Research Article

Indian Journal of Extension Education
Vol. 58, No. 3 (July–September), 2022, (46-50)

ISSN 0537-1996 (Print)
ISSN 2454-552X (Online)

Assessment of Farmer's Attitude and Social Vulnerability to Climate Change in the Semi-arid Region

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ARTICLE INFO

Keywords: Climate change, Farmer's perception and attitude, Adaptive capacity, Social vulnerability, SWC measures, Semi-arid region

http://doi.org/10.48165/IJEE.2022.58310

ABSTRACT

This study was conducted in the semi-arid region, Agra of Uttar Pradesh, during 2016-19 to assess farmers' perceptions and attitudes about climate change and farmers' social vulnerability; and identify the significant factors that influence social vulnerability. Primary data was collected from 120 farmers using a well-structured interview schedule. Results revealed that most respondents recognized the decline in the rainfall quantum and rise in temperatures and the increase in the frequency of hot days and droughts. Almost all respondents believed that soil and water conservation measures were most effective in mitigating the adverse effects of climate change. The social vulnerability index illustrated that more than half of respondents were moderate socially vulnerable in climate-changing scenarios. The multiple regressions results confirmed that land size, total income, perception, knowledge, awareness of climate change phenomena, and adaptive capacity were significant predictor variables for social vulnerability to climate change. There is a need to improve knowledge and perception and change attitudes among the respondents through an educational campaign, mass media exposure, and individual contact with trained extension personnel to effectively cope with the consequences of climate change.

INTRODUCTION

Agriculture is expected to be the most affected sector due to climate change (IPCC, 2007). Climate change and extreme hazards like floods and severe droughts lead to substantial crop losses, volatility of food prices, and livelihood insecurity. The projection assesses that 2.5°C to 4.9°C rises in temperature will lead to a 32-40 per cent drop in rice yields and 41-52 per cent in wheat productivity in India, which can cause a GDP drop of 1.8-3.4 per cent (Gupta & Pathak, 2016). Climate change is likely to have adverse environmental and socio-economic impacts on Indian agriculture, especially rainfed agriculture. These impacts depend on farmers' perceptions, attitudes, and adaptive capacity to climate change. Previous studies (Banerjee et al., 2015; Ravikumar et al., 2015; Dupdal et al., 2021) reported that climate change adaptation strategies could not be effective without understanding farmers' perceptions, knowledge, and attitude toward climate change. Even the extension professional knowledge regarding impact of climate change in agriculture was reported to be low to moderate (Ghanghas et al., 2015). With farmers' perception, knowledge and perspective, vulnerability is also one of the critical components of risk. Its assessments offer insights and allow investigation of the complex relationships between humans and their socio-physical environments (Fraser et al., 2011). The social vulnerability has emerged as the least known element under the changing climatic scenario. It explicitly deliberates on all socio-economic and demographic factors affecting the magnitude of impacts of climate change (Heinz, 2002). Information on social vulnerability also helps establish actions by informing policymakers and practitioners, alerting the public, raising awareness, stimulating discussion, gaining

Received 23-03-2022; Accepted 21-05-2022

funding, etc. Vulnerability's impact on the individual's behaviour depends on their perception of risks and their capability to confront such risks. The situation recalls an urgent need to develop and deploy enhanced adaptation and mitigation strategies to provide quality of life under changing climate scenarios. In India, research on social vulnerability and the role of soil and water conservation technologies in mitigating the effects is limited. Still, there are multiple works on measuring social well-being, inequalities, poverty, and social exclusion. Therefore, it is crucial to assess how society responds to climate change and identify the significant driver of social vulnerability under changing climate scenarios.

METHODOLOGY

The ICAR-Indian Institute of Soil and Water Conservation, Research Centre in the semi-arid region of Agra, India carried out the study during 2016-19, as Agra is one of the highly vulnerable districts to climate change (Ramarao et al., 2014). A multiple-stage sampling procedure was employed to select a sample of 120 respondents. Three blocks from Agra and one village from each selected block were selected randomly. Primary data from respondents was collected through a well-developed and pre-tested interview schedule. Perception and attitude towards climate change were measured on a Likert types scale of 1-5 (strongly agreed, agreed, undivided, disagreed, and strongly disagreed), and attitude statements included 11 positive and four negative statements). A scoring pattern of 5 to 1 for positive statements and 1 to 5 for negative statements was used in the study. A composite social vulnerability index was calculated and respondents were grouped into highly vulnerable, moderately vulnerable, and less vulnerable categories based on the social vulnerability index. The values of each social vulnerability indicator were normalized by applying the following formula:

