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Vulnerability to climatic variability and its association with independent variables among dairy farmers in Jharkhand

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ABSTRACT

Jharkhand owns a huge cattle population of 8.78 million. Despite of having this large number of animals, the production of milk in the state is not satisfactory. The attributing factors behind this are many like low producing animals, deficiencies in feed and fodder, poor knowledge of dairy farmers about the scientific rearing practices etc. In past few decades, climate has also changed abruptly which impacts the animals directly or indirectly and thus increasing the vulnerability of dairy farming. In this context, the study to know the vulnerability of dairy farmers to climatic variability and its association with independent variables was conducted. The present study encompassed 240 respondents from 6 districts that fall under three different agro-climatic regions of Jharkhand. Vulnerability Index (VI) was used to determine the extent of vulnerability of the respondents. The indicator method in conjunction with Principal Component Analysis (PCA) was utilized to assess the VI. The results obtained showed that 58.75% of the respondents were in the moderately vulnerable group followed by 32.92% and 8.33% respondents belonging to highly and less vulnerable group, respectively. However there was no significant difference in region-wise distribution of these respondents. Out of seven indicators used, attitude of respondents towards climate change contributed most followed by risk perception, awareness level, social cohesiveness, knowledge about adaptation practices, fatalism and level of dependence, respectively. The independent variables like age, education, gender, farming experience, land holding, annual income, SES, and the psychological variables were significantly correlated with vulnerability ($p < 0.01$). Caste was also found to be a significant factor, but at a lower threshold ($p < 0.05$). The above findings suggested that targeted awareness campaigns and training programs should be organized to shift the farmer's attitudes towards a more favorable stance. In this regard, the SAUs/SVUs and State A.H. departments can contribute a lot. Along with this, an effective and long-term action plan pertaining to climate change should be formulated by the policymakers to minimize the risks and vulnerability faced by dairy farmers due to climate change.

Key words: Vulnerability, Climate change, Dairy farmers, Jharkhand

1. INTRODUCTION

Livestock plays a significant role in the agriculture of Jharkhand contributing 27% of the total agricultural value output. Over the years, rural areas of the state have traditionally reared various livestock species, with cattle and goats being the major contributors to the livestock population. According to the 20th Livestock Census, the state owns 8.78 million cattle. Despite of having this huge cattle population, the production of milk in the state is poor. The milk productivity of cows in Jharkhand is reported at 1.59 kg per day, significantly lower than the national average of 3.0 kg per day. Similarly, the annual per capita availability of milk is only 47.45 kg which is significantly lower than the national average of 96.0 kg (Deogharia, 2018).

The low productivity of dairy animals in Jharkhand is attributed by various factors like rearing of low producing animals, deficiencies in feed and fodder, poor knowledge of dairy farmers about the scientific rearing practices and inadequate decision-making processes. The condition is further aggravated by the changing climate in past few decades which impacts the animals both directly and indirectly and thus increasing the vulnerability of dairy farming.

Climate change is a complex phenomenon that takes a certain time period for recognition. It is mainly indicated by the shifting temperature, humidity and rainfall patterns either locally or globally. The state Jharkhand has also witnessed this shift which is mentioned in the "Jharkhand – Action Plan on Climate Change" prepared by the Government of Jharkhand. This Action Plan highlights concerns regarding deviations in temperature patterns, particularly in the city of Ranchi. Data from 2001 to 2006 clearly indicates that Ranchi had experienced significant deviations from its normal temperature and the highest average annual temperature was recorded in the month of May. According to Gupta (2013), 20% of the annual precipitation in the state is lost in the atmosphere due to evaporation, 50% flows as surface runoff, and 30% infiltrates in the ground to replenish soil moisture and groundwater. Such changes in precipitation patterns and water distribution ultimately have implications for the production and health parameters of livestock, both directly and indirectly, making the dairy sector vulnerable.

The Intergovernmental Panel on Climate Change (IPCC) in 2001 defined vulnerability to climate change as the susceptibility of a system to adverse effects, including those from climate variability and extremes. Vulnerability arises from the character, magnitude, and rate of climate variation to which a system is exposed, combined with the system's inherent sensitivity and adaptive capacity. In response to vulnerability assessments, the IPCC has recommended integrating the potential impacts of climate change into national and local-level development plans.

