A Scale to Measure Farmers' Perception towards Climate Vulnerability

Varsha Shrivasatava [a*#]

[a] *ICAR-ATARI, Zone-IX, Jabalpur, India.*

Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

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ABSTRACT

Perception is influenced by various factors such as attitude, knowledge, information, socio-cultural factors, and previous experience. To understand human behavior, it is necessary to understand the process of perception. The farming community may not have knowledge about the reasons for climate vulnerability but they can understand and realize the consequence of it. Agriculture is susceptible to climate vulnerability through increased temperature and changes in rainfall patterns. These factors affect germination, plant growth, grain development, and maturity in turn productivity. Increased temperature creates heat stress on crops and this adversely affects the production of crops. While the uneven distribution of rainfall creates drier or waterlogged conditions for crops that hampered the growth of crops. In this direction, the research was designed to develop a scale to measure farmers' perception of climate vulnerability. A list of 62 statements indicating the positive or negative perception was considered for scale construction. The statements were edited in light of the informal criteria suggested by Edwards. The total individual score of judges was calculated by summing up the weights given by judges to the individual states. Based on total individual scores, 25 percent of judges with the highest total individual scores and 25 percent of judges with lowest total individual scores were taken assuming that these groups provided criterion groups in terms of high and low evaluated by the individual states. Item analysis is done by the 't' value for each statement using the formula and procedure given by Edwards. Finally, 52 statements that had a 't' value of 1.75 and above qualified for inclusion in the scale.

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[#] *Research Associate,*
Corresponding author: E-mail: varshashrivastavagdr@gmail.com;

1. INTRODUCTION

Climate change is already a hard reality at the global level. Its impact on agricultural activities in developing countries has increased dramatically. According to Intergovernmental Panel on Climate Change (IPCC) report, the United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as a change in climate which is attributed directly or indirectly to human activity that alters the composition of the global and/or regional atmosphere and which is in addition to natural climate variability observed over comparable time periods [1]. The Intergovernmental Panel on Climate Change [1] has projected that by 2100 atmospheric concentrations of carbon dioxide could have reached between 540 ppm and 970 ppm and that; as a result, global surface temperature could rise by between 1.4°C and 5.8^0C. In India agriculture matters first and foremost, not least because the farmer holds a special place in Indian hearts and minds. Developing countries like India are most vulnerable to climate change and variability [2]. From an economic point of view, Indian agriculture accounts for 16 percent of GDP [3], thus agriculture plays important role in the social and economic life of people in India. The Increasing climatic vulnerability to global warming has seasonal/annual fluctuations in food production. Nageswararao *et* al. [4] studied the impact of variability in climatic conditions on productivity of Rabi season crops in the northwest part of India by finding the correlation between the variables and the crop yield. Rabi crops are known as winter crops. They are grown in October or November. The crops are then harvested in spring. Droughts, floods, tropical cyclones, heavy precipitation events, hot extremes, and heat waves have a negative impact on agricultural production and farmers' livelihood. An increase in CO_2 to 550 ppm increases the yield of rice, wheat, pulses, and oilseeds by 10-20%. A 1°C increase in temperature may reduce the yield of wheat, soybean, and mustard by 3-7% [5]. Losses will be more with an increase in temperature. The productivity of most crops decreases only marginally by 2020 but by 2100 it will be 10-40 percent due to an increase in temperature and rainfall as well as a decrease in irrigation water [6].

Concentrated efforts need to fulfill the need of the growing population and stabilize output and income, agriculture system must become more resilient i.e., more capable of performing well in the face of disruptive events. Effective adaptation and mitigation are required to cope with climate change [7] can be effective when farmers perceive climate vulnerability in a better way. Any coping strategies or adaptation measures toward climate change will be formulated on the basis of the farmers' interest at the grass root level.

Perception provides better insights and information relevant to the environment and based on experience. Perception is the way in which people was perceives things that define character and attitude. It represents our understanding of a present situation on the basis of our past experiences. The perception of the farmers gives information about the climate vulnerability and is driven by multiple forces.

Understanding farmers' perceptions about climate vulnerability can contribute to informing scientific and policy discussions on climate change. Hence, the present study was designed to develop and standardize a scale for measuring farmers' perception of climate vulnerability which would bring about an understanding of farmers' experience with climate vulnerability.

