Indian Research Journal of Extension Education
ISSN: 0972-2181 (Print), 0976-1071 (e-Print)
NAAS Rating : 5.22
Journal homepage: seea.org.in
RESEARCH ARTICLE
https://doi.org/10.54986/irjee/2022/jul_sep/1-9

# Farmers' Perceptions, Vulnerability and Adaptation Strategies to Climate Change in South-Eastern Rajasthan

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*Received on March 21, 2022, Accepted on May 20, 2022 and Published Online on July 01, 2022*

## ABSTRACT

*Agricultural production in South-eastern Rajasthan is highly vulnerable to the impacts of climate change. A study conducted with randomly selected 150 sample farmers' households from three tehsils of Baran district of South-eastern Rajasthan recorded various responses on farmers' perceptions on climate variability and change and its impact on agriculture and livelihood together with different strategies adopted by farmers to deal with it. 80 per cent of the respondents foresee that the availability of water will reduce in future while 78 per cent have the opinion that monsoon, when compared to the past, receded earlier due to changing climate scenarios in the region. 75 per cent per cent of the respondents expressed their opinion that climate change reduced milk production while 70 per cent have belief in favour of a reduction in crop yield followed by increased incidents of pests and diseases (68%) in crops. In order to withstand the climate change, various coping and adaptation strategies were followed by the farmers which indicate that majority of the farmers(70%)changed the cropping pattern followed by installation of bore well (57%), selling of field trees (40%), selling livestock (38%) adoption of soil and water conservation technologies (37%).The study also identified the extent of vulnerability in sample households and classified 55 per cent as highly vulnerable, 44 per cent in vulnerable and only 01 per cent in a moderately vulnerable group. Income, landholding, education, value orientation (Fatalism), knowledge and attitude were the important and significant variables that affect the level of vulnerability in the study area. The study concludes that perceptions cause farmers to adopt strategies to cope with climate variability, and among the most important are, increased farmer access to timely weather information, skill development and capacity building for various soil and water conservation measures and rural livelihood options besides exposure to agriculture insurance schemes in the region.*

***Key words:*** *Attitude; Adaptation; Climate change; Knowledge; Perception; Vulnerability index*

Farming activities rely on favourable climate conditions and are at risk under a changing climate; thus, it may be expected that farmers will have a long-term perspective on climate because of its direct impact on their livelihoods. Several studies have now examined farmer perspectives of climate change and its risks, as well as the potential adoption of adaptation and mitigation behaviours. India is a large emerging economy with a great variety of geographical regions, biodiversity and natural resources. However, the country is one of the most vulnerable to climate change risks worldwide. More than half of India's population of over 1.25 billion people lives in rural areas and depends on climate-sensitive sectors like agriculture, fisheries and forestry for their livelihoods. Agricultural vulnerability to climate change is one of the greatest challenges facing the sustainability of agricultural production system (*Mase et al., 2017*). Among the different sectors, agriculture is comparatively more vulnerable (*Molua, 2002*), and within the agriculture rain fed regions are considered more vulnerable to climate change and vulnerability. The vulnerability in countries like India could be due to weak institutional capacity, limited engagement in environmental and adaptation issues, and lack of validation of local knowledge. A better understanding