In this context, the following objectives were determined and assessed

1. To assess the vulnerability of dairy farmers
2. To identify the most contributing factor for their vulnerability and
3. To find out the association between vulnerability and the independent variables under study.

2. MATERIALS AND METHODS

The present study was conducted in Jharkhand, a state often called Vananchal. The state falls within Agro-climatic Region VII of India (Eastern Plateau and Hill Region).

According to the National Institute of Disaster Management (NIDM), the state is further divided into three agro-climatic regions. Two districts were randomly selected from each region for the present study. Ranchi and Hazaribagh from Region I (Central North-eastern Plateau), Latehar and Khunti from Region II (Western Plateau), and Seraikela Kharsawan and East Singhbhum from Region III (South-eastern Plateau). From each district, two blocks and from each block, two villages were randomly chosen. From each village, ten dairy farmers owning at least two dairy animals and having a minimum of ten years of farming experience were selected as respondents. Thus, a total of 240 respondents were included in the study and interviewed using a pre-structured interview schedule to generate and meaningfully interpret the data.

Vulnerability Index (VI) was used to determine the extent of vulnerability of the respondents. The indicator method in conjunction with Principal Component Analysis (PCA) was utilized to assess the VI. The Seven indicators identified and measured were as follows;

1. Level of awareness about climate change - Modified "bad consequence" scale (3-point continuum) of O'Connor *et al.* (1999).
2. Attitude towards climate change - Modified scale (5-point continuum) of DEFRA (2007)
3. Knowledge about adaptation practices - Modified scale (dichotomous continuum) of Austin *et al.* (1998)
4. Fatalism - Modified scale (5-point continuum) of Leiserowitz (2006)
5. Social cohesiveness - Structured schedule (dichotomous continuum scale)
6. Risk perception - Structured schedule (5-point continuum scale)

7. Level of dependence on natural and social resources - Structured schedule (3-point continuum scale)

The raw data of each indicator was then normalized to standardize their values within a comparable range using method adopted from the computation of the life expectancy index of HDI by Hahn *et al.* (2009).

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

Following normalization, each indicator was subjected to factor analysis using PCA (Principal Component Analysis). Based on the criterion of an Eigenvalue greater than one, the components were extracted. Further, these extracts were subjected to Varimax rotation for each indicator. Subsequently, the method outlined by Maiti (2013) and Raghuvanshi and Ansari (2020) was used to assign weights to the indicators. Finally, the Vulnerability Index of each farmer was calculated by using the following formula:

$$VIj = \frac{\Sigma\, WiNVij}{\Sigma\, Wi}$$

Where,

VIj – Vulnerability index of the j^{th} respondent

NVij – Normalized value of the i^{th} indicator for the j^{th} respondent

∑Wi – Summated value of weightage of all indicators

n – No. of indicators

The Vulnerability Index (ranging from 0 to 1) for each respondent was measured. Further, the respondents were categorized into three groups on the basis of equal class distribution. A higher vulnerability index indicates a lower level of vulnerability, and conversely, a lower index indicates higher vulnerability.

3. RESULTS AND DISCUSSION

3.1. Vulnerability of dairy farmers due to climatic variability

Vulnerability, at the household level, refers to the extent to which a farmer is susceptible to and unable to cope with the adverse effects of climate change. By considering various dimensions of individual (awareness, attitude, knowledge, and perception), social (fatalism and social cohesiveness), and physical (level of dependence on natural and social resources), an effort was made to construct a vulnerability index for sample households, drawing upon methodologies employed by TERI (2003) and UNDP (2002). Following a careful study of all indicators, the results obtained are presented in Table 1.

Table 1: Region-wise distribution of respondents according to different indicators of vulnerability

Category	Region I *f* (%)	Region II *f* (%)	Region III *f* (%)	Pooled *f* (%)
A. Awareness about climate change				
• Less aware (Up to 28) • Moderately aware (29 to 41) • Highly aware (Above 41)	25 (31.25) 49 (61.25) 6 (7.50)	11 (13.75) 44 (55.00) 25 (31.25)	14 (17.50) 46 (57.50) 20 (25.00)	50 (20.83) 139 (57.92) 51 (21.25)
Chi-square = 18.2051	p = 0.001125**			
B. Attitude towards climate change				
• Less favourable (Up to 48) • Moderately favourable (49-62) • Highly favourable (Above 62)	34 (42.50) 41 (51.25) 5 (6.25)	24 (30.00) 45 (56.25) 11 (13.75)	29 (36.25) 48 (60.00) 3 (3.75)	87 (36.25) 134 (55.83) 19 (7.92)
Chi-square = 7.7501	p = 0.101175			