Index value = (Actual value – Minimum value)/ (Maximum value – Minimum value)

The index value was reversed for the indicator with a negative connotation (1- index value). The overall index was estimated from the sub-indices weighted average, and the respective weights for sub-indices were drawn from literature and experts' opinions. The overall equation for the model employed in the study is mentioned below:

$$HSVI = \Sigma (Ii * Wi) \quad ...(1)$$

HSVI refers to household social vulnerability index; I_i means sub-index, and W_i was weighted by the sub-index. The HSVI range from 0 to 1; close to 0 means high vulnerability, and 1 means high resilience. Since indicators are dynamic, HSVI provides a general picture that allows comparisons among communities, identifying vulnerable households, and appropriate policy for climate change adaptation.

A stepwise multiple regression approach was used to identify the significant drivers of the farmer's social vulnerability. In this article, age (A), land size (L), education (E), number of livestock (N), income (I), social participation (S), mass media exposure (M), extension agency contact (C), awareness about climate change (AC), attitude (T), perception about climate change (P), knowledge (K) were used as the explanatory variables. The following specific multiple regression model was used in this study.

$$SV = f (A, L, E, N, I, S, M, C, AC, F, T, AC, P, K) \quad ...(2)$$

$$SV = b_0 + X b + \varepsilon \quad ...(3)$$

RESULTS AND DISCUSSION

Respondent's perception and attitude towards climate change

The farmer's perception of climate change is vital for effectively implementing any policy/strategies on climate change in actual field situations (Arunachalam et al., 2020). The weighted mean of statements above 4 showed that most of the respondents identified significant indicators of climate change in the form of irregular, untimely, and enhanced frequency of extreme rainfall, increase in temperature or heatwaves droughts and water shortage (Table 1). Thus, most farmers perceived that climate change was a severe issue. Similarly, results showed that farmers believed that climate change affects agriculture in their area. Respondents

Table 1. Distribution of respondents according to their perception of climate change

Statement	Weighted mean
Climate change is real	4.02
Climate change is a severe problem	3.78
Climate change is affecting agriculture	4.10
Industrialization is responsible for climate change	3.74
Heavy use of fossil fuels has led to rapid global climate change	3.76
Large-scale deforestation is a reason behind the present climate change	3.94
Compared to the past; the monsoon rainfall occurs earlier now	2.58
Compared to the past, nowadays, the monsoon rainfall retreats earlier	3.79
Nature and intensity of rainfall have become more unusual	4.12
Droughts have become more frequent than in the past 10-20 years	3.95
In the coming 10-20 years, the frequency of droughts will be decreased due to climate change	2.89
In the coming 10-20 years, the monsoon rainfall will occur much earlier than now	2.67
In the coming 10-20 years, problems of water shortages or stress will be increased due to climate change	4.05
In the last 10-20 years, there has been an increase in heatwaves	4.17
Low yields of crops in the recent past are due to climate change	4.07
In the next 10-20 or so years, livestock will be more adversely affected	3.99
Changing the sowing date and time would be a better strategy to adapt to climate change	3.45
In the coming years, desertification of arable land will be increased	3.77
Heard about different climate-resilient technologies?	2.95

perceived that climate change had a powerful negative impact on crop and livestock yields. The results showed that the respondents identified industrialization, heavy use of fossil fuels, and large-scale deforestation as reasons behind climate change. However, most of the respondents were not well aware of the climate-resilient strategies such as zero & minimum tillage, cover crops, mulching, conservation agriculture, *etc*. to overcome or tackle the adverse effects of climate change. Therefore, there is a need for an educational campaign to increase awareness among farmers about climate change and its causes. Climate Resilient Agriculture (CRA) must be motivated and mobilized to adopt proper adaptation measures and mitigation practices to cope with the adverse events effects of climate change.

Table 2 presented revealed the weighted mean score of attitude toward climate change results showed that the highest mean score (3.85) was found for the statement that scientists could find solutions to the problems of climate change, followed by the statement that humans could find ways to adapt to the vagaries of climate change (3.58). The weighted mean of most statements ranged from 3.00 to 3.50. It revealed that the predisposition of the respondents is mixed due to variations in the belief system and personality. Respondents showed a negative attitude towards protecting the environment, maintaining ecological balance and biodiversity. Nevertheless, respondents showed an attitude of dependency on external agencies, the Government, for managing problems being given rise by climate change. The data could not deduce farmers' attitudes toward self-initiated adoption behaviour. Hence, it is imperative to provide motivational, attitudinal, and infrastructural support to the people to develop their capabilities to adopt village-centric adaptive mechanisms and measures.