of the local dimensions of vulnerability is therefore, essential to develop appropriate adaptation measures that can mitigate these adverse consequences. So, the risks associated with increasing climate variability pose technological and economic challenges to those communities which are highly dependent on agriculture for their livelihood. However, it is well defined that to what extent climate change has, or is going to have the effect on the productivity and economic viability of agriculture, mainly depend on how much, it is possible to adapt against the adverse impact of climate change and variability and what coping strategies stakeholders are following in a particular region. Adaptation is essential to reduce the negative impacts of climate change and variability on food security and to protect the livelihoods of the poor farmers (*Bryan et al. 2009*). Adaptation can be defined as the adjustments or changes made in the crop production system to minimize the negative impact and, optimize the positive impacts of climate change and variability so as to sustain ecological, social (*Folke, 2006*) and agricultural production systems (*Howden et al., 2007*).). It was noted by *UNDP, 2014* that farmers are failing to adapt/ cope to changes in climate and this has affected their yield and overall, their livelihood. In other words, adaptation reduces the level of damages that might have otherwise occurred. However, the application of adaptation strategies varies from location to location and farmer to farmer depending on the region specific features such as biophysical environment (drought severity, extent of groundwater depletion and rainfall), attributes of new technologies, access to market, institutional setup (credit, extension facilities, access to climate information, agricultural subsidies, social capital, training of farmers), socio-economic status (age, education, farm size etc.) of the farmers and other factors (perception of climate change, financial motives and managerial considerations, perceived effectiveness of adaptive measures, climate risk perception (*Deressa et al., 2011; Alauddin and Sarker, 2014; Li, et al., 2017; Dang, et al., 2017; Zeweld et al., 2017; Ndamani and Watanabe, 2017 and Mase et al., 2017*). Knowing the role of perceptions in influencing current adaptation strategies will enable us to formulate appropriate policies since adaptation helps farmers achieve their food, income and livelihood security objectives in the face of perceptions and other variables. It is important to recognize that in the past many regions and communities have faced harsh changes in environmental conditions and have been trying, testing and adopting different types of coping and adaptation strategies for crop and livestock production over time. Farmers' knowledge and perception of the severity of climate change and its effect on-agriculture is important in the adaptation and mitigation of climate change, since it can influence the willingness of the farmers to act or respond to climate change effects. Region specific enhanced understanding of perception, vulnerability, knowledge, and attitude of people in relation to various environmental changes can contribute to scientific and policy discussions on climate change. Keeping in view the above discussion and issues, the study has been conducted with following specific objectives

- To examine the perception, awareness and extent of knowledge of farmers on climate change and their perceived adverse impact on crop production
- To determine the attitude of farmers and determine the factors influencing knowledge and attitude of farmers towards soil and water conservation technologies under the changing climatic scenario
- To examine level and factor affecting vulnerability and coping strategies in the region

## METHODOLOGY

South-eastern Rajasthan covered an area of eight districts namely; Kota, Bundi, Baran, Jhalawar, Sawaimadhopur, Karuli, Dholpur and Tonk districts. All these districts have about 45-55 percent of rainfed area under agriculture. Following multistage simple random sampling, one district namely; Baran has been selected randomly for the study. In second stage, three tehsils out of eight tehsils namely; Chhabra, Kisanganj and Anta in Baran district selected randomly. One village each from three selected tehsils as Kaidiya nohar, Amlavada and Bijora were finally selected to select ultimate sample households at third stage. A sample of 50 farmers from each village were selected randomly. Thus, a total of 150 sample households were considered to elicit the desired information. Data were collected by interviewing individual farmer with a semi-structured questionnaire supplemented by key informants' interview and focus group discussions. Apart from the sample, line department officials were also involved in study to know the institutional measures which they are taking for tackling climate variability in the region for mitigating climate effects over time. Primary data collected from the farmers consists of perception of risk,

knowledge, attitude, awareness of technologies, and perception on climate change and adaptation measures practiced besides coping strategies. In addition, socio-economic data like; farm assets, irrigation status and source, soil and water conservation measures, income, access to market, contact with extension agency, etc. were also gathered.

The collected information was compiled in Excel format using MS Excel. Frequencies and percentages regarding vulnerability**,** knowledge levels, attitude and adaptive capacity of farmers towards soil and water conservation technologies under the changing climatic scenario have been calculated. To identify the factors responsible for vulnerability and other parameters, regression analysis was employed.

## RESULTS AND DISCUSSION

*Socio-economic-personal characteristics*: The average family size is about seven persons, and family system comprises about 68 per cent as nuclear families. Data on education indicate good trend as 41 per cent of the sample households were educated secondary and above which signifies good adoption potential as exposure to high level of education is an added advantage in terms of climate change adaptation measures. *Maddison (2006),* and *Onubuogu et al. (2014)* observed in their studies that higher education was likely to enhance information access to the farmer for improved technology up take and higher farm productivity. They have also observed that education is likely to enhance the farmers' ability to receive, decipher and comprehend information relevant to making innovative decisions in their farms that education diminishes the probability that no adaptation is taken. Landholding pattern revealed that majority of the farmers (58.7%) under study were marginal farmers followed by small (21.3%) and semi-medium (14.7%) categories. *Deressa et al., 2008* noted that large farm size improves farmers technical, allocative, resource-use efficiency as well as easy adaptation to climate change. 64 per cent of the households maintain less than 4 animals. About 86 per cent of the respondents had agriculture as the main occupation and labour as their subsidiary occupation. However, only 12 per cent of the respondents had dairy as their main occupation. Respondent's average annual income was ₹ 1.1 lakh per household. The share of agricultural income was about 57 per cent while other portion of income realized through other sources like, labour, animal husbandry, government jobs and business activities. The trend of income shows positive relation with farm size (Table 1).