C. Knowledge about adaptation practices				
• Low (Up to 3) • Medium (4-5) • High (More than 5)	12 (15.00) 33 (41.25) 35 (43.75)	17 (21.25) 35 (43.75) 28 (35.00)	3 (3.75) 36 (45.00) 41 (51.25)	32 (13.34) 104 (43.33) 104 (43.33)
Chi-square = 12.0144	p = 0.017244*			
D. Fatalism				
• Low (Up to 3) • Medium (4-5) • High (More than 5)	4 (5.00) 37 (46.25) 39 (48.75)	15 (18.75) 50 (62.50) 15 (18.75)	22 (27.50) 28 (35.00) 30 (37.50)	41 (17.08) 115 (47.92) 84 (35.00)
Chi-square = 28.9314	p = 0.00001**			
E. Social cohesiveness				
• Low (Up to 3) • Medium (4) • High (5)	56 (70.00) 20 (25.00) 4 (5.00)	64 (80.00) 16 (20.00) 0 (0.00)	54 (67.50) 22 (27.50) 4 (5.00)	174 (72.50) 58 (24.17) 8 (3.33)
Chi-square = 5.931	p = 0.204			
F. Risk perception				
• Low (Up to 80) • Medium (81 to 87) • High (more than 87)	22 (27.50) 45 (56.25) 13 (16.25)	18 (22.50) 42 (52.50) 20 (25.00)	21 (26.25) 38 (47.50) 21 (26.25)	61 (25.42) 125 (52.08) 54 (22.50)
Chi-square = 3.1293	p = 0.536419			
G. Level of dependence on natural and social resources				
• Low (Up to 6) • Medium (7 to 9) • High (More than 9)	9 (11.25) 58 (72.50) 13 (16.25)	2 (2.50) 48 (60.00) 30 (37.50)	16 (20.00) 59 (73.75) 5 (6.25)	27 (11.25) 165 (68.75) 48 (20.00)
Chi-square = 32.6093	p = 0.00001**			

Awareness about climate change

57.92% of the respondents were moderately aware of climate change whereas, 21.25% and 20.83% respondents were highly and less aware of climate change, respectively. The region-wise distribution of respondents showed a statistical significant difference ($p < 0.01$). The result indicated non-ignorance of respondents about climate change and their awareness about existence, cause, features and impacts of climate change. The findings are in line with the findings of Raghuvanshi and Ansari (2020) but contradict with those of Escarcha *et al.* (2018), who reported highly aware farmers rearing water buffalo.

Further the detail analysis revealed that majority of the respondents were fully aware about climate change caused by excessive burning of fossil fuels (51.67%), increase in temperature during summers (52.08%), decline in rainfall (65%), deteriorating quality of natural rangeland (47.50%), extreme vulnerability of agriculture to climate change (68.33%), adverse effect on rainfed crops due to changing precipitation pattern (62.50%) and reduced feed intake of livestock due to heat stress (74.17%).

Most of the farmers were somewhat aware about changing land use pattern, deforestation, land clearing, agriculture and other activities resulting into increased emission of carbon dioxide causing climate change (56.67%), prolonged summer (64.58%), delayed onset of monsoon (62.50%), unpredictable rainfalls (73.33%), delayed onset of winters (57.92%), occurrence of fog during winter season (50%), long dry spells and increased rate of draught (47.92%), increased heat and cold waves (77.08%), change in the season cycle during the last 10-15 years (62.08%), rise in extreme climatic events (57.08%), severe water shortage due to changing rainfall pattern (59.17%), reduced soil moisture and increased evaporation and transpiration increasing land degradation and desertification (49.17%), 'Water stress' for human-beings and livestock due to lowering of underground water level (44.17%), increased risk of extinction for

many species (47.08%), increase in endemic morbidity and mortality due to vector born diseases (67.92%), high temperature reducing crop yield, whereas encouraging weed and pest proliferation (79.17%), changing precipitation pattern causing increase in the incidence of crop failure and decline in production (67.08%), reduced fertility due to heat stress (49.17%), increased temperature and humidity causing decline in milk production (60%) and increased rate of temperature-related illness and vector borne diseases among livestock (71.67%). Most farmers were unaware of climate change caused by excessive emission of greenhouse gas (74.16%), short winters (67.92%) and changes in temperature and precipitation as the key 'Climate-related risks' (53.33%). Similarly, Escarcha *et al*. (2018) reported high awareness of the increasing frequency of extreme events and Mysaa *et al.* (2021) observed awareness regarding the impact of climate change on dairy cattle performance and health.