Social vulnerability and influencing factors

The household social vulnerability index (HSVI) scores ranged from 0.104 (most vulnerable) to 0.572 (least vulnerable). About 62 per cent of respondents fall under the moderately vulnerable group, while about 21 per cent fall in the highly vulnerable group. These findings are in line with Raghuvanshi et al., (2020). The description, mean, and SD of explanatory variables used in the model for identifying significant variables are presented in Table 3.

The results of significant factors influencing social vulnerability presented in Table 4 and the coefficient of land size (0.33) showed that farmers who have a larger size of own land are more climate-resilient than farmers who have marginal landholding as a positive sign of coefficient showed the resilience to climate change or less social vulnerability. Similar results were found by Sugden et al., (2014). The coefficient of total income (0.26) revealed that income is also a key driver of social vulnerability as it enhances education access, wealth, physical assets ownership, and coping capacity (Rufat et al., 2015). The coefficients of perception (0.31), knowledge (0.23), and awareness (0.18) were positively significant at a 95 per cent confidence level, and these results showed that households those having a high level of perception, awareness, and knowledge were more climate-resilient. Thus, these variables are significant drivers of social vulnerability to climate change; the positive significant coefficient of knowledge is in line with the previous studies' results that reported education commonly correlates positively with adopting agriculture conservation practices or climate-resilient technologies (Meena et al., 2020). The coefficient of adaptive capacity of households was found positively significant at a 99 per cent significance level, which showed that households with more adaptive capacity were less socially vulnerable to climate change. Further, these factors are also positively associated with extension agencies' contact, mass media exposure, and social participation (Harvatt et al., 2011). Thus study identified the land size, total income, perception, knowledge, awareness of climate change phenomena, and adaptive capacity as the leading empirical drivers of social vulnerability to climate change. Therefore, policymakers should focus on improving perception and awareness through improving access to information and education level (through effective use of extension system and mass media exposure) to promote the adoption of adaptation strategies for coping with the adverse effects on agriculture and women's drudgery needs to be addressed in this era of climate change (Bishnoi et al., 2014).

Results presented in Table 5 illustrated that more than 75 per cent of the respondents believed that change in cropping patterns might be beneficial to overcome the adverse impact of climate change. The majority of the respondents expressed casual labour,

Table 2. Distribution of respondents according to their attitude toward climate

Statement	Weighted mean
Do worry about the loss of flora and fauna	3.28
Humans can find ways to adapt to the vagaries of climate change	3.58
The Scientists will find solutions to the problems of climate change	3.85
The indigenous knowledge system of the area holds the potential to find solutions to climate change problems and make sustainable adaptations for livelihood and survival	2.80
Climate change is beyond control - it is too late to do anything now	3.60
It is the wrath of God for the greed and unhealthy ways of humans toward nature	3.25
The effects of climate change are too far in the future to worry	3.43
The environment is a low priority compared to livelihood and other things	3.11
It takes too much effort to do environmentally friendly things	3.26
hard to change habits to be more environmentally - friendly	3.27
Individual behaviour, everyday lifestyle, and livelihood activities contribute to climate change	3.15
Can afford to lose some of the area's biodiversity to meet the livelihood demands of the people of the area	2.94
There is nothing that individuals can do personally to help stop the loss of biodiversity	3.04
The Government must maintain ecological balance in the area	3.82
The community has a more significant role than the Government in checking ecological degradation in the area	3.48

Table 3. Definition and descriptive statistics of variables employed in the analysis

Variables	Description	Weighted Mean	SD
Age	Years	54.24	12.23
Land size	ha	1.38	1.17
Education	Farmer's education level; If illiterate = 0 Can read and write = 1, Primary -2, Middle school-3, Secondary school -4, Higher Secondary-5, Graduate-6, Above graduate-7	2.21	1.68
Total income	Net income annually (Rs.)	149414	12292
Social participation	Membership in farmer's organization/association; If a non-member-0, member-1	0.98	0.59
Mass media exposure	Index worked out on a scale of 0-2; 0 = Never, 1 = occasionally, and 2 = regularly	0.37	0.28
Extension agency contact	Index worked out on a scale of 0-2; 0 = Never, 1 = occasionally, and 2 = regularly	0.31	0.24
Awareness	Number of Yes and No answers to a question related to awareness of climate change (If Yes- 1, No -0)	0.60	0.26
Fatalism	Value orientation of fatalism about climate change measured with an index computed on a scale of 1-5	3.42	0.41
Attitude	An attitude of farmers toward climate change is measured with an index computed on a scale of 1-5	3.11	0.22
Adaptive capacity	Number of correct answers about skills related to adaptation practices (If correct-1, Incorrect-0)	0.31	0.27
Perception	The perception of farmers about climate change was measured with an index computed on a scale of 1-5	3.85	0.39
Knowledge	Number of correct answers about adaptation practices (If correct- 1, Incorrect -0)	0.67	0.26