2. MATERIALS AND METHODS

Perception is the process of receiving information or stimuli from our environment and transforming it into psychological awareness [8]. According to Ray [9], perception is selective and perceives what one wants to perceive, this happens because before one perceives stimuli, he needs to give attention to the stimuli. Perception in this study was operationalized as the degree to which information or idea is perceived by the farmers about climate vulnerability. A psychometric scale was developed to measure the perception of the farmers toward climate vulnerability. The method of summated rating suggested by Likert [10] was followed in the development of the scale and was tested for reliability and validity. The following steps were considered for measuring the perception of farmers towards climate vulnerability.

2.1 Collection of Statements

The first step in the construction of the perception scale is to collect statements related to the perception of climate vulnerability. A tentative list of 75 statements was collected in relevance to the subject through consultation with Extension experts, Agricultural scientists, and available literature.

2.2 Editing of Statements

These statements were edited as per the "informal criteria of Edwards and Kilpatrick, 1948" [11,12]. Statements that were overlapping in meaning or content, and irrelevant to the local condition were rejected. Out of 75 statements, 62 statements were retained after editing. Further, these statements were evaluated by the concerned experts/scientists for the suitability of the items.

2.3 Response to Selected Statements

The proforma containing raw statements were mailed electronically and also handed over personally to a total of 150 judges. These judges were experts in the field of Extension Education from various Agricultural Universities and Institutes. The responses of judges were obtained on a three-point continuum i.e. most relevant, relevant, and not relevant. The judges were requested to make necessary modifications and additions or deletions if desired so. Out of 150 judges, only 62 judges had returned the statements after duly recording their judgments in a stipulated span of 3 months and were considered for the item analysis.

2.4 Item Analysis

Item analysis is an important step while constructing a valid and reliable scale. The total individual judges' score was calculated by summing up the score of each statement given by the individual judge.

2.5 Calculation of 't' Values

The 't' value equal to 1.75 or more than is the thumb rule for selecting statements. Basically 't' test finds the differences in the mean score for each statement between the high and low groups selected for the scale [13]. Based on the total individual scores, the judges were arranged in descending order. The top 25 percent of judges with their total individual scores were considered as the high group and the bottom 25 percent as the low group so these two groups provided criterion groups in terms of evaluating the

individual statements. With the help of these criterion groups, 't' values were calculated for each statement of the proforma by using the under-mentioned formula [10]. Thus, out of 62 judges to whom the statements were administered for the item analysis, 16 judges with highest and 16 judges with lowest scores were used as criterion groups to evaluate individual statements.

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

Where

t	=	the extent to which a given statement differentiates between the high and low groups,
$\overline{X}_H$	=	the mean score on a given statement for the high group,
$\overline{X}_L$	=	the mean score on a given statement for the low group,
$\sum(X_H - \overline{X}_H)^2$	=	The variance of the distribution of responses of the high group to the statements,
$\sum(X_L - \overline{X}_L)^2$	=	The variance of the distribution of responses of the low group to the statements, and
n	=	number of subjects in the low or high group

2.6 Final Selection of the Statements

The 't' value is a measure of the extent to which a given statement differentiates between the high score and low score groups. The 't' value equal to or greater than 1.75 were selected, finally for inclusion in the perception scale.

2.7 Reliability of Scale

A scale is reliable when it gives consistently the same results when applied to the same sample. The final set of the 52 statements which represents the perception of the farmers towards climate vulnerability, was administered on a five continuum basis to a fresh group of 20 farmers, which were not included in the actual sample. The designed perception scale for the study was pre-tested for its reliability by using the split-half technique. Reliability was calculated by using the mentioned Formula [14,15].

$$r_{SB} = \frac{2r_{hh}}{1 + r_{hh}} \quad (2)$$

Where,

r_{hh} = Pearson correlation between odd and even

Table 1. Standardized scale to measure the perception of the farmers' towards climate vulnerability