Attitude towards climate change

55.83% of the respondents showed a moderately favorable attitude towards the climate change while 36.25% showed a less favorable attitude. Only 7.92% respondents were identified with a highly favorable attitude. The region-wise distribution of respondents showed statistically non-significant difference. The findings is likely due to the less distinct impact of climate change on the dairy animals, particularly non-descript ones. Farmers may struggle to discern the causes and factors contributing to climate change impacts in animal husbandry due to various factors beyond climatic variability, such as management practices and individual differences, which influence livestock production systems.

On detail analysis it was observed that, maximum farmers strongly agreed with their inability to do anything personally to stop the loss of the biodiversity (38.75%) and increased exploitation of nature and artificial lifestyle of human being responsible for climate change (50.42%), agreed with climate change being beyond the control of human beings (51.25%), more importance of livelihood and other things in their life than the environment (64.27%), very hard to opt the more environment-friendly habits (56.25%), not believing their behaviour, lifestyle or livelihood activities contribute to climate change (52.08%), Government's duty to maintain the ecological balance in their area (46.25%).

However maximum farmers disagreed with worrying about the loss of native flora and fauna of their area (38.75%), seriousness of climate change problems and need of expert solution (60%), capability of human beings in solving the problem of climate change (69.17%), potentiality of indigenous knowledge of people in finding out solutions to the issues of climate change (50.42%), ill treatment of nature by humans as the cause of climate change (58.33%), too far effects of climate change in the future to really worry them (52.92%), more potential ability of community than Govt. in taking initiatives for maintaining the ecological balance (59.17%) and adopting sustainable practices by the farmers to prevent climate change (65.83%) whereas 42.50% farmers were unable to decide about affording to lose some of the biodiversity of area to meet the livelihood demands of the people.

Knowledge about adaptation practices

An equal portion of respondents (43.33% each) showed medium and high level of knowledge about adaptation practices while the remaining 13.34% showed low level of knowledge. This distribution showed a significant difference in the region-wise distribution of respondents at the 5% level of significance.

Further it was observed that, majority of the farmers were knowing about adoption of climate resistant breed of livestock (66.25%), diversification of livestock type in the farm (66.67%), change of herd size in the farm (74.17%), diversification of farming to non farming activity (52.08%), storage of fodder for animals in odd time of year (73.75%) and change of feed of animals based on its availability (72.92%). In contrast, majority did not know to bring any water harvesting scheme (98.75%), to take any climate friendly technology in last 5 years (99.58%) and to take any forestation initiative or participation in any such programme (98.75%). All respondents knew how to change feeding or grazing schedules of their livestock to mitigate the impact of climate change, but they lacked knowledge about the benefits of livestock insurance. However, they did not take any initiatives to increase awareness among other farmers.

Fatalism

Nearly half of the respondents (47.92%) belonged to the group of medium level fatalism whereas, 35% and 17.08% respondents belonged to the group of high- and low-level fatalism, respectively. The region-wise distribution of respondents showed a significant difference at the 1% level of significance. The findings are in line with that of Raghuvanshi (2018). The high proportion of respondents in the medium fatalism category may be due to educational deficits and adherence to a traditional value system.

Further inquiry in detail revealed that, maximum farmers strongly agreeing with control of life by the Almighty (42.50%), agreeing with life is like a lottery (57.92), disagreeing with no use of worrying about public affairs as they are helpless to do anything (72.92%). Nothing is going to change by electing another political leader (59.58%) and strongly disagreeing with not to trust anyone (57.50%) and no use of making serious plans as the future is very uncertain (66.67%).