Table 4. Major factors influencing the social vulnerability

Variables	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	SE	Beta			Tolerance	VIF
Constant	-0.140	0.089		-1.578	0.120		
Knowledge	0.090	0.041	0.229	2.200	0.032	0.531	1.884
Land size	0.026	0.007	0.330	3.884	0.000	0.799	1.252
Extension agency contact	0.064	0.034	0.158	1.872	0.067	0.815	1.226
Total income	3.0E-07	0.000	0.264	3.132	0.003	0.811	1.233
Perception	0.082	0.027	0.312	2.994	0.004	0.531	1.882
Adaptive capacity	0.086	0.030	0.242	2.837	0.006	0.792	1.262
Awareness	0.038	0.017	0.185	2.300	0.025	0.895	1.117
R^2	0.688						
Adjusted R^2	0.648						

Note: SE= standard errors, VIF= variation inflation factor

selling of trees from fields, and bore-well as adaptive strategies to deal with climate change. Based on the socio-economical and psychological characteristics of the respondents, it is inferred that the people in the semi-arid area need a concerted approach in their capacity building for improving their adaptive potential. Thrust areas of intervention in the semi-arid region include an emphasis on afforestation, intensification of research, promotion of conservation agriculture and climate-resilient technologies, Govt. financial support in the implementation of SWC structures, building up the preparedness to face the climate change apart from enlightenment campaign, educating people in health and environment protection, etc. (IISWC, 2020).

Table 5. Adaptive technologies to climate change

S.No.	Coping Strategies	Percentage of Respondents
1	Migration	3
2	Bore-well	33
3	Change in cropping pattern	76
4	Partial sale of livestock	23
5	Distress selling off assets	9
6	Casual labours	36
7	Selling of tress from field	36

SWC practices as a mitigating strategy for climate change

Table 6 depicted that all respondents believed that soil and water conservation (SWC) measures, *viz.* contour bund, farm pond, Nala bund, check dam, recharge filter are beneficial in mitigating the effects of climate change. Similarly, more than two-thirds of farmers perceived that bunding and leveling are very helpful in mitigating the impacts of climate change. Thus, the SWC measures were considered a pivotal strategy for mitigating the impact of climate change on agriculture and improving farmer's income (Meena et al., 2021).

Table 6. Soil and water conservation practices

S.No.	Conservation measure/ practice	Help in mitigating the effects of Climate Change		
		Fully	Some What	Not at All
1	Bunding	33.33	35.19	38.89
2	Contour Bund	100.00		
4	Vegetative bund		15.00	85.00
5	Broad bed furrow	14.29		85.71
6	Summer Ploughing			88.89
7	Farm Pond	100.00	100.00	
8	Nala bund	100.00	100.00	
9	Check Dam	100.00	100.00	
10	Recharge filter	100.00	100.00	

CONCLUSION

Results reveal that most respondents recognize the change in climate change indicators such as an increase in temperatures and heatwaves and fluctuation in the rainfall pattern and intensity. Respondents attributed industrialization, heavy use of fossil fuels, and large-scale deforestation to climate change. Respondents have a negative attitude toward protecting the environment and maintaining ecological balance and biodiversity. Interestingly, respondents think that scientists and humans can solve climate change. Results confirm that soil and water conservation plays a significant role in mitigating climate change's adverse effects. The social vulnerability index reveals that about two-thirds of respondents were moderately socially vulnerable to climate change. Farmer's perception, awareness, and knowledge of climate change, adaptive capacity, and land size are the significant drivers of social vulnerability in climate-changing scenarios. There is a need to undertake awareness-increasing programs to change people's attitudes and improve the adaptive capacity of farmers in dealing with current and future climate change by evolving farmers-centric long-term climate adaptation and mitigation policy.

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