S.No.	Statements	t value
(A)	**Perception towards climate events**	
1.	There is an increase in environmental temperature	4.648*
2.	There is a decrease in environmental temperature	1.704
3.	There is no change in environmental temperature	1.016
4.	I experienced scorching sunshine	5.208*
5.	Sunshine is not scorching	0.698
6.	I observed that the number of rainy days (>2.5mm) is more	1.698
7.	I observed that the number of rainy days (>2.5mm) is less	1.968*
8.	There is no change in the number of rainy days	0.739
9.	I observed that the amount of rainfall is less	1.754*
10.	Uneven distribution of rainfall during the cropping season	2.460*
11.	Late onset of monsoon in my region	2.257*
12.	Early withdrawal of monsoon during the cropping season	1.623
13.	There is a long dry spell during the cropping season	2.380*
14.	The unpredictability of rainfall in my region	3.384*
15.	The occurrence of the drought was frequent	3.411*
16.	Floods are occurring frequently in my region	1.589
17.	There is an increasing incidence of strong wind	3.417*
18.	Hailstorm is common in the rabi season	3.904*
19.	Winter has become colder and rainier	4.201*
20.	The summer season is widened	4.362*
21.	Rabi season is shortened	4.261*
(B)	**Perception of the causes of climate change**	
22.	Climate change is the punishment of God for ill-treatment of nature by human beings	0.823
23.	Ancestral spirits are responsible for climate change	1.358
24.	Deforestation is the prime cause of climate change	2.244*
25.	Continuous cropping makes changes in climate events	4.441*
26.	Overgrazing is a reason for climate change	7.376*
27.	Excess use of agrochemicals in farms may emit greenhouse gases responsible for global warming	5.650*
28.	Urbanization is responsible for climate change	3.742*
29.	Climate change is a natural phenomenon	2.147*
30.	There is no role of human activity in climate vulnerability (-)	4.580*
(C)	**Perception of the impact of climate vulnerability in agriculture**	
31.	Weather variation makes farm operations more difficult	2.668*
32.	There is more incidence of insects and pests	4.491*
33.	There is more incidence of plant diseases	4.897*
34.	Climate change affects weed infestation in the field	4.716*
35.	Climate change affects the crop maturity	4.301*
36.	Climate change reduces crop yield	4.293*
37.	Climate change reduces the grain quality of the crops	2.100*
38.	Climate change affects the post-harvest management of crops.	4.261*
39.	There is a fall in the groundwater level	5.184*
40.	Sometimes a complete failure of crops on my farm due to climate vulnerability	4.032*
41.	There are more incidences of animal diseases.	4.620*
(D)	**Climate risk perception**	
42.	Extreme weather events will happen more frequently in the future.	7.550*
43.	New insect pests may arise due to climate change	8.518*
44.	New weed species may occur in farms due to climate change	8.081*
45.	New plant diseases may arrive in farms due to climate change	5.644*
46.	Adaptation measures to climate change may increase the cost of cultivation	3.019*
47.	Climate change may affect the crop yield on my farm	5.848*

S.No.	Statements	t value
48.	Climate change may reduce the grain quality	4.401*
49.	Climate change may have potential impacts on agriculture	3.177*
50.	Climate change may have a potential impact on the human system	2.441*
(E)	**The overall perception of the farmers towards climate vulnerability**	
51.	Climate effects are extreme and notable	2.705*
52.	There is no change in climate in my region (-)	1.678
53.	There is variation in summer temperature	6.253*
54.	There is variation in winter temperature	5.681*
55.	Erratic distribution of rainfall during the crop growth period	3.109*
56.	Cropping season is changing in my village due to climate vulnerability	3.886*
57.	Degradation and unsuitability of land for cultivation	2.737*
58.	Climate vulnerability is affecting my farming	7.080*
59.	Climate change increases food insecurity	3.733*
60.	The critical crop growth stage is highly vulnerable to weather variability	1.973*
61.	Climate vulnerability forces the migration of village people to urban area	3.886*
62.	My standard of living will improve due to climate vulnerability (-)	3.255*

statements selected for scale

The coefficient of correlation between odd and even scores was 0.82 found to be significant at a 1 percent level of significance. It showed that scale is reliable.

2.8 Validity of Scale

Validity of scale is the property that ensures the obtained test score is valid, if and only if it measures what it is supposed to measure. A scale is said to be valid if it stands for one's reasoning.