Social cohesiveness

72.50% of the respondents displayed a low level of social cohesiveness followed by 24.17% and 3.33% respondents displaying medium and high social cohesiveness, respectively. The regional distribution of respondents showed a non-significant difference. It was observed that most farmers were original inhabitants (78.33%). These farmers primarily had local kinship ties (80%) and depended on the region mainly for food exchange (87.92%).

Risk perception of farmers

52.08% of the farmers were identified with medium risk perception followed by 25.42% and 22.50% having low and high risk perception, respectively. There was no significant difference in the region-wise distribution of respondents. The moderate level of risk perception likely stems from the visibility and identifiability of many climate change-related activities. The findings are in conformity with Raghuvanshi and Ansari (2020).

The data also indicated that, most of the farmers were strongly agreeing with increase in temperature every year due to climate change (63.75%), effect on milk production due to temperature fluctuations (64.58%), increased problem of water shortage has due to changing climate condition (54.17%), adverse effect on round the year availability of feed and fodder due to climate change (60.83%), change in livelihood patterns of farmers because of changing climatic conditions (50.42%) and adverse effect on productive capacity of dairy animals due to extreme climate conditions (50.42%).

Majority of the farmers agreed with climate change being the most important problem now days (57.92%), livestock rearing has become vulnerable due to climate change (51.67%), increased incidence of parasitic diseases now a days (47.92%), adverse effect of changes in weather pattern on farm operations (72.92%), uncertainty in rainfall pattern as one of the major factors that affect the fodder production (69.58%), extreme cold weather, strong wind and foggy weather affecting dairy farming (57.50%), difficulties in crop cultivation due to changes in weather pattern (61.25%), climate change caused by both natural changes in environment and human activities (51.67)%, extreme weather events in the last few years affecting the adaptation and mitigation practices (47.92%), deforestation becoming more severe due to climate change (56.67%), change in land use pattern due to changing climatic condition (52.92%), reduced availability of natural grazing land for the dairy animals (48.75%) and climate change threatening the biodiversity (43.33%). However, 43.75% farmers disagreed with changes in dairy animal rearing practices due to climate change.

Level of dependence on natural and social resources

68.75% of respondents belonged to the medium dependency group followed by 20% and 11.25% respondents belonging to the high and low dependency groups, respectively. The respondents showed a significant difference in the region-wise distribution at 1% level of significance.

Maximum respondents were entirely dependent on cultivable land (71.67%) and community (54.58%) whereas somewhat dependent on community grazing land (55.42%) water sources/river/pond (96.25%) neighborhood (60.83%) and village institutions (38.33%) and not dependent on forest (68.33%) and dairy co-operatives (95.83%). The greater dependency of respondents on cultivable land and community indicates a lack of self-establishment. Sarkar *et al.* (2010) and Raghuvanshi and Ansari (2020) also reported similar findings.

Vulnerability of farmers to climate change

The result indicated 58.75% respondents falling in the moderately vulnerable group followed by 32.92% and 8.33% in the highly and less vulnerable groups, respectively (Table 2). The region-wise distribution of respondents showed no significant difference.

About 60% respondents in the present study area were in the moderately vulnerable group, which may be attributed to factors such as their small land holding, low educational status, low farming experience, low annual income and SES, low-risk orientation and medium level of decision-making ability, innovativeness and scientific orientation. The results are in consistent with the findings of

Raghuvanshi and Ansari (2020), yet contrary to the findings of Sarkar *et al.* (2010), Radhakrishnan and Gupta (2017), and Kumar *et al*. (2022).

Table 2: Region-wise distribution of respondents according to their level of vulnerability to climate change

Category	Region I *f* (%)	Region II *f* (%)	Region III *f* (%)	Pooled *f* (%)
• Highly vulnerable (up to 0.42) • Moderately vulnerable (0.43 to 0.69) • Less vulnerable (More than 0.69)	34 (42.50) 42 (52.50) 4 (5.00)	22 (27.75) 47(58.75) 11(13.75)	23 (28.75) 52 (65.00) 5 (6.25)	79 (32.92) 141 (58.75) 20 (8.33)
Chi-square = 8.7309 p = 0.068189				

3.2. Principal Component Analysis (PCA) to identify the most contributing factor for vulnerability of farmers to climate change

The seven variables were entered into a correlation matrix and a Varimax orthogonal rotation with Kaiser normalization applied to the solution. The analysis met the criteria for conducting PCA (Principal Component Analysis) as the values for the Determinant (0.310), KMO (0.593) and Bartlett's Test of Sphericity (B.T.S., 0.000) all fell within the acceptable ranges (Determinant > 0.001, KMO > 0.05 and B.T.S. < 0.05). This approach generated three factors with eigenvalues greater than one. These three factors accounted for 67.614% of the variance (Table 3 and Fig. 1).