**Table 1. Socio-economic profile of households (N=150)**

| Character/category | No. | % |
|---|---|---|
| *Age* | | |
| <25 Years | 10 | 6.7 |
| 25-50 year | 80 | 53.3 |
| 50-75 years | 54 | 36.0 |
| >75 Years | 6 | 4.0 |
| *Family (Persons)* | | |
| <3 | 11 | 7.3 |
| 3-6 | 86 | 57.3 |
| 7-9 | 29 | 19.3 |
| >9 | 24 | 16.0 |
| *Education Level* | | |
| Illiterate | 26 | 17.3 |
| Primary | 31 | 20.7 |
| Middle | 32 | 21.3 |
| Secondary & > | 61 | 40.7 |
| Land holding size | | |
| <1 ha | 88 | 58.7 |
| >1-2 ha | 32 | 21.3 |
| >2-4 ha | 22 | 14.7 |
| >4-8 ha | 4 | 2.7 |
| >8 ha | 4 | 2.7 |
| No. of animals | | |
| <2 | 51 | 34.0 |
| 2-4 | 45 | 30.0 |
| 4-6 | 24 | 16.0 |
| 6 & above | 30 | 20.0 |

*Mass media exposure*: Mobile (49%) was a very effective mass media in study area followed by Television (37%) and any other means (14%). According to the data furnished in Table 2 the utilization of other mass media like pamphlet, bulletin, agriculture fair, group meeting and films were very low. However, 37 per cent of the farmers visited agricultural exhibitions and farmer's fair occasionally; which showed that there is a need to enhance awareness about climate change and its impacts among the rural community by various mass media sources like television, radio and newspaper in more effective way supplemented with information on mobile. *Knowler and Bradshaw (2007)* and *Deressa et al. (2008)* noted that adequate mass media exposure have a positive relationship with the adoption of agricultural technologies in transferring modern agricultural technologies which can counteract the negative impact of climate change in their area.

**Table 2. Mass media exposure of Sample households**

| Mass media | Exposure | | | | | |
|---|---|---|---|---|---|---|
| | Regularly | | Occasionally | | Never | |
| | No. | % | No. | % | No. | % |
| Newspaper | 37 | 25 | 73 | 49 | 40 | 27 |
| Farm Magazine | 0 | 0 | 40 | 27 | 110 | 73 |
| Television | 56 | 37 | 58 | 39 | 36 | 24 |
| Radio | 1 | 1 | 9 | 6 | 140 | 93 |
| Bulletin | 1 | 1 | 24 | 16 | 125 | 83 |
| Agril.Exhibition/Fair | 2 | 1 | 56 | 37 | 92 | 61 |
| Mobile | 74 | 49 | 34 | 23 | 42 | 28 |
| Internet | 13 | 9 | 21 | 14 | 116 | 77 |
| Demonstration | 0 | 0 | 29 | 19 | 121 | 81 |
| Other | 1 | 1 | 2 | 1 | 147 | 98 |

*Perception about climate change:* It is well defined that different farmers living in different agro-ecological settings perceive the occurrence of climate change differently, study perception results revealed that 82 per cent of the respondents perceived climate change as a problem and 50 per cent of the respondents disagreed with the contention that this problem is not in their region (Table 3). 54 per cent of the farmers perceived that frequency of drought has increased in the last 10-20 years; while 67 per cent of the farmer respondent was agreed in positive with the question whether this frequency will reduce in future. 80 per cent of the respondents also foresee that the availability of water will reduce in future while 78 per cent have the opinion that monsoon, when compared to past, receded earlier due to changing climate scenario in the region. The overall findings reveal that majority of the sample households realized the imminence of the phenomenon and problems of climate change. However, educational campaign needs to be launched for increasing scientific awareness among people in order to promote proactive adaptive interventions. *Maddison (2006),* noted that farmers' access to information on climate change is likely to enhance their probability to perceive climate change, and hence adopt new technologies and take-up adaptation techniques.

