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Scale to analyse the vulnerability level of farmers to climate change in Telangana state

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Abstract

An attempt is made in the present study to develop and standardize scale to analyze the vulnerability level of farmers to climate change in Telangana state. The developed vulnerability scale found to be highly reliable and valid. The vulnerability scale consists of 89 statements classified as It depends on extent of farmers' Exposure to climate change (rainfall &temperature), their level of Sensitivity, Perception towards climate change, Attitude towards climate change, Egalitarianism: (The developed perception scale was administered to 32 farmers in Medchal District of Telangana state during 2023-24. The results revealed that a vast majority of the respondents (81.24%) had high vulnerability level to moderate vulnerability level towards climate change whereas less than one fourth (18.76%) are less vulnerable to climate change.

Keywords: Vulnerability, climate change, exposure, sensitivity, farmers

Introduction

Climate change and agriculture are interrelated processes, both of which take place on a global scale. Climate change affects agriculture in a number of ways, including changes in average temperature, rainfall and climate extremes, changes in pests and diseases, changes in atmospheric carbon dioxide and ground-level ozone concentrations and changes in sea level. The average global annual temperature has risen by approximately 0.4 to 0.7 °C (Singh, 2008) [1], marking a notably rapid change in ecological terms. Lal (2001) [2] noted that the annual mean area-averaged surface warming across the Indian subcontinent is projected to range between 3.5 and 5.5 °C by 2080. This projection suggests a greater degree of warming during the winter season compared to the summer season. The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2007) [3] documents observed trends towards stronger storms and prolonged, hotter dry periods. Scientists analyzing daily rainfall data have demonstrated two key findings for central India from 1951 to 2000: (i) an increasing trend in the frequency of heavy rain events and (ii) a notable decrease in the frequency of moderate events (Prasad *et al*., 2007) [4]. The impacts of climate change are global, but countries like India are more vulnerable in view of the high population depending on agriculture.

Climate change has the potential to affect various sectors, with farmers emerging as a particularly vulnerable group. Given India's heavy reliance on agriculture and natural resources, the country is especially susceptible. Projections for medium-term (2010-2039) climate change suggest significant negative impacts, with yield reductions estimated between 4.5 to 9.0 percent, contingent upon the extent and distribution of warming. As agriculture contributes approximately 16 percent to India's GDP, a 4.5 to 9.0 percent decline in production implies a climate change-related cost of up to 1.5 percent of GDP annually (Anonymous, 2019a) [5].

India's agrarian economy is heavily reliant on the monsoon's onset and subsequent behavior throughout the year. The year 2002 serves as a poignant example of the profound impact of rainfall variability on food grain production, as it experienced a widespread drought due to a significant rainfall deficit. Declared as an "All-India drought," this event underscored the vulnerability of agriculture to climatic fluctuations, with repercussions extending across vast swathes of the country. In March 2004, elevated temperatures had detrimental effects on various crops across Himachal Pradesh, India, including wheat, apple, mustard, rapeseed, linseed, potato, vegetables, pea, and tea. Yield losses ranged from 20 to 60 percent, varying depending on the crop. Harvesting of wheat and potatoes was expedited by 15-20 days, while apple blossoming occurred 15 days earlier than usual. Although the optimal temperature for apple blossom and fruit set is 24 °C, temperatures soared above 26 °C for 17 consecutive days. Throughout Himachal Pradesh, maximum temperatures in March 2004 were between 2.1 °C and 7.9 °C higher than the normal range (Prasad *et al*., 2007) [4].

Climate change has become an important area of concern for India to ensure food and nutritional security for growing population. The greenhouse effect stands as a pivotal factor, within human capability to alter. Shortwave radiation readily penetrates the atmosphere, while longwave terrestrial radiation emitted from the Earth's warm surface encounters partial absorption by various atmospheric gases. These gases, known as greenhouse gases, contribute to the phenomenon of global warming. Among the primary natural greenhouse gases are CO2, CH4, N2O, water vapor, and ozone (Santra, 2006) [6].