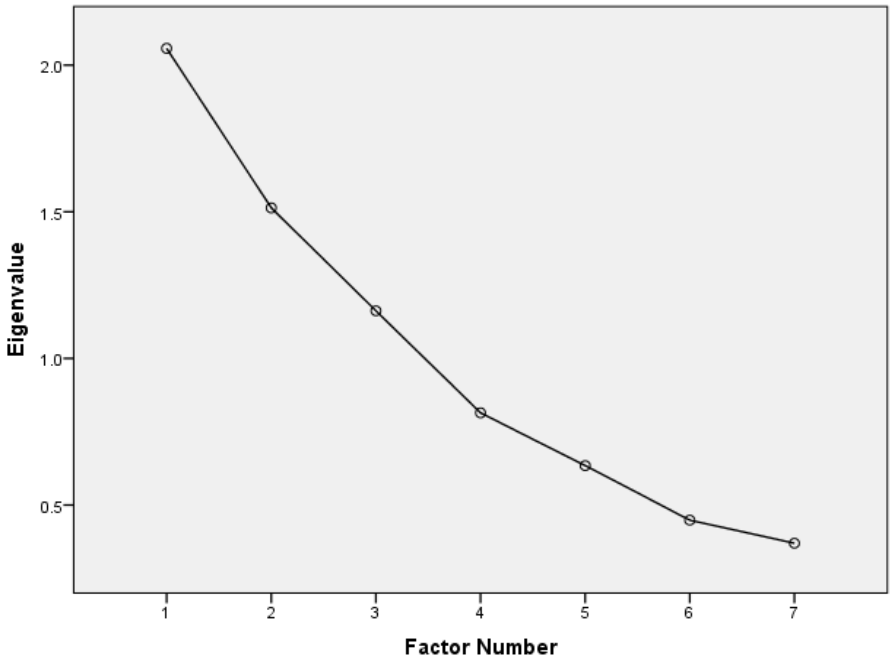

Fig. 1: Scree Plot representing Eigen value for vulnerability indicators

Table 3: Eigen value for vulnerability indicators

Component No.	Initial Eigen values		
	Total	% Variance	Cumulative %
1	2.057	29.388	29.388
2	1.513	21.620	51.008
3	1.162	16.606	67.614

4	0.814	11.634	79.248
5	0.635	9.066	88.314
6	0.448	6.406	94.720
7	0.370	5.280	100.000

Table 4: Rotated factor (Varimax) matrix of each indicator

S. No.	Indicators	Factors		
		I	II	III
1	Awareness level	0.241	-0.073	0.036
2	Attitude towards climate change	0.312	0.051	0.716
3	Knowledge about adaptation practices	0.001	0.377	0.008
4	Fatalism	0.036	0.037	-0.161
5	Social cohesiveness	0.009	0.507	-0.040
6	Risk perception	0.541	0.041	-0.470
7	Level of dependence	-0.071	0.079	0.127

Table 5: Indicators explained by the three factors

S. No.	Vulnerability Indicators	Loadings	Communality (h^2)	Rank
1	Awareness level	0.241	0.537	**III**
2	Attitude towards climate change	0.716	0.808	**I**
3	Knowledge about adaptation practices	0.377	0.362	**V**
4	Fatalism	0.037	0.192	**VI**
5	Social cohesiveness	0.507	0.455	**IV**
6	Risk perception	0.541	0.663	**II**
7	Level of dependence	0.127	0.158	**VII**

Rotated factor (Varimax) matrix of indicators

The findings on the factor loading of each indicator under the three factors were analyzed and the results are presented in Table 4. The analysis involved scanning of each factor column to identify indicators with the most significant correlation to the particular factor. Thus, from each factor column, the indicators with greater factor loading were chosen. and grouped in Table 5.