*Perceived impacts on livelihood activities of the rural communities*: Study also examine effect of climate change as perceived by farmers or negative consequences related with climate change. Analysing risk perception of farmers is valuable for understanding their behaviour. If people perceive a risk to be real, they behave accordingly. It also helps in determining how they would recover. The insight gained and recording of intended behaviour of the farmers in the event of bad consequences due to climate change would be highly useful in devising a strategy for preparedness and adaptation measures to constant the unfavourable consequences of climate change. Seventy per cent of the respondents expressed negative impacts of

**Table 3. Farmers perceptions about climate change**

| Statement | Farmers responses (%) | | | | |
|---|---|---|---|---|---|
| | SA | A | Un | D | SD |
| Do you perceive that climate change is real. | 33 | 49 | 13 | 3 | 1 |
| I concerned because climate change is a serious problem. | 22 | 56 | 17 | 4 | 1 |
| I concerned because climate change is affecting agriculture in my region. | 32 | 51 | 11 | 5 | 1 |
| I don't think that industrialization is responsible for climate change. | 5 | 30 | 9 | 43 | 13 |
| To my mind, heavy use of fossil fuels has led to rapid global climate change. | 31 | 50 | 13 | 5 | 1 |
| I perceive large-scale deforestation as a reason for the present climate change. | 47 | 43 | 5 | 3 | 2 |
| I think compared to the past, the monsoon rainfall now occurs earlier. | 5 | 23 | 35 | 30 | 7 |
| Compared to the past, now a days the monsoon rainfall retreats earlier. | 27 | 51 | 17 | 6 | 0 |
| To me, the nature and intensity of rainfall have become more unusual in me region. | 17 | 59 | 17 | 6 | 1 |
| I think droughts in my region have become more frequent in comparison of past 10-20 years. | 6 | 48 | 29 | 13 | 4 |
| In the coming 10-20 years, I foresee decrease in frequency of droughts due to climate change. | 0 | 20 | 47 | 28 | 5 |
| I think in the coming 10-20 years, the monsoon rainfall will occurs much earlier than now. | 3 | 20 | 55 | 17 | 5 |
| In the last 10-20 years, there is an increase in heat waves. | 26 | 46 | 23 | 5 | 0 |
| To my mind, the low yields of crops in recent past are due to climate change. | 31 | 54 | 13 | 2 | 0 |
| I personally feel that, in the next 10-20 or so years, livestock in my region will be more adversely affected. | 23 | 64 | 13 | 1 | 0 |
| I don't think that changing sowing date and time would be a better strategy to adapt to climate change. | 7 | 33 | 27 | 31 | 2 |
| In the coming 10-20 years, I foresee more increased water shortages or stress. | 43 | 39 | 14 | 3 | 2 |
| In the coming years, I foresee more and more desertification of arable land. | 2 | 20 | 55 | 17 | 6 |

**Table 4. Climate Change effects on Livelihood (N=150)**

| Effects | Responses | | | |
|---|---|---|---|---|
| | Yes | | No | |
| | No. | % | No. | % |
| Reduces crop yield | 105 | 70 | 45 | 30 |
| Causes ill-health | 99 | 66 | 51 | 34 |
| Reduces milk yield | 113 | 75 | 37 | 25 |
| Increase in diseases and pest infestation | 102 | 68 | 48 | 32 |
| It reduces the amount of rainfall | 26 | 17 | 124 | 83 |
| It causes pollution of the environment | 102 | 68 | 48 | 32 |

climate change on reduction in milk production (75%) followed by reduction in crop yield (70%) and environmental pollution besides increased incidents of pest and diseases in crops (68 %) due to change in climate during the last 10-20 years. These results are in conformity with *Kumari et al., 2020* (Table 4).