The escalating concern surrounding the profound impacts of climate change, particularly within the agricultural sector, has reached alarming levels. The adverse effects of climate variability on agriculture are increasingly severe. Examples include sporadic occurrences such as droughts and floods, posing significant threats to the livelihoods of rural communities reliant on agriculture (Ranganathan *et al*., 2010) [7]. A decline in water availability for irrigation is anticipated due to rainfall deficits resulting from intensified droughts, consequently diminishing irrigated food production (Anon., 2002) [8]. The likelihood of crop losses is heightened by amplified climate variability, presenting a critical issue that will significantly influence future food security (Ranganathan *et al*., 2010) [7]. The influence of climate change on agriculture in India has been substantial, and its future impact on agricultural production is expected to be significant. While the specific effects may vary by region, overall, it predominantly results in adverse outcomes (Anon., 2007) [9].

The climate poses a direct and growing threat to the livelihood of millions of people in India. In agriculture environment, relevant and timely information helps farmers to choose proper agricultural management practices for adaptation to climate variability. Providing information on weather trends and best management practices in farming to cope with climate aberrations helps farmer make correct decisions, such as what crops to grow and where to sell their product and buy inputs. Assessing vulnerability to current climate variability and extremes is a fundamental initial step for any adaptation strategy. Social scientists have significantly contributed to the study and evaluation of adaptation, drawing upon a diverse range of disciplines and building upon a longstanding tradition of examining vulnerability to natural hazards and food insecurity (Dilley and Boudreau, 2001) [10]. In this context, understanding farmer's vulnerability helps in formulating relevant strategies to manage their farms and participate in the implementation of agri-environmental measures.

Materials and Methods

Operationalization and measurement of Vulnerability level of farmers to climate change

Vulnerability of farmers due to climate change

An attempt has been made in the present investigation to develop a scale to measure the vulnerability of farmers due to climate change.

Vulnerability of farmers' due to climate change is operationally defined as the degree to which farmers are susceptible to or unable to cope with adverse effects of climate change

It depends on extent of farmers' Exposure to climate change (rainfall &temperature), their level of Sensitivity, Perception towards climate change, Attitude towards climate change, Egalitarianism.

a. **Exposure of farmers to climate variability:** Is operationally defined as degree of climate variability and change (rainfall & temperature) that farmers experiences over a period of time.
b. **Sensitivity of farmers:** To climate change is operationally defined as the degree in which withstanding capacity of farmers is adversely affected due to changes in rainfall and temperature.
c. **Perception towards climate change:** The perception of farmers towards climate can be operationally defined as their subjective understanding, beliefs, attitudes, and interpretations regarding various climatic factors, including temperature, rainfall patterns, extreme weather events, and overall climate variability. The responses of the respondents were obtained against each statement in terms of their agreement or disagreement. The positive statements were scored 5, 4, 3, 2 and 1 for strongly agree, agree, undecided, disagree and strongly disagree respectively and in case of negative statements the scoring system was reversed.
d. **Attitude towards climate change:** The attitude of farmers towards climate change is operationally referred to their feelings, beliefs, and behavioral tendencies regarding the phenomenon of climate change. It encompasses farmers' opinions, concerns about the causes, impacts, and severity of climate change on their livelihoods, agricultural practices, and the environment. The responses of the respondents were obtained against each statement in terms of their agreement or disagreement. The positive statements were scored 5, 4, 3, 2 and 1 for strongly agree, agree, undecided, disagree and strongly disagree respectively and in case of negative statements the scoring system was reversed.
e. **Egalitarianism:** Egalitarianism of farmers to climate change operationally implies to the principle or belief among farmers that all individuals should have equal access to resources, opportunities, and support in addressing climate change impacts and adaptation strategies. The responses of the respondents were obtained against each statement in terms of their agreement or disagreement. The positive statements were scored 5, 4, 3, 2 and 1 for strongly agree, agree, undecided, disagree and strongly disagree respectively and in case of negative statements the scoring system was reversed.