The table reveals that the indicator - attitude towards climate change ranked first, exhibiting the highest communality (h^2) value of 0.808. It was followed by other indicators like risk perception (2^{nd}), awareness level (3^{rd}), social cohesiveness (4^{th}), knowledge about adaptation practices (5^{th}), fatalism (6^{th}) and level of dependence (7^{th}), respectively communality values of 0.663, 0.537, 0.455, 0.326, 0.192 and 0.158 respectively.

3.3. Association between vulnerability of farmers and independent variables

The correlational analysis (Table 6) revealed a positive association between vulnerability and independent variables like age, farming experience, land holding, annual income, SES and the psychological variables (decision-making ability, innovativeness, risk orientation and scientific orientation) at the 1\% level of significance ($p < 0.01$). Herd size, mass media exposure, contact with extension personnel, extension participation and cosmopoliteness showed non-significant association with vulnerability. ANOVA (Analysis of Variance) indicated a significant effect on vulnerability from both education and gender ($p < 0.01$), and from caste ($p < 0.05$). Occupation, however showed a non-significant effect (Table 7). These findings are in line with the findings of Sarkar *et al.* (2010) and Kumar *et al.* (2022).

Table 6: Correlation between farmer's level of vulnerability to climate change and independent variables

Sl. No.	Variables	Level of vulnerability to climate change	
		r	P value
1	Age	0.532**	0.000
2	Farming experience	0.516**	0.000
3	Land holding	0.249**	0.000
4	Herd size	0.008	0.897
5	Annual income	0.301**	0.000
6	Socio-economic status	0.372**	0.000
7	Mass media exposure	0.075	0.246
8	Contact with extension personnel	0.77	0.238
9	Extension participation	0.018	0.776
10	Cosmopoliteness	0.032	0.619
11	Decision making ability	0.344**	0.000
12	Innovativeness	0.2178**	0.001
13	Risk orientation	0.219**	0.001
14	Scientific orientation	0.183**	0.005

** Significant at the 0.01 level & * Significant at the 0.05 level

Table 7: Effect of selected independent variables on farmer's level of vulnerability to climate change using one-way ANOVA

Variables	Mean	N	STD. Deviation	P Value
Education				
• Illiterate	196.3974	78	16.40188	0.000**
• Up to Primary school	194.4444	9	16.61408	
• Up to Middle school	200.8235	68	14.75162	
• Up to High and Higher Secondary	207.3770	61	12.50488	
• Up to Degree and Above	219.2500	24	13.62941	
Gender				
• Female	184.5417	48	10.70486	0.000**
• Male	207.1823	192	14.09516	

Caste • SC • ST • OBC • General	197.0000 197.6136 203.8368 204.7500	2 44 190 4	14.14214 16.43623 16.13894 12.99679	0.0135*
Occupation • Two occupations • Three occupations • Four occupations	202.8315 202.0656 207.0000	178 61 1	15.89424 17.44312 -	0.918

** Significant at the 0.01 level & * Significant at the 0.05 level

4. CONCLUSION

The study revealed that majority of the respondents belonged to the moderately vulnerable group and attitude towards climate change was the most influential factor among the various indicators of vulnerability.

The findings suggest that there should be organization of targeted awareness campaigns and training programs which can shift the farmer's attitudes towards a more favorable stance. The SAUs/SVUs and State A.H. departments should also shoulder this responsibility. Such efforts will ultimately foster greater resilience and preparedness within the farming community. Along with this, an effective and long-term action plan pertaining to climate change should be formulated by the policymakers to minimize the risks and vulnerability faced by dairy farmers due to climate change.

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Authors contributions

Dr. Kumari Shweta has carried out the social research and thesis write up under the guidance of Dr. Jagarnath Oraon and Dr. Alok Kumar Pandey, along with Dr. Absar Ahmad who had done the statistical analysis, and with full emotional support of Dr. Pankaj Kumar.

Informed consent

Oral informed consent was obtained from individual participants included in the study.

Ethical approval

The study was done in conformity with ethical guidelines. Participation was entirely voluntary, and all respondents provided informed consent. The participants' anonymity and confidentiality were ensured, and the data obtained were utilized purely for the study. The ethical guidelines for Human Subjects are followed in the study.

Conflicts of interests

The authors declare that they have no conflicts of interests, competing financial interests or personal relationships that could have influenced the work reported in this paper.

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Data and materials availability

All data associated with this study are present in the paper.

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