a high group and a low group

Sample statement	Response category	Low group				High group			
		X	**F**	**Fx**	**fx²**	**X**	**f**	**fx**	**fx²**
	Strongly agree	5	1	5	25	5	5	25	125
	Agree	4	6	24	96	4	4	16	64

	Undecided	3	1	3	9	3	1	3	9
	Disagree	2	2	4	8	2	0	0	0
	Strongly disagree	1	0	0	0	1	0	0	0
		$\sum$	10	36	138	$\sum$	10	44	198
			n_L	$\sum X_L$	$\sum X_L^2$		n_H	$\sum X_H$	$\sum X_H^2$

Where, X = Score assigned to the response category; f = Frequency

$$\bar{X}_L = \frac{\sum X_L}{n_L} = \frac{36}{10} = 3.6, \qquad \bar{X}_H = \frac{\sum X_H}{n_H} = \frac{44}{10} = 4.4$$

$$\sum(X_H - \bar{X}_H)^2 = \sum(X_H)^2 - \frac{(\sum X_H)^2}{n} = 198 - \frac{(44)^2}{10} = 4.4$$

$$\sum(X_L - \bar{X}_L)^2 = \sum(X_L)^2 - \frac{(\sum X_L)^2}{n} = 138 - \frac{(36)^2}{10} = 8.4$$

$$t = \frac{4.4 - 3.6}{\sqrt{\frac{4.4+8.4}{10(10-1)}}} = \frac{0.8}{0.37} = 2.16$$

Final selection of item:The critical ratio ('t'-value) of relevant statements was determined for the final selection of items. The calculated‘t’ value of statements was found to be distributed between 0.46 and 5.80. Later, statements with a ‘t’ value equal to or greater than 1.75 were selected (Table 3) for the attitude scale, as this‘t’ value significantly differentiated between high and low groups of items. In this way, a total of 22 statements (19 positive and 3 negative) were included in the final scale for assessing farmers' attitudes toward climate smart agriculture.

Table 3:Final selected attitudewith their respective ‘t’ value

S.No.	Statements	t-value	Decision
1.	Climate-smart farming aids in the fight against climate change.	2.75	Selected
2.	Awareness of meteorological events allows farmers to produce more suitable crops.	3.21	Selected

3.	Adaptation measures include growing drought-resistant varieties, expanding the crop selection, spraying more pesticides, and adding fertilizer.	0.98	Rejected
4.	Changes in weather conditions under climate change affect farmer choices and outcomes.	3.66	Selected
5.	Climate change adaptation is made possible through the creation of new varieties of crops and production techniques.	2.05	Selected
6.	Climate-smart agriculture contributes to better resource management and enhancement.	1.74(1.96)	Rejected
7.	Crop insurance cannot be a good way to cope with increased risk.	1.76	Selected
8.	Climate change is predicted by past experiences.	3.21	Selected
9.	Climate Smart Agriculture ensures sustainable agriculture.	0.80	Rejected
10.	Diversification of crops and varietals can be a successful adaptation strategy in response to Smart Agricultural practices.	3.21	Selected
11.	Climate Smart Agriculture technologies and practices may take a long time to reap the benefits.	0.80	Rejected
12.	Drip irrigation systems are expensive to install.	2.05	Selected
13.	Climate Smart Agriculture positively influences the quality of agricultural products.	0.80	Rejected
14.	Early weather knowledge aids in reducing the risk associated with crop cultivation.	3.66	Selected
15.	Effective use of pesticides is made easier by integrated pest management.	3.25	Selected
16.	Improved communication and localized extension services enhance the adoption of smart farming practices	3.03	Selected
17.	Important CSA practices are developed for location-specific solutions.	2.38	Selected
18.	Information regarding weather forecasts can be obtained through a mobile weather app.	1.25	Rejected
19.	Natural resources are preserved through climate-smart	1.25	Rejected