The method of summated rating scale suggested by Edwards (1969) [11] & Likert (1932) [12] was followed in the development of the vulnerability scale.

Procedure followed for development of scale to analyse the vulnerability level of farmers to climate change

1. **Identification of components:** Statements related to vulnerability level of farmers to climate change were identified based on review of literature and discussion with teachers, experts in the relevant field.
2. **Collection and editing of vulnerability statements:** A

tentative list of 148 statements pertaining to the vulnerability level of farmers to climate change through extensive review of literature and by consulting teachers. These 148 statements were edited as per the 14 criteria enunciated by Edwards (1969) [11], and Thurstone and Chave (1929) [13]. As a consequence 121 statements were included for the study

3. **Relevancy test:** 121 statements were sent to 105 experts/judges in the relevant field to critically evaluate the relevancy of each statement *viz.*, Most Relevant (MR), Relevant (R), Somewhat Relevant (SWR), Less Relevant (LR) and Not Relevant (NR) with the score of 5,4,3,2 and 1, respectively. A total of 80 judges/experts returned the questionnaires duly completed and the vulnerability statements were considered for further processing. From the data gathered, 'Relevancy Percentage (RP)' and 'Mean Relevancy Score (MRS)' were worked out for all the statements. Using these criteria, individual vulnerability statements were screened for relevancies using the following formulae.

Relevancy percentage (RP): It was obtained by using the following formula

$$R.P. = \frac{MR\times5 + R\times4 + SWR\times3 + LR\times2 + NR\times1}{\text{Maximum possible score}} \times 100$$

Mean Relevancy Score (MRS): It was worked out using the following formula

$$M.R.S. = \frac{MR\times5 + R\times4 + SWR\times3 + LR\times2 + NR\times1}{\text{Number of judges/experts responded}}$$

Accordingly, statements having 'relevancy percentage' of 80.00 percent and above and mean relevancy score of 4.25 and above were considered for final selection. Hundred vulnerability statements were retained after relevancy tests and these statements were suitably modified and written as per the comments of the judges wherever applicable.

4. **Item analysis:** Hundred statements were subjected to item analysis to delineate the items based on the extent to which they can differentiate the respondent having less vulnerability from the respondent with high vulnerability to climate change. A sample study was conducted in non-sample area by interviewing 30 farmers and utilizing 100 statements for measuring vulnerability. The respondents were asked to indicate their degree of agreement or disagreement on a five-point continuum ranging from 'strongly agree' to 'strongly disagree'. The critical ratio, that is, the 't' value which analyses the extent to which a given statement differentiates between the high and low groups of respondents for each statement, was calculated by using the following formula.

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

Where,
$\bar{X}_H$= The mean score on given statement of the high group
$\bar{X}_L$ = The mean score on given statement of the low group
$\sum X^2_H$ = Sum of squares of the individual score on a given statement for high group
$\sum X^2_L$ = Sum of squares of the individual score on a given statement for low group
n = Number of respondents in each group
$\sum$ = Summation
t = The extent to which a given statement differentiates between the high and low groups.

After computing the 't' value for all the 100 items, 89 vulnerability statements with 't' value equal to or greater than 1.692 were finally selected and included in the final vulnerability scale.

