***Original Research Article***

**ASSOCIATION BETWEEN PROFILE OF FARMERS AND THEIR VULNERABILITY TOWARD CLIMATE CHANGE IN SOUTH GUJARAT**

**ABSTRACT**

 Climate change has emerged as one of the most persistent global challenges affecting the farmers in developing countries like India especially the small and marginal farmers whose primary source of livelihood is agriculture. They are most vulnerable to climate change due to their high dependence on natural resources, limited adaptive capacity, lack of access to modern technology, financial support and timely information. This study aims to assess the vulnerability of farmers due to climate change and their association with a focus on socio-economic, environmental and institutional factors. The present study was conducted in Navsari, Surat and Tapi districts of South Gujarat using ex-post facto research design. From each district, three talukas were selected and from each taluka two villages were selected. From each village 15 respondents were selected randomly comprising a total of 270 respondents. It was found that the majority (72.22 %) of the farmers had medium to high level of vulnerability towards climate change. Age and farming experience had positively associated at five per cent level of significance while, extension contacts is positively and significantly associated with the vulnerability of farmers toward climate change relationship at one per cent level of significance. Annual income has negatively associated with the vulnerability of farmers toward climate change at five per cent level of significance whereas social participation and decision making ability is negatively associated with the vulnerability of farmers toward climate change at five per cent level of significance. Social participation, extension contacts and decision making ability were accounting about 15.10 per cent variation on the vulnerability of farmers toward climate change.

**Keywords:** Vulnerability, farmers, climate change, correlation, regression, arbitrary

1. **INTRODUCTION**

 Climate refers to conditions of the [atmosphere](https://www.britannica.com/science/atmosphere) at a particular location over a long period of time – it includes patterns of temperature, precipitation (rain or snow), humidity, wind patterns and seasons (Krishnamurti and David, 2025). Climate change is affecting agriculture by inducing changes on farmers’ behaviour, quantity and quality, cost of production, changes in production, consumption, prices and trade patterns, fluctuations in market responses at global and local levels. These changes are not only depending on the domestic and global adaptive capacity but their economic impact also varies by region, sector and various stakeholder groups (Watson *et. al*., 1996). A decrease in the availability of water for irrigation is likely due to rainfall deficits caused by the intensity of droughts, reducing the amount of irrigated food production (Anon., 2002). Crop losses may raise due to increased climate variability, and this impact will be one of the deciding issues that manipulate future food security (Ranganathan *et al.*, 2010).

The developing countries, India may be most vulnerable to climate change due to its high reliance on natural resources mainly agriculture, inability to adapt financially and institutionally, low per capita GDP, extreme poverty and huge population. Temperature and rainfall are the most important crucial factors which affect plant development, growth and yield. So, any changes in the climate will adversely affect the productivity of the major crops through changes in the phenological process of the crop. Rawson (1995) reported that biomass and yield of major crops tend to decline with increasing temperature, as higher temperature shortens crop duration, enhances respiration and reduces time for radiation interception. The frequency of different climatic extreme events like drought, flood, cyclone, sea surge etc. tends to increase under changing climatic scenario. All these changes will affect our agricultural production negatively in long run. Among these different sectors, agriculture is highly sensitive to climate change where a large number of small and marginal farmers depend on agriculture and allied activities for their livelihood (Nanjappan, B. and Parameswaranaik, J., 2018).

Gujarat, located in the dry and semi-arid region of India, is particularly vulnerable to these processes due to its dependence on monsoon precipitation, which is characterized by significant variability (Bhatla *et al.*, 2025). The Gujarat suffers from water scarcity every year, particularly during the summer (Bandyopadhyay, 2022). Coastal regions of Gujarat are particularly vulnerable to the impacts of climate change, including sea-level rise and increased coastal erosion.

 Understanding the dimensions and drivers of farmers' vulnerability is critical for designing effective adaptation strategies and resilience-building interventions. The main aim of this study to understand the extent of vulnerability experienced by farmers due to climate change, identify the major contributing factors and provide insights into potential policy and extension interventions that can enhance the adaptive capacity of farming communities. With this background present study was conducted with following objectives;

**1.1 OBJECTIVES**

* To analyse the vulnerability of farmers due to climate change
* To study the association between profile of farmers and their vulnerability toward climate change
1. **METHODOLOGY**

 The present study was conducted in South Gujarat region.The districts of South Gujarat region are Bharuch, Narmada, Surat, Tapi, Valsad, Navsari and The Dangs. Out of these districts, three district Navsari, Surat and Tapi were selected purposively. From each district, three talukas were selected. From each taluka, two villages were selected randomly. From each village, 15 farmers were selected randomly. Thus, total 270 farmers were selected for the present study. An *ex-post-facto* research design was used in the present investigation. The vulnerability of farmers due to climate change was measured with the help of well structured interview schedule consisting 30 statements in six sections. The variable arranged on a continuum of strongly agree, agree, undecided, disagree and strongly disagree with scoring of 5, 4, 3, 2 and 1, respectively. The vulnerability score of each respondent can be calculated by summing the scores obtain by him on all the items. The maximum and minimum score each respondent could obtain were 150 and 30, respectively. An arbitrary method was used for categorization of each section. For that the higher score is subtracted from the lower score and divided by the number of categories. The obtained score is added into the lower score until you get the highest score. The statistical measures mean, frequency, percentage, standard deviation, range, arbitrary method, correlation and regression were used in the study by using IBM SPSS Version 29 and Python.