*Attitude of farmers towards changing climatic scenario*: Table 5 depicted an attitude of respondents towards climate change which indicate. 59 per cent of the respondent has the opinion that maintaining ecological balance is the duty of the government while 31 per cent respondents thought that community has a more significant role than government in taking initiatives for checking ecological degradation in the area. About 74 per cent of the respondents have the opinion that scientists are capable in finding solutions to the problems of climate change. However, 83 per cent (34% strongly agreed) with the statement "I do worry about the loss of flora and fauna of my area" which is a positive sign for them that they are aware of the possible loss as a result of climate change. In contrast, 28 per cent & 66 per cent of the respondents disagreed with the statement that it is hard to change their habits for more environmentally friendly and effects of climate change are too far in the future to worry them 44 per cent of the farmer respondents had the view that we can afford to lose some biodiversity to meet the requirements for livelihood security. Thus, overall results indicate mixed predisposition of the respondents mainly because of belief system and personality orientation. Attitude for self - initiated adoption behaviour could not be deduced from the results. Hence, it is imperative to provide motivational, attitudinal and infrastructural support to the people in order to develop their capabilities for village-centric adaptive mechanism and measures.

*Factors influencing knowledge and attitude*: To determine factors predicting knowledge and attitude of farmers, statements covering various aspects of climate change were devised and scored based on a 5-point continuum of 'strongly agree' 'agree' 'undecided' disagree and 'strongly disagree' response categories for regression analysis. The results presented in Table 6 reveal that the fourteen variables taken together could explain for around 48 per cent ($R^2$ value being 0.489) of variation in the dependent variable, attitude. Among the fourteen variables, only four variables namely; size of land holding, education, family type, and value

**Table 5. Attitude towards climate change**

| Statements | Farmers response (%) | | | | |
|---|---|---|---|---|---|
| | SA | A | Un | D | SD |
| I do worry about the loss of flora and fauna of my area. | 34 | 49 | 11 | 2 | 4 |
| Humans are capable of finding ways to make adaptation to vagaries of climate change. | 9 | 65 | 17 | 8 | 1 |
| The Scientists will find solutions to the problems of climate change. | 25 | 49 | 21 | 5 | 0 |
| The indigenous knowledge system of the area holds potential in finding solutions to problems related to climate change and making sustainable adaptation for livelihood and survival. | 13 | 53 | 16 | 17 | 1 |
| Climate change is beyond control - it is too late to do anything now. | 31 | 18 | 26 | 17 | 8 |
| It is the wrath of God for the greed and ill ways of humans towards the nature. | 12 | 47 | 6 | 28 | 7 |
| The effects of climate change are too far in the future to really worry me. | 1 | 13 | 20 | 49 | 17 |
| The environment is a low priority for me as compared to livelihood and other things in my life. | 2 | 15 | 30 | 43 | 10 |
| It takes too much effort to do things that are environment friendly. | 24 | 48 | 13 | 0 | 6 |
| I find it hard to change my habits to be more Environment - friendly. | 4 | 32 | 36 | 17 | 11 |
| I don't believe my behaviour, everyday lifestyle and Livelihood activities contribute to climate change. | 2 | 21 | 31 | 33 | 12 |
| We can afford to lose some of the biodiversity of area to meet the livelihood demands of the people of the area. | 3 | 41 | 37 | 14 | 5 |
| There is nothing that I can do personally to help or stop loss of the biodiversity in my area. | 2 | 10 | 31 | 44 | 13 |
| It is the duty of the Government to maintain the ecological balance in the area. | 5 | 54 | 10 | 12 | 19 |
| The community has a larger role than Govt. in taking initiatives for checking ecological degradation in area. | 54 | 40 | 0 | 2 | 4 |

orientation (Fatalism) were the significant factors which determine the attitude of an individual farmer in the study area. All other variables did not show any relationship with the dependent variable. Similarly in case of knowledge only two variables, awareness and value orientation influenced knowledge. *Pravallika and Mazhar (2021)* in their study also revealed that knowledge level of farmers had significant relationship with the independent variables (age, education, annual income, land holding, mass media exposure, extension contact, innovativeness and risk orientation (Table 6&7).