Table 1: Critical ratios of statements under item analysis

Sl. No.	Statements	t-value
1	Experienced a rise in the frequency of rainy days.	5.75
2	Experienced an increase in the total amount of rainfall.	3.94
3	Experienced changes in the onset of the rainy season.	4.74
4	Experienced a transition in the monthly rainfall schedule.	3.20
5	Experienced more instances of dry weather at critical stages	2.53
6	Experienced severe drought during the crop cultivation period.	2.67
7	Experienced alterations in the rainfall during the crop cultivation period.	4.13
8	Experienced an increase in cyclonic events during the monsoon season.	1.51
9	Experienced unusual failure of bore wells due to a shortfall in rainfall.	3.58
10	Experienced rains at harvesting stage of crops	1.95
11	Experienced a reduction in temperature	3.79
12	Experienced harsh sunlight	4.73
13	The summer was extremely hot	5.11
14	Experienced a delay in the onset of the summer season	5.35
15	Experienced a delay in the start of the Rabi season	4.35
16	Experienced a delay in the commencement of the Kharif season	4.13
17	The unpredictability of climate change affect the profitable crops and planting season.	4.62
18	Lack of farming experience can lead to decreased crop production in the face of climate change.	4.49
19	Families led by women may face challenges in making decisions about climate-resilient technologies.	5.37
20	A lack of education can hinder the effective use of climate resilience technologies.	5.11

21	Elderly family members may struggle to adapt to changing climate conditions.	4.63
22	Families without secondary occupations may face greater economic hardship during climate change.	4.90
23	Limited interaction with rural organizations can result in poor decision-making during climate crises.	1.63
24	Intense rainfall results in soil erosion	5.97
25	Soil nutrient depletion is caused by heavy rainfall.	4.77
26	High temperatures can lead to the volatilization of soil nutrients.	5.51
27	The lack of timely availability of essential inputs can hinder crop production.	5.20
28	The absence of appropriate technologies can affect crop yield.	1.52
29	The failure to adapt suitable crop varieties recommended for the area can reduce crop production.	5.66
30	Climate change has affected the availability of water in my open/bore wells.	5.37
31	Limited access to weather information can hinder timely crop production activities in climate change conditions	5.72
32	Excessive rainfall impacts the effectiveness of fertilizers and pesticides, leading to increased cultivation costs in my farm	5.66
33	Delayed precipitation affects seed germination resulting in crop loss.	5.84
34	The emergence of new pests and diseases can affect crops results in increased cultivation costs and decreased crop yield.	4.24
35	The lack of soil moisture at critical stages affects crop growth and yield.	4.55
36	The adverse effects of climate change leads to a decrease in crop yield.	5.87
37	Delay in onset of monsoon or early monsoon due to climate change affects the timely planting of crops.	5.16
38	Practicing monocropping lead to rapid spread of pathogens in crops which results in food insecurity.	3.96
39	Monocropping relies on the heavy use of agro-chemicals, fertilizers and pesticides, which contributes to agricultural pollution and soil erosion	5.66
40	An increase in weed infestation leads to a rise in cultivation costs.	5.66
41	Changes in rainfall patterns affect weed control during critical growth periods.	5.16
42	Adaptation of soil and water conservation activities helped to conserve moisture and nutrients to enhance yield	5.97
43	Water scarcity had a detrimental effect on irrigation in my farm	5.72
44	Timely application of FYM/ manure improves the water-holding capacity of the soil.	5.03
45	Application of organic manures helps in maintain soil fertility and productivity	5.04
46	Climate change has affected timely plant protection activities.	1.63
47	Climate change has affected the timely harvesting of crops.	5.84
48	The quality of the yield has been affected by climate change.	1.41
49	Crop yield has drastically reduced due to climate change	5.06
50	Climate change has affected post-harvest management practices like cleaning, sorting, grading, packing etc	5.84
51	Immediate rainfall during harvesting crops affects the availability of food grains, fodder and their quality.	4.63
52	Climate change has affected the agricultural crop yield and income of my farm.	5.84
53	The cost of cultivation has increased due to changes in temperature and rainfall patterns.	5.11
54	Climate change has forced farmers like me to sell our produce at lower prices to meet their family's needs.	4.63
55	Climate change has affected the availability of sufficient food for my family members.	4.74
56	Migration, a negative effect of climate change, has led to shortage of family labour.	1.35
57	A low proportion of non-agricultural income to total household income affecting livelihood security.	5.97
58	Climate change affects the availability of fodder for my livestock.	5.04
59	The adverse effects of climate change resulted in non-availability of fodder seed material for future multiplication.	5.66
60	The incidence of pests and diseases in livestock has increased due to climate change.	4.63
61	Climate change adversely affected small ruminants, often resulting in fatalities in my farm.	4.24
62	Shortage of fodder due to climate change adversely affects the milk yield of my livestock.	4.63
63	During climate change situations, the milk yield suffered due to the adverse impact of mastitis, foot and mouth disease in animals	5.72
64	Animals including sheep and goats, experience weight reduction and milk yield reduction amid climate change situations in my farm	5.84
65	Water scarcity due to drought adversely affected dairy, fish, sheep and goat farming.	5.84
66	Climate change has adverse effects on the spread of infectious disease vectors such as malaria, dengue fever, meningitis, cholera, etc.	5.72
67	Human dehydration is caused by high temperatures resulting in bodily weakness.	4.24
68	Higher temperatures adversely affect the performance of farmers	5.72
69	Severe fever is caused by variations in weather conditions due to climate change.	4.24
70	Skin diseases and sun scorching are caused by high temperatures.	5.28
71	Severe headache is a result of high temperatures.	5.72
72	Undernourishment occurs due to a reduced number of meals in a day.	5.11
73	Hospital visits become more frequent due to climate change.	4.63
74	Climate change has direct effect on consumption of medicines by farmers	1.07
75	Climate change leads to variations in blood pressure of farmers due to stress.	1.51
76	Rise in healthcare costs due to illnesses triggered by climate change.	1.52
77	Scientists and policymakers increasingly align in acknowledging climate change.	5.11
78	The urgency and gravity of this issue cannot be understated.	5.16
79	Claims suggesting it's a non-existing concept that lacks credibility and evidence.	4.18
80	Climate change unfolds gradually, step by step.	6.09
81	The decline of native plants and animals in my area concerns me.	5.11
82	Human possess the capacity to adapt to the unpredictable nature of climate change.	4.82