1. **RESULTS AND DISCUSSION**

**3.1 Vulnerability of farmers due to climate change**

Vulnerability was operationalized as the inability of individuals/households to cope up with or adapt to climate change induced stresses placed on their livelihood and well-being. The data were collected from respondents and grouped into five categories *viz.,* as presented in figure 1.

**Figure 1:** **Distribution of farmers according to their level of vulnerability to climate change**

 The data presented in figure 1 revealed that 50.37 per cent farmers had medium level of vulnerability followed by 22.22 per cent had high level, 10.74 per cent very low level, 10.00 per cent had low level and 06.67 per cent had very high level of vulnerability, respectively. Hence, it has been concluded that majority (72.22 %) of the farmers had medium to high level of vulnerability. The probable reason may be socio-economic constraints such as small landholdings, limited income sources, low access to formal credit and minimal asset ownership reduce their ability to cope with and recover from climate-induced stresses. This finding has been supported by the findings of Das (2021).

**3.2 Association between profile of farmers and their vulnerability toward climate change**

The association between vulnerability of farmers toward climate change and independents variables *viz.,* age, education, family size, farming experience, occupation, land holding, annual income, social participation, extension contacts, mass media exposure, innovativeness, information seeking behaviour, scientific orientation, risk orientation, economic orientation and decision making ability were worked out with the help of correlation coefficient (*r*) and data are presented in table 1 and figure 2.

**Table 1:** **Association between profile of farmers and their vulnerability toward climate change**

 **(n=270)**

|  |  |  |
| --- | --- | --- |
| **Sr. No.** | **Independent variables** | **Correlation coefficient (*r*)** |
| 1. | Age | 0.133\* |
| 2. | Education | -0.103NS |
| 3. | Family size | 0.010NS |
| 4. | Farming experience | 0.130\* |
| 5. | Occupation | 0.104NS |
| 6. | Land holding | -0.114NS |
| 7. | Annual income | -0.130\* |
| 8. | Social participation | -0.259\*\* |
| 9. | Extension contacts | 0.230\*\* |
| 10. | Mass media exposure | 0.034NS |
| 11. | Innovativeness | -0.046NS |
| 12. | Information seeking behaviour | -0.050NS |
| 13. | Scientific orientation | -0.025NS |
| 14. | Risk orientation | 0.109NS |
| 15. | Economic orientation | 0.040NS |
| 16. | Decision making ability | -0.200\*\* |
| \*Significance at 5 % \*\* Significance at 1 % NS= Non Significant |

1. **Age and Vulnerability Toward Climate Change**

 The data presented in table 1 and figure 2 indicated that vulnerability of farmers toward climate change were found positively and significant relationship with their age (*r*=0.133\*) at 5 % level of significance. So null hypothesis was rejected and alternative hypothesis was accepted. It means that the education of the farmers exerts its influence on vulnerability toward climate change of the respondent farmers. This may be due to older farmers often rely on traditional farming methods and may be less likely to adopt new technologies or climate-resilient practices compared to younger counterparts. Their physical capacity to adapt, engage in labour-intensive adaptation measures, or diversify income sources is often limited. This finding was similar with findings of Shankara *et al*. (2023) and Das (2021).

1. **Education and Vulnerability Toward Climate Change**

 The data presented in table 1 and figure 2 revealed that vulnerability of farmers toward climate change were found negatively and non significant relationship with their education (*r*=-0.103NS). Hypothesis (H0): There is no relationship between the vulnerability of farmers toward climate change with their education was therefore, accepted. It means that the education of the farmers does not exert its influence on vulnerability toward climate change of the respondent farmers. This is because formal education does not necessarily equip farmers with practical knowledge on climate resilience. These findings are in conformity with the findings of Shinde (2024).