	agriculture.		
20.	Nutrient application at specific locations is costly.	4.14	Selected
21.	Solar energy use in agricultural operations reduces negative environmental impacts.	3.66	Selected
22.	The availability of nitrogen in the soil cannot be increased when legumes are grown.	1.35	Rejected
23.	Temperature and rainfall variations will impact pest occurrence and virulence on main crops.	3.80	Selected
24.	The development of CSA technologies requires the involvement of the public and private sectors as well as development partners.	5.80	Selected
25.	The effects of climate change on agriculture vary over time and space.	3.80	Selected
26.	There isno need to increase youth participation in CSA.	2.74	Selected
27.	Traditional varieties of crops are more resilient to climatic change and environmental stress because they are better matched to local conditions.	3.65	Selected
28.	The use of a drip irrigation system helps conserve water.	3.22	Selected
29.	Traditional varieties of crops cost little and are easy to obtain.	4.00	Selected
30.	Indige1us Indian cattle breeds have more resilient to regional threats like parasites and disease, and heat stress.	2.20	Selected
31.	Small and marginal farmers are not considered as the vulnerable community to the effects of climate change	0.46	Rejected

Standardization of the scale: To ensure reliability and validity, the current scale was standardized utilizing the split-half approach and content validity.

Reliability of scale*:*Reliability refers to the ability of a scale to consistently measure an attribute and how well the items fit together conceptually (Haladyna 1999; De Von *et al*. 2007). The split-half method was employedto test the reliability of the scale. The 22 statements were divided into two sets, with 11 odd-numbered statements in one half and 11 even-numbered statements in the other. These two sets of statements were administered on a five-point continuum (Strongly agree, Agree, Undecided, Disagree and Strongly disagree) to a group of 40 farmers. Scoring was done for positive statements as 5, 4, 3, 2, 1, and for negative statements as 1, 2, 3, 4,5, respectively. The Pearson product moment correlation between two sets was 0.598.This coefficient indicates the split-half method of reliability of scale. To adjust the split-half reliability to full test reliability, the Spearman-Brown (1910) prophecy formula was used, which is as follows:

$$R = \frac{2r}{1+r} = \frac{2 \times 0.598}{(1+0.598)} = 0.748$$

Where, R= Reliability coefficient of the whole scale

r = Estimated correlation between two halves (Pearson r)

The reliability of the test was determined to be 0.748(P<0.01). The main limitation of the split-half method has been that it does not provide the same information as the correlation between two forms given at different times (Cronbach, 1946). In order to overcome the above problem, Cronbach's alpha, which is interpreted by many researchers as the average of all possible split-half correlations (Cortina 1993), Cronbach's alpha also assumes that the average covariance among non-parallel items is equal to the average covariance among all parallel items. Thus, in the present study, standardized Cronbach's alpha was also used to achieve more stability and accuracy utilizing the following formula:

$$\text{standardized} = \frac{\text{Kr}}{[1+(\text{K}-1)\text{r}]}$$

Where, K = Number of statements in scale

r = Mean of the K (K-1)/2 non-redundant correlation coefficients

In Excel and SPSS, the split-half reliability coefficient was determined using Cronbach's alpha. Cronbach's alpha was calculated and found to be 0.759, indicating that the scale is consistent in measurement.

Content validity of scale:Content validity involves systematic examination of the test content to determine whether it covers a representative sample of the behavior domain to be measured (Anastasi 1968). It allows the instrument to be used to make relevant and acceptableinferences and/or decisions from the instrument score given the assessment purpose (Messick 1989 and Moss 1995). As the content of the attitude towards climate smart agriculture was thoroughly covered through various literature, expert advice, judges' comments, and so on, and the suggestions of the experts were included in the scale, it was expected that the present scale satisfied the content validity. As the scale value difference for almost all the statements included had a very high discriminating value, it seemed fair to accept the scale as a valid and genuine measure of attitude.As a result, this scale indicates a reasonable level of content validity. Finally, 22 statements were chosen to determine farmers' attitudes regarding climate smart agriculture, and they were presented in such a way that both positive and negative responses appeared at random to avoid biased responses.

Administration and scoring of attitude scale:The final scale consisted of 22 statements. These statements can be administered on a five-point continuum as followed by Likert (1932) viz., strongly agree, agree, undecided, disagree, and strongly disagree, with a score of 5, 4, 3, 2, and 1, respectively, for positive statements and reverse scoring for negative statements. Therefore, the overall possible attitude score of the individual respondent towards climate smart agriculture could range from 22 to 110. The high score on the scale will represent the favourable attitude of farmers towards smart practices. Attitude is a multifaceted component of personality, beliefs, values, behaviours, and motivations. It plays a vital role in providing internal cognitions, beliefs, and thoughts about people and objects and helps us to behave in a particular way toward an object or person.

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