83	Scientists are actively seeking solutions to address climate change challenges.	5.72
84	Human greed and mistreatment of nature are seen as the cause of this environmental crisis.	5.11
85	Prioritizing livelihood and other aspects of life takes precedence over environmental concerns for me.	5.66
86	Engaging in environmental friendly practices demands excessive effort, according to some perspectives.	5.84
87	Adapting to more environmentally friendly habits poses a challenge for me.	6.77
88	I do not believe my daily behaviours, lifestyle, and livelihood practices significantly contribute to climate change.	4.63
89	I feel powerless to personally contribute to preventing the loss of the state's biodiversity.	4.24
90	The responsibility to preserve the ecological balance in our state falls on the government.	2.87
91	The community holds a larger responsibility than the government in taking action to curb ecological degradation in the state.	5.72
92	Farmers in our state should adopt sustainable agricultural practices.	4.24
93	The unpredictability of the future makes it challenging to make concrete plans.	1.52
94	I perceive minimal influence over the course of my life.	1.59
95	A more equitable distribution of wealth is essential for the world's betterment.	4.63
96	I endorse the government's initiatives to eradicate poverty.	6.09
97	I advocate for affirmative action.	5.72
98	Organizations and institutions should be structured to allow everyone to impact significant decisions.	4.90
99	Increased equality in treatment could result in fewer societal issues.	4.63
100	A more equitable global distribution of wealth among nations could foster a more peaceful world.	5.72
	TOTAL	

5. Reliability: Reliability refers to precision of the scale constructed for any purpose. A reliability test will be *reliable* when it gives the same repeated result under the same conditions. In any social science research, a newly constructed scale has to be tested for its reliability before it is used. The split-half method was employed to test the reliability of the vulnerability scale. The value of correlation coefficient was 0.776 and this was further corrected by using Spearman Brown formula to obtain the reliability coefficient of the whole set. The 'r' value of the scale was 0.825, which was significant at one percent level indicating the high reliability of the scale. It was concluded that the vulnerability scale constructed was reliable.