1. **Family Size and Vulnerability Toward Climate Change**

 The data presented in table 1 and figure 2 revealed that vulnerability of farmers toward climate change were found positive and non significant relationship with their family size (*r*=0.010NS). Hypothesis (H0): There is no relationship between the vulnerability of farmers toward climate change with their family size was therefore, accepted. It means that the family size of the farmers does not exert its influence on vulnerability toward climate change of the respondent farmers. This might be due to that not all members of larger families are actively involved in farming activities, some may be too young, elderly, pursuing education or working in non-agricultural occupations, also larger families may also increase household expenses which can offset any potential benefits so its leading not that much impact on vulnerability. These findings are in conformity with the findings of Shankara *et al.* (2023).

1. **Farming Experience and Vulnerability Toward Climate Change**

The data presented in table 1 and figure 2 indicated that vulnerability of farmers toward climate change were found positively and significant relationship with their farming experience (*r*=0.130\*) at 5 % level of significance. So null hypothesis was rejected and alternative hypothesis was accepted. It means that the farming experience of the farmers exerts its influence on vulnerability toward climate change of the respondent farmers. This may be because experienced farmers having observed long-term climatic patterns and changes over the years. Additionally, experienced farmers often adhere to conventional farming methods that may be less adaptive to current climate variability. These findings are in similarity with the findings of Das (2021) and Baisakhee (2024).

1. **Occupation and Vulnerability Toward Climate Change**

 The data presented in table 1 and figure 2 revealed that vulnerability of farmers toward climate change were found positive and non significant relationship with their occupation (*r*=0.104NS). Hypothesis (H0): There is no relationship between the vulnerability of farmers toward climate change with their occupation was therefore, accepted. It means that the occupation of the farmers does not exert its influence on vulnerability toward climate change of the respondent farmers.

1. **Land Holding and Vulnerability Toward Climate Change**

 The data presented in table 1 and figure 2 revealed that vulnerability of farmers toward climate change were found negatively and non significant relationship with their land holding (*r*=-0.114NS). Hypothesis (H0): There is no relationship between the vulnerability of farmers toward climate change with their land holding was therefore, accepted. It means that the land holding of the farmers does not exert its influence on vulnerability toward climate change of the respondent farmers. These findings are in conformity with the findings of Shankara *et al.* (2023).

1. **Annual Income and Vulnerability Toward Climate Change**

 The data presented in table 1 and figure 2 indicated that vulnerability of farmers toward climate change were found negatively and significant relationship with their annual income (*r*=-0.130\*) at 5 % level of significance. So null hypothesis was rejected and alternative hypothesis was accepted. It means that the annual income of the farmers exerts its negatively influence on vulnerability toward climate change of the respondent farmers. This is may be due to if they have low annual income, they were more vulnerable they can’t invest their money in advance technology or practices. These findings are in conformity with the findings of Baisakhee (2024).

1. **Social Participation and Vulnerability Toward Climate Change**

 The data presented in table 1 and figure 2 indicated that vulnerability of farmers toward climate change were found negatively and significant relationship with their social participation (*r*=-0.259\*\*) at 1 % level of significance. So null hypothesis was rejected and alternative hypothesis was accepted. It means that the social participation of the farmers exerts its negatively influence on vulnerability toward climate change of the respondent farmers. These findings are in similar with the findings of Baisakhee (2024).

1. **Extension Contacts** **and Vulnerability Toward Climate Change**

 The data presented in table 1 and figure 2 indicated that vulnerability of farmers toward climate change were found positive and significant relationship with their extension contacts (*r*=0.230\*\*) at 1 % level of significance. So null hypothesis was rejected and alternative hypothesis was accepted. The probable reason might be extension services are currently more reactive than proactive with contact increasing primarily after the onset of climate-related stress.These findings are in conformity with the findings of Baisakhee (2024).

1. **Mass Media Exposure** **and Vulnerability Toward Climate Change**

The data presented in table 1 and figure 2 revealed that vulnerability of farmers toward climate change were found positive and non significant relationship with their mass media exposure (*r*=0.034NS). Hypothesis (H0): There is no relationship between the vulnerability of farmers toward climate change with their mass media exposure was therefore, accepted. It means that the mass media exposure of the farmers does not exert its influence on vulnerability toward climate change of the respondent farmers.

1. **Innovativeness** **and Vulnerability Toward Climate Change**

 The data presented in table 1 and figure 2 revealed that vulnerability of farmers toward climate change were found negatively and non significant relationship with their innovativeness (*r*=-0.046NS). Hypothesis (H0): There is no relationship between the vulnerability of farmers toward climate change with their innovativeness was therefore, accepted. It means that the innovativeness of the farmers does not exert its influence on vulnerability toward climate change of the respondent farmers. These findings are in conformity with the findings Shankara *et al.* (2023).

1. **Information Seeking Behaviour** **and Vulnerability Toward Climate Change**

 The data presented in table 1 and figure 2 revealed that vulnerability of farmers toward climate change were found negatively and non significant relationship with their information seeking behaviour (*r*=-0.050NS). Hypothesis (H0): ‘There is no relationship between the vulnerability of farmers toward climate change with their information seeking behaviour was therefore, accepted. It means that the information seeking behaviour of the farmers does not exert its influence on vulnerability toward climate change of the respondent farmers. This finding was similar with findings of Das (2021).