*Adaptation strategies*: Adaptation refers to adjustment made by the people in their behaviour or economic and livelihood patterns that reduce their vulnerability to climate change induced stresses. Important strategies adopted by the sample households in study area to cope with the erratic rainfall and the occurrence of frequent droughts for sustaining livelihood over time, indicate

**Table 6. Determinants of attitude of sample households**

| Independent Variable | Regression Coefficient b(i) | Standard Error Sb(i) | Standardized Coefficient | t- Statistic to Test H0: B (i)=0 | Prob Level |
|---|---|---|---|---|---|
| Intercept | 51.23918 | 8.403593 | 0 | 6.097 | 0.0000 |
| Income | 1.896511E-07 | 4.813348E-06 | 0.004109196 | 0.039 | 0.9686 |
| Land | 0.09985553 | 0.06096553 | 0.1573757 | 1.638 | 0.0038** |
| Gender | -3.267098 | 2.706667 | -0.09694966 | -1.207 | 0.2295 |
| Education | 0.4216025 | 0.2528239 | 0.153859 | 1.668 | 0.0077** |
| Family type | -1.862762 | 0.9833766 | -0.1600501 | -1.894 | 0.0060** |
| Occupation | 0.1826822 | 0.2330032 | 0.06330564 | 0.784 | 0.4344 |
| Social participation_ | 0.2144285 | 0.2872808 | 0.06239622 | 0.746 | 0.4567 |
| Mass media source of communication | 0.1392998 | 0.1900372 | -0.07485143 | -0.733 | 0.4648 |
| Extension contacts | 0.06554995 | 0.145765 | -0.04399323 | -0.450 | 0.6537 |
| Awareness about climate change | 0.05618455 | 0.101545 | -0.05794966 | -0.553 | 0.5810 |
| Experience reg climate change | 0.06673889 | 0.07361182 | -0.07370549 | -0.907 | 0.3662 |
| Fatalism | 0.3446621 | 0.1239117 | 0.2479116 | 2.782 | 0.0062** |
| Dependence on Natural physical and social resources | -0.1538159 | 0.149316 | -0.1046324 | -1.030 | 0.3048 |
| Knowledge | 0.03236556 | 0.1441094 | 0.02036 | 0.225 | 0.8226 |
| $R^2$ = 0.4895353 | **Significant at 1% | | *Significant at 5% | | |

**Table 7. Factors affecting Knowledge**

| Independent Variable | Regression Coefficient b (i) | Standard Error Sb (i) | Standardized Coefficient | t- Statistics to Test H0: β(i)=0 | Prob Level |
|---|---|---|---|---|---|
| Intercept | 29.35595 | 5.072498 | 0 | 5.787 | 0.0000 |
| Income | 3.50565E-06 | 2.85827E-06 | 0.120962 | 1.226 | 0.2221 |
| Land | 0.001976228 | 0.03676311 | 0.004959997 | 0.054 | 0.9572 |
| Gender | 1.897258 | 1.61667 | 0.08965807 | 1.174 | 0.2426 |
| Education | 0.03773206 | 0.1524779 | 0.0219285 | 0.247 | 0.8049 |
| Family type | -0.7534295 | 0.5913992 | -0.1030908 | -1.274 | 0.2049 |
| Occupation | 0.0367563 | 0.1394107 | 0.02028415 | 0.264 | 0.7924 |
| Social participation | 0.01173737 | 0.171891 | 0.005439081 | 0.068 | 0.9457 |
| Mass media | 0.04941782 | 0.1136205 | 0.04228751 | 0.435 | 0.6643 |
| Extension Contact | 0.08337829 | 0.0868079 | 0.08911391 | 0.960 | 0.3385 |
| Awareness about climate change | 0.1730655 | 0.05884719 | 0.2842651 | 2.941 | 0.0039** |
| Experience reg climate change | 5.676612E-06 | 0.04408851 | 9.983642E-06 | 0.000 | 0.9999 |
| Fatalism | -0.1972075 | 0.07416305 | -0.2258945 | -2.659 | 0.0088** |
| Dependence on Natural physical and social resources | 0.04771622 | 0.08941466 | 0.05169038 | 0.534 | 0.5945 |
| Attitude | 0.01153991 | 0.05138208 | 0.01837729 | 0.225 | 0.8226 |
| $R^2$ = 0.4852408 | **Significant at 1% | | *Significant at 5% | | |

that seventy five percent would try to bring change in cropping pattern on year-to-year basis based on past experience followed by establishing bore well (57%) even under condition of deep ground water and lack of resources. In addition, they also resorted to work as Casual labour (69%), selling of field trees (40%), selling livestock (38%), migration for work in nearby towns (44%) to find some job. Therefore, Access to climate change information is an important precondition for farmers' strategies to take up adaptation measures (*Madison, 2006*) (Table 8).