a) Half test reliability formula.

$$r_{1/2} = \frac{N(\sum XY) - (\sum X)(\sum Y)}{\sqrt{(N\sum X^2 - (\sum X)^2)\,(N\sum Y^2 - (\sum Y)^2)}}$$

Where,

$\sum X$= Sum of the scores of the odd number items

$\sum Y$ = Sum of the scores of the even number items

$\sum X^2$= Sum of the squares of the odd number items

$\sum Y^2$ = Sum of the squares of the even number items

b) Whole test reliability formula

$$r_{1/1} = \frac{2_{r1/2}}{1 + r_{1/2}}$$

Where,

$r_{1/2}$= Half test reliability

Validity

It refers to how well a scale analyses what it is supposed to measure. The data was subjected to statistical validity, which was found to be 0.915 for scale which is greater than the standard requirement of 0.700 (Validity=$\sqrt{r_{11}}$). Hence, the validity coefficient was also found to be appropriate and suitable for the tool developed.

Administration of vulnerability scale and method of scoring: The final scale consists of 89 statements for determining the vulnerability of farmers to climate change. The response could be collected on a five-point continuum, namely, strongly agree, agree, undecided, disagree and strongly disagree with assigned score of 5,4,3,2 and 1, respectively. The vulnerability score of a respondent could be calculated by adding up the scores obtained by him/her on all the 89 statements. The vulnerability score of this scale ranges from a minimum of 89 score to a maximum of 445 score, respectively. Based on the mean and half standard deviation, the respondents could be categorized into three vulnerability categories, *viz.*, less, moderate and high. Higher score on this scale indicates that the respondent has high vulnerability to climate change and the lower score indicates that the respondent has low vulnerability to climate change.

Table 2: Scale to measure the vulnerability of farmers to climate change

Sl. No.	Statements	SA	A	UD	DA	SDA
I	**Farmers' exposure to the effects of climate change**					
	A. Rainfall (Past 5Years)					
1	Experienced a rise in the frequency of rainy days.	5	4	3	2	1
2	Experienced an increase in the total amount of rainfall.	5	4	3	2	1
3	Experienced changes in the onset of the rainy season.	5	4	3	2	1
4	Experienced a transition in the monthly rainfall schedule.	5	4	3	2	1
5	Experienced more instances of dry weather at critical stages	5	4	3	2	1
6	Experienced severe drought during the crop cultivation period.	5	4	3	2	1
7	Experienced alterations in the rainfall during the crop cultivation period.	5	4	3	2	1
9	Experienced unusual failure of bore wells due to a shortfall in rainfall.	5	4	3	2	1
10	Experienced rains at harvesting stage of crops	5	4	3	2	1
	B. Temperature (Past 5Years)					