1. **Scientific Orientation** **and Vulnerability Toward Climate Change**

 The data presented in table 1 and figure 2 revealed that vulnerability of farmers toward climate change were found negatively and non significant relationship with their scientific orientation (*r*=-0.025NS). Hypothesis (H0): There is no relationship between the vulnerability of farmers toward climate change with their scientific orientation was therefore, accepted. It means that the scientific orientation of the farmers does not exert its influence on vulnerability toward climate change of the respondent farmers. These findings are in conformity with the findings of Das (2021).

1. **Risk Orientation** **and Vulnerability Toward Climate Change**

 The data presented in table 1 and figure 2 revealed that vulnerability of farmers toward climate change were found positive and non significant relationship with their risk orientation (*r*=0.109NS). Hypothesis (H0): There is no relationship between the vulnerability of farmers toward climate change with their risk orientation was therefore, accepted. It means that the risk orientation of the farmers does not exert its influence on vulnerability toward climate change of the respondent farmers. These findings are in conformity with the findings of Das (2021).

1. **Economic Orientation** **and Vulnerability Toward Climate Change**

 The data presented in table 1 and figure 2 revealed that vulnerability of farmers toward climate change were found positive and non significant relationship with their risk orientation (*r*=0.040NS). Hypothesis (H0): There is no relationship between the vulnerability of farmers toward climate change with their economic orientation was therefore, accepted. It means that the economic orientation of the farmers does not exert its influence on vulnerability toward climate change of the respondent farmers. These findings are in conformity with the findings of Das (2021).

1. **Decision Making Ability** **and Vulnerability Toward Climate Change**

 The data presented in table 1 and figure 2 indicated that vulnerability of farmers toward climate change were found negatively and significant relationship with their decision making ability (*r*=-0.200\*\*) at 1 % level of significance. So null hypothesis was rejected and alternative hypothesis was accepted. It means that the decision making ability of the farmers exerts its negatively influence on vulnerability toward climate change of the respondent farmers.



**Figure 2:** **Correlation heatmap of association of profile of farmers with their vulnerability towards climate change**

**3.3 Stepwise Regression Analysis of Independent Variables and Vulnerability towards climate change**

 Stepwise multiple regression analysis was carried out with 16 independent variables and vulnerability towards climate change as dependent variable. The data are presented in table 2.

**Table 2: Stepwise multiple regression analysis of independent variables and vulnerability**

 **(n=270)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Sr. No.** | **Independent variable** | **Partial regression coefficient (b)** | **Standard error** | **Multiple Correlation Coefficient ‘R’** | **Adjusted R2** |
| 1. | (Constant) | 92.034 | 7.350 | 0.401 | 0.151 |
| 2. | Social participation (X8) | -6.439 | 1.351 |
| 3. | Extension contacts (X9) | 0.976 | 0.228 |
| 4. | Decision making ability (X16) | -0.809 | 0.254 |

As a result of stepwise regression analysis, the following model was obtained:

*Y2 = a +b8X8+ b9X9+ b16X16*

Where,

*Y2*= Resilience

*a* = the intercept i.e., -92.034

*bi* = Regression coefficient, *i* = 1,2,3…., n

*X8*=Social participation

*X9*= Extension contacts

*X16*= Decision making ability

 Therefore, the fitted equation would be as under:

*Y2* = 92.034+ -6.439 *X8*+ 0.976 *X9* + -0.809 *X16*

The data presented in table 2 revealed that out of 16 independent variables, three variables namely social participation (-6.439), extension contacts (0.976) and decision making ability (-0.809) were significantly influencing on the vulnerability of farmers toward climate change. All the three independent variables together accounted 15.10 per cent variation as indicated by adjusted R2 value for vulnerability of farmers towards climate change.

**4.**  **CONCLUSION**

It can be concluded that majority of the farmers had medium to high level of vulnerability. Age and farming experience had positive and significant relationship with vulnerability of farmers toward climate change at five per cent level of significance while, extension contact has positive and significant relationship with vulnerability of farmers toward climate change at one per cent level of significance. Annual income had negative and significant relationship with vulnerability of farmers toward climate change at five per cent level of significance. Decision making ability and social participation had negative and significant relationship with vulnerability of farmers toward climate change at one per cent level of significance. Out of the 16 independent variables social participation, extension contacts and decision making ability were accounting about 15.10 per cent variation in the vulnerability of farmers toward climate change.

**DISCLAIMER (ARTIFICIAL INTELLIGENCE)**

 Author(s) hereby declares that no generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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