The content validity of the scale was tested. The content validity is the representative or sampling adequacy of the content, the substance, the matter, and the topics of a measuring instrument. This method was used in the present scale to determine the content validity of the scale. As the content of the perception thoroughly covered the entire universe of climate vulnerability through literature and expert opinion, it was assumed 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 reasonable to accept the scale as a valid measure of the desired dimension.

3. RESULTS AND DISCUSSION

The final scale consisting of 52 statements can be administered to the farmers on a five-point continuum viz., Strongly Agree (SA), Agree (A), Undecided (UD), Disagree (D), and Strongly Disagree (SD) with a weightage of 5,4,3,2 and 1 for positive statements and reverse scoring system for negative statements. The overall possible maximum and minimum score ranges from 260 to 52 (Table 2).

Table 2. The final perception scale comprising 52 statements

S. no.	Statements	Responses				
		SA	A	UD	D	SD
(A)	**Perception towards climate events**					
1.	There is an increase in environmental temperature					
2.	I experienced scorching sunshine					
3.	I observed that the number of rainy days (>2.5mm) is less					
4.	I observed that the amount of rainfall is less					
5.	Uneven distribution of rainfall during the cropping season					
6.	Late onset of monsoon in my region					
7.	There is a long dry spell during the cropping season					
8.	The unpredictability of rainfall in my region					
9.	The occurrence of the drought was frequent					
10.	There is an increasing incidence of strong wind					
11.	Hailstorm is common in the rabi season					
12.	Winter has become colder and rainier					

S. no.	Statements	Responses				
		SA	A	UD	D	SD
13.	The summer season is widened					
14.	Rabi season is shortened					
(B)	**Perception of the causes of climate change**					
15.	Deforestation is the prime cause of climate change					
16.	Continuous cropping makes changes in climate events					
17.	Overgrazing is a reason for climate change					
18.	Excess use of agrochemicals in farms may emit greenhouse gases responsible for global warming					
19.	Urbanization is responsible for climate change					
20.	Climate change is a natural phenomenon					
21.	There is no role of human activity in climate vulnerability (-)					
(C)	**Perception of the impact of climate vulnerability in agriculture**					
22.	Weather variation makes farm operations more difficult					
23.	There is more incidence of insects and pests					
24.	There is more incidence of plant diseases					
25.	Climate change affects weed infestation in the field					
26.	Climate change affects the crop maturity					
27.	Climate change reduces crop yield					
28.	Climate change reduces the grain quality of the crops					
29.	Climate change affects the post-harvest management of crops.					
30.	There is a fall in the groundwater level					
31.	Sometimes the complete failure of crops on my farm due to climate vulnerability					
32.	There are more incidences of animal diseases.					
(D)	**Climate risk perception**					
33.	Extreme weather events will happen more frequently in the future.					
34.	New insect pests may arise due to climate change					
35.	New weed species may occur on farm due to climate change					
36.	New plant diseases may arrive in farms due to climate change					
37.	Adaptation measures to climate change may increase the cost of cultivation					
38.	Climate change may affect the crop yield on my farm					
39.	Climate change may reduce the grain quality					
40.	Climate change may have potential impacts on agriculture					
41.	Climate change may have a potential impact on the human system					
(E)	**The overall perception of the farmers towards climate vulnerability**					
42.	Climate effects are extreme and notable					
43.	There is variation in summer temperature					
44.	There is variation in winter temperature					
45.	Erratic distribution of rainfall during the crop growth period					
46.	Cropping season is changing in my village due to climate vulnerability					
47.	Degradation and unsuitability of land for cultivation					
48.	Climate vulnerability is affecting my farming					
49.	Climate change increases food insecurity					
50.	The critical crop growth stage is highly vulnerable to weather variability					
51.	Climate vulnerability forces the migration of village people to urban area					
52.	My standard of living will improve due to climate vulnerability (-)					

4. CONCLUSION

Effective adaptation towards climate vulnerability mainly depends upon when farmers were able to understand climate change and vulnerability which in turn is reflected by their perception of it. Hence, a scale to measure the perception of farmers toward climate vulnerability has been presented in this paper. This scale can be used with suitable modification by future researchers to measure the perception of farmers towards climate vulnerability.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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