1	Experienced a reduction in temperature	5	4	3	2	1
2	Experienced harsh sunlight	5	4	3	2	1
3	The summer was extremely hot	5	4	3	2	1
4	Experienced a delay in the onset of the summer season	5	4	3	2	1
5	Experienced a delay in the start of the Rabi season	5	4	3	2	1
6	Experienced a delay in the commencement of the Kharif season	5	4	3	2	1
II	**Susceptibility to changes and strains due to climate change (Past 5Years)**					
	A. Impact of social and demographic factors on agricultural yield.					
1	The unpredictability of climate change affect the profitable crops and planting season.	5	4	3	2	1
2	Lack of farming experience can lead to decreased crop production in the face of climate change.	5	4	3	2	1
3	Families led by women may face challenges in making decisions about climate-resilient technologies.	5	4	3	2	1
4	A lack of education can hinder the effective use of climate resilience technologies.	5	4	3	2	1
5	Elderly family members may struggle to adapt to changing climate conditions.	5	4	3	2	1
6	Families without secondary occupations may face greater economic hardship during climate change.	5	4	3	2	1
	B. Impact of climate change on agricultural production.					
i	**Pre planting activities**					
1	Intense rainfall results in soil erosion	5	4	3	2	1
2	Soil nutrient depletion is caused by heavy rainfall.	5	4	3	2	1
3	High temperatures can lead to the volatilization of soil nutrients.	5	4	3	2	1
4	The lack of timely availability of essential inputs can hinder crop production.	5	4	3	2	1
6	The failure to adapt suitable crop varieties recommended for the area can reduce crop production.	5	4	3	2	1
7	Climate change has affected the availability of water in my open/bore wells.	5	4	3	2	1
8	Limited access to weather information can hinder timely crop production activities in climate change conditions	5	4	3	2	1
ii	**Crop Growth periods**					
1	Excessive rainfall impacts the effectiveness of fertilizers and pesticides, leading to increased cultivation costs in my farm	5	4	3	2	1
2	Delayed precipitation affects seed germination resulting in crop loss.	5	4	3	2	1
3	The emergence of new pests and diseases can affect crops results in increased cultivation costs and decreased crop yield.	5	4	3	2	1
4	The lack of soil moisture at critical stages affects crop growth and yield.	5	4	3	2	1
5	The adverse effects of climate change leads to a decrease in crop yield.	5	4	3	2	1
6	Delay in onset of monsoon or early monsoon due to climate change affects the timely planting of crops.	5	4	3	2	1
7	Practicing monocropping lead to rapid spread of pathogens in crops which results in food insecurity.	5	4	3	2	1
8	Monocropping relies on the heavy use of agro- chemicals, fertilizers and pesticides, which contributes to agricultural pollution and soil erosion	5	4	3	2	1
iii	**Intercultivation and Plant Protection Activities**					
1	An increase in weed infestation leads to a rise in cultivation costs.	5	4	3	2	1
2	Changes in rainfall patterns affect weed control during critical growth periods.	5	4	3	2	1
3	Adaptation of soil and water conservation activities helped to conserve moisture and nutrients to enhance yield	5	4	3	2	1
4	Water scarcity had a detrimental effect on irrigation in my farm	5	4	3	2	1
5	Timely application of FYM/ manure improves the water-holding capacity of the soil.	5	4	3	2	1
6	Application of organic manures helps in maintain soil fertility and productivity	5	4	3	2	1
iv	**Harvesting, Post Harvest & Marketing**					
1	Climate change has affected the timely harvesting of crops.	5	4	3	2	1
3	Crop yield has drastically reduced due to climate change	5	4	3	2	1
4	Climate change has affected post-harvest management practices like cleaning, sorting, grading, packing etc	5	4	3	2	1
5	Immediate rainfall during harvesting crops affects the availability of food grains, fodder and their quality.	5	4	3	2	1
6	Climate change has affected the agricultural crop yield and income of my farm.	5	4	3	2	1
7	The cost of cultivation has increased due to changes in temperature and rainfall patterns.	5	4	3	2	1
8	Climate change has forced farmers like me to sell our produce at lower prices to meet their family's needs.	5	4	3	2	1
9	Climate change has affected the availability of sufficient food for my family members.	5	4	3	2	1
11	A low proportion of non-agricultural income to total household income affecting livelihood security.	5	4	3	2	1
	C. Impact of climate change on Livestock production					
1	Climate change affects the availability of fodder for my livestock.	5	4	3	2	1
2	The adverse effects of climate change resulted in non-availability of fodder seed material for future multiplication.	5	4	3	2	1
3	The incidence of pests and diseases in livestock has increased due to climate change.	5	4	3	2	1
4	Climate change adversely affected small ruminants, often resulting in fatalities in my farm.	5	4	3	2	1
5	Shortage of fodder due to climate change adversely affects the milk yield of my livestock.	5	4	3	2	1
6	During climate change situations, the milk yield suffered due to the adverse impact of mastitis, foot and mouth disease in animals	5	4	3	2	1
7	Animals including sheep and goats, experience weight reduction and milk yield reduction amid climate change situations in my farm	5	4	3	2	1
8	Water scarcity due to drought adversely affected dairy, fish, sheep and goat farming.	5	4	3	2	1
	D. Impact of climate change on Human Health					
1	Climate change has adverse effects on the spread of infectious disease vectors such as malaria, dengue fever,	5	4	3	2	1