*Role of Soil and water conservation measures for mitigating climate effects*: Soil and water conservation can increase the ability of farmers to adapt to climate change by reducing vulnerability to drought and enriching the local natural resource base on which farm productivity depends. Out of the total 150 respondents 56 were those households who adopted bunding, 16 (LBCD), 6 vegetative bund and 11 farmers used diversification as an adaptation strategy to mitigate the effects of climate change. These measures were adopted either under watershed programme implemented long back or by investing money at their own. However, majority of the farmers had an opinion that some measures are helpful in mitigating climate effects to some extent. The larger impact of these measures solely depends on rainfall pattern, specifications and maintenance of the measures in the region. It was also reported that rural community have renovated a village pond constructed under watershed project implemented long back in Kaidiya nohar village by investing money from MNREGA scheme to ensure drinking water for village animals round the year (Table 9).

*Level and factor affecting vulnerability*: A composite vulnerability index was worked out and respondents were grouped under the categories of highly vulnerable, vulnerable, moderately vulnerable and non-vulnerable.

**Table 8. Different coping strategies adopted by the sample households (N=150)**

| Coping strategies | Responses | | | |
|---|---|---|---|---|
| | Yes | | No | |
| | No. | % | No. | % |
| Migration | 66 | 44 | 84 | 56 |
| Bore-well | 86 | 57 | 64 | 43 |
| Change in cropping pattern | 113 | 75 | 37 | 25 |
| Selling Livestock | 57 | 38 | 93 | 62 |
| Distress selling of assets | 44 | 29 | 106 | 71 |
| Casual labours | 104 | 69 | 46 | 31 |
| Selling of tress from field | 60 | 40 | 90 | 60 |
| Any others | 4 | 3 | 146 | 97 |

**Table 9. Soil and water conservation practices adopted by sample households for mitigating climate effects (N= 150)**

| SWC measures | Constructed by | | Help in mitigating the effects of climate change | | |
|---|---|---|---|---|---|
| | Govt. | Self | fully | To some extent | Not at all |
| Bunding | 36 (24) | 20 (13.3) | 12 (21.4) | 04 (7.1) | 40 (71.4) |
| Contour bund | 01 (0.006) | 02 (0.01) | 00 | 03 (100) | - |
| Loose boulder check dams | 02 (1.33) | 14 (9.33) | 3 (18.75) | 13 (81.2) | - |
| Vegetative bund | 01 (0.006) | 05 (3.33) | 01 (16.66) | 05 (83.4) | - |
| Farm pond | - | 01(0.06) | 01(100) | - | - |
| Agri-horti system | 01 (0.006) | 10 (6.66) | - | 11 (100) | - |
| Community pond * | 01 | - | 100% | - | - |

Figures in parentheses indicate percentage to total

*Constructed under WS programme in Kadhiya nohar village and all respondents supported the view that it helped to mitigate the heat effect as it supplies water to livestock round the year

*Note:* figures in parentheses indicate the percent of total who adopted different soil and water conservation measures among selected households

For each component of vulnerability (awareness about consequences of climate change, perception and attitude towards climate change and adaptation orientation, possession of knowledge and skills about adaptation technologies, social cohesiveness, possession of physical resources, and value orientation like fatalism) sub-indices were worked out using method given by *Sarkar et. al., 2010.* The values of each indicator were normalized to the range of values in the data set by applying the following formula:

$$\text{Index value} = \frac{(\text{Actual value} - \text{Minimum value})}{(\text{Maximum value} - \text{Minimum value})}$$

The overall index was formed from weighted average of the sub-indices, with weights derived from theoretical understanding. The aggregated figure ranged from 0 to 1, where 0 signified highest level of vulnerability. The results revealed a majority of the respondents (about 55%) were in highly vulnerable group followed by about 44 per cent in vulnerable group, while only 01 per cent was in moderately vulnerable group (Table 10). The farmers in the area largely having marginal and small land holdings, poor

knowledge about new technologies applicable under climate variability or stress conditions, besides limited resources hamper adaptation towards climate change together with very high training needs in various areas of adaptation technology could be the factors for their vulnerability. Therefore, adequate training programmes in areas of adaptation technology need to be organized besides launch of social protection measures to empower them for better preparedness and adaptation to the consequences of climate change. The study also identified the factors which are the most important in defining vulnerability of farmers in the area and found that Income, landholding size, Education, Value orientation (Fatalism), Knowledge and attitude were significant variables (Table 11) which affect the level of vulnerability.