	meningitis, cholera, etc.					
2	Human dehydration is caused by high temperatures resulting in bodily weakness.	5	4	3	2	1
3	Higher temperatures adversely affect the performance of farmers	5	4	3	2	1
4	Severe fever is caused by variations in weather conditions due to climate change.	5	4	3	2	1
5	Skin diseases and sun scorching are caused by high temperatures.	5	4	3	2	1
6	Severe headache is a result of high temperatures.	5	4	3	2	1
7	Undernourishment occurs due to a reduced number of meals in a day.	5	4	3	2	1
8	Hospital visits become more frequent due to climate change.	5	4	3	2	1
III	**Perception towards the climate change**					
1	Scientists and policymakers increasingly align in acknowledging climate change.	5	4	3	2	1
2	The urgency and gravity of this issue cannot be understated.	5	4	3	2	1
3	Claims suggesting it's a non-existing concept that lacks credibility and evidence.	5	4	3	2	1
4	Climate change unfolds gradually, step by step.	5	4	3	2	1
IV	**Attitude towards the climate change**					
1	The decline of native plants and animals in my area concerns me.	5	4	3	2	1
2	Human possess the capacity to adapt to the unpredictable nature of climate change.	5	4	3	2	1
3	Scientists are actively seeking solutions to address climate change challenges.	5	4	3	2	1
4	Human greed and mistreatment of nature are seen as the cause of this environmental crisis.	5	4	3	2	1
5	Prioritizing livelihood and other aspects of life takes precedence over environmental concerns for me.	5	4	3	2	1
6	Engaging in environmental friendly practices demands excessive effort, according to some perspectives.	5	4	3	2	1
7	Adapting to more environmentally friendly habits poses a challenge for me.	5	4	3	2	1
8	I do not believe my daily behaviours, lifestyle, and livelihood practices significantly contribute to climate change.	5	4	3	2	1
9	I feel powerless to personally contribute to preventing the loss of the state's biodiversity.	5	4	3	2	1
10	The responsibility to preserve the ecological balance in our state falls on the government.	5	4	3	2	1
11	The community holds a larger responsibility than the government in taking action to curb ecological degradation in the state.	5	4	3	2	1
12	Farmers in our state should adopt sustainable agricultural practices.	5	4	3	2	1
V	**Egalitarianism**					
1	A more equitable distribution of wealth is essential for the world's betterment.	5	4	3	2	1
2	I endorse the government's initiatives to eradicate poverty.	5	4	3	2	1
3	I advocate for affirmative action.	5	4	3	2	1
4	Organizations and institutions should be structured to allow everyone to impact significant decisions.	5	4	3	2	1
5	Increased equality in treatment could result in fewer societal issues.	5	4	3	2	1
6	A more equitable global distribution of wealth among nations could foster a more peaceful world.	5	4	3	2	1

Table 3: Vulnerability level of farmers towards climate change, (n=32)

Sl. No.	Vulnerability level of farmers to climate change	Farmers		Mean	SD
		Number	Percent		
1	Less Vulnerable	6	18.76		
2	Moderately Vulnerable	11	34.38		71.02
3	Highly Vulnerable	15	46.86	389.34	
	Total	32	100		

Conclusion

The vulnerability scale developed is found to be reliable and valid, hence it can be used to analyze the vulnerability level of farmers to climate change in Telangana state. The vulnerability scale when administered to the farmers revealed that vast majority of the respondents (81.24%) had high vulnerability level to moderate vulnerability level towards climate change whereas less than one fourth (18.76%) are less vulnerable to climate change.

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