## CONCLUSION

The study showed that the majority of the sample households perceived climate change and its negative impact on agriculture, dairying and other natural systems during the last 10-20 years and reflected through increased temperature, reduced and erratic rainfall, increased frequencies of droughts, and infestation of weeds, pests and diseases. Change in cropping patterns, installation of bore wells, selling of field trees and livestock were the major coping adaptation strategies to reduce the effect of climate change in the region. Size of Landholding, education, family type, and value orientation (Fatalism) were the significant factors that determine the attitude of an individual farmer in the study area while awareness and value orientation influenced knowledge. The level of vulnerability indicates that

**Table 10. Distribution of farmers according to their level of vulnerability (N=150)**

| Vulnerability index intervals | No. | % |
|---|---|---|
| Highly Vulnerable (> 0.312) | 66 | 44 |
| Vulnerable (0.312-0.668) | 83 | 55 |
| Mod. Vulnerable (0.6678<) | 01 | 01 |
| Mean: 0.327 and SD: 0.089 | | |

**Table 11. Factors affecting level of vulnerability**

| Independent Variable | Regression coefficient b(i) | Standard error Sb(i) | Standardized coefficient | t- statistic to test H0: β(i)=0 | Prob level |
|---|---|---|---|---|---|
| Intercept | -0.1777536 | 0.0005545121 | 0.0000 | -320.559 | 0.0000 |
| Income | 3.101035E-07 | 2.812388E-10 | 0.4100 | 1102.634 | 0.0000** |
| Land | 0.003026459 | 3.597349E-06 | 0.2910 | 841.303 | 0.0000** |
| Gender | -0.0002604547 | 0.0001589978 | -0.0005 | -1.638 | 0.1037 |
| Education | 0.02462523 | 1.492351E-05 | 0.5483 | 1650.096 | 0.0000** |
| Family type | 7.791068E-05 | 5.821588E-05 | 0.0004 | 1.338 | 0.1831 |
| Occupation | 1.706335E-05 | 1.364501E-05 | 0.0004 | 1.251 | 0.2133 |
| Social participation | 1.601287E-05 | 1.68 2001E-05 | 0.0003 | 0.952 | 0.3428 |
| Mass media source of communication | 9.592348E-06 | 1.112568E-05 | 0.0003 | 0.862 | 0.3901 |
| Extension contacts | -6.151316E-06 | 8.523221E-06 | -0.0003 | -0.722 | 0.4717 |
| Awareness about climate change | -5.196162E-06 | 5.939857E-06 | -0.0003 | -0.875 | 0.3833 |
| Experience reg climate change | 3.121752E-06 | 4.314109E-06 | 0.0002 | 0.724 | 0.4706 |
| Fatalism | -1.622295E-05 | 7.444557E-06 | -0.0007 | -2.179 | 0.0311* |
| Dependence on Natural physical and social resources | -5.320333E-06 | 8.758546E-06 | - | -0.607 | 0.5446 |
| Knowledge | 0.006632408 | 8.421681E-06 | 0.2541 | 787.540 | 0.0000** |
| Attitude | 0.003824912 | 5.028732E-06 | 0.2334 | 760.612 | 0.0000** |
| $R^2 = 0.99$ | **Significant at 1% | | *Significant at 5% | | |

99 per cent of respondents were categorised as either highly vulnerable or vulnerable. Income, landholding, education, value orientation (Fatalism), knowledge and attitude were the important and significant variables that affect the level of vulnerability in the study area. The study also suggests that future thrust of climate change impact studies should examine the relationship between perceptions and all forms of infrastructure available in the region, as well as the consistency of irrigation–perception relationships in other regions and under different farming systems.

## CONFLICTS OF INTEREST

The authors have no conflicts of interest.

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