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Assessing Farmers' Awareness of Climate Change Impact: A Case of the Bundelkhand Region, India

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HIGHLIGHTS

- Bundelkhand is considered to be one of the most drought-prone regions in the country.
- Agriculture in Bundelkhand is still Monsoon-dependent, and therefore vulnerable to climate change.
- Farmers in Bundelkhand showed a mediocre understanding of the effects of climate change.
- Improving climate resilience requires a focus on education and knowledge sharing.

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ABSTRACT

The study was conducted in 2023-24 in the Bundelkhand region, India and examined the awareness of climate variability and its impacts on farmers. Analytical and descriptive research design was used in the present study. The present study was carried out in two districts namely, Jalaun and Datia of Bundelkhand. Four blocks were selected randomly from these districts, and a total of 320 respondents were selected randomly. The results revealed that most of the respondents were well informed about changes in crop cycles (81.87%), new pests and diseases (63.12%) and natural hazards like earthquakes and cyclones (69.06%). There are still considerable gaps in their knowledge of topics like biodiversity loss and groundwater depletion. Factor analysis revealed four principal components influencing awareness; natural hazards (.717), soil productivity (.681), pest and disease emergence (.775) excess water in surface (.818), and decline in groundwater level (.738). Correlation and regression analysis indicate that education, landholding, socio-economic status, information-seeking behaviour, economic motivation and scientific orientations are significantly and positively associated with climate change awareness. The findings suggest that focused awareness efforts need to be made that utilize media and extension advisory services to improve farmers' awareness and ability to adapt.

INTRODUCTION

The Bundelkhand region of India has a distinct agro-climatic environment as compared to the other parts of the country. The region is spread in the two states i.e. Uttar Pradesh and Madhya Pradesh. Altogether, 16 districts from both the states constitute the Bundelkhand region. Climate plays a crucial role in determining the survival of life on the earth. It has arisen as one of the primary constraints of agriculture productivity (Raghuvanshi et al., 2018). It is crucial for maintaining balance and providing nourishment to all living beings (Gupta et al., 2024). The entire world is observing the impact of climate change, especially on agriculture, but the

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country like India are particularly vulnerable because of their huge agricultural-dependent population and unsustainable use of natural resources (Ravi Shankar et al., 2013). Current global economic, social and political challenges are intricate and influenced by climate variability and its agricultural repercussions. The interplay between agriculture, food safety and climate change appears to be both straight forward and intricate, resulting in serious repercussions for developing countries (Pandey et al., 2017; Ojo & Baiyegunhi, 2020; Omerkhil et al., 2020). India as a developing nation is particularly susceptible to the negative effects because it is primarily in tropical regions and has weak socioeconomic, demographic, and institutional allies (Dupdal & Patil, 2019). Indian agricultural is susceptible to climate change as the higher temperature and extremely low temperature often lead to yield losses as well an increase in the insects and pests. India has shown high vulnerability to the effects of climate change as 58 per cent of our population still depends on agriculture (Yadav et al., 2022). India's population, like many developing nations, relies heavily on natural resources for both economic sustenance and daily survival. Any adverse impact on these resources directly threatens the nation's economic stability, undermines livelihoods, and exacerbates wealth inequality (Sarkar & Padaria, 2010). Agencies and stakeholders assisting farmers in scaling up the adoption of climate smart agricultural practices, like precision conservation agriculture, should develop a shared understanding and strategy for promoting these cutting-edge technologies within farming communities (Shitu & Nain, 2024).

The Bundelkhand region faces unique challenges due to its distinct agro-climatic conditions. The growing threat of climate change has far-reaching consequences, particularly in regions like Bundelkhand where livelihoods are closely tied to natural resources. The adverse effects of rising temperatures, irregular rainfall patterns, and the increasing prevalence of pests and diseases are already impacting agricultural productivity. Various socioeconomic factors, including the lack of adaptive capacity, insufficient knowledge, and inadequate institutional support further compound the vulnerability of agriculture in the region. Therefore, addressing the issue of climate change through sustainable practices, policy interventions, and the enhancement of local adaptive capacities is crucial for safeguarding the future of agriculture in the Bundelkhand region and ensuring the economic security of the nation as a whole.

METHODOLOGY

The research was carried out in the Bundelkhand region of the country, which includes thirteen districts from Madhya Pradesh and Uttar Pradesh. The boundaries of the study were from 23°8' to 26°30'N latitude and 78°11' to 81°30'E longitude. The Jalun and Datia districts were purposively chosen for the study as these districts are characterized as rain-fed with low, unpredictable, and uncertain rainfall patterns (Gupta et al., 2014). Further, this region of the country historically experienced severe droughts approximately every 16 years, with a tripling of such events from 1968 to 1992 (Samra, 2008). The two blocks namely Mahewa and Kadaura from Jalaun, and Bhander and Datia from Datia were randomly chosen from the selected district. A list of villages from each selected block was compiled, and four villages were randomly chosen from each block applying a lottery system of selection, totalling sixteen villages were chosen for the present study. From each village, twenty respondents were selected through simple random sampling, resulting in a total sample size of 320 respondents for the present study. To obtain responses from farmers a structured interview schedule was administered, a pilot study was also conducted in non-sampled villages for testing the data collection tool.

This study employed both analytical and descriptive research designs. Data analysis was done using various statistical tools and methods, including frequency and percentage distributions, mean calculations, correlation analysis, regression analysis and factor analysis. Statistical factor analysis was employed to examine the data. For the factor to effectively explain the variance in each of the original variables, the communality value of each item must be 0.30 or higher. Factor analysis was performed using several widely accepted criteria. This study's factor analysis is divided into four sections. First, the matrix's overall factorability and sample adequacy were assessed. Second, elements were retrieved and displayed. Thirdly, variables were converted to determine which ones belonged to the intended constructs. Fourth, Cronbach's alpha was used to measure the components' reliability. These techniques were utilized to assess and interpret the data collected comprehensively.

RESULTS

Farmer's awareness about climate change

It was found that respondent's had varying levels of consciousness about climate change and its impact (Table 1). Most were well-informed about key issues such as changes in crop cycles (81.87%), new pests and diseases (63.12%) and natural hazards like earthquakes and cyclones (69.06%). Many also recognized the reduced of crop productivity (63.44%) and lower nutritional content in food (69.37%). A moderate level of awareness was seen for the presence of less water in surface water bodies (58.43%) and alterations in rainfall patterns (60.93%). Nevertheless, there were deficiencies in knowledge regarding more precise consequences, such as heightened soil productivity (62.18%) and a precipitous decrease in groundwater levels (60.31%). A smaller percentage of participants were completely cognizant of the implications of biodiversity losses (66.25%) and health-related consequences (60.31%).

Unearthing the under laying factors of Awareness (Factor Analysis)

Feasibility of Factor Analysis Data

Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity

The estimated value of the Kaiser-Meyer-Olkin (KMO) test was 0.704, suggesting that the sampling adequacy is within the acceptable range of 0.7 to 0.8 (Table 2). Consequently, the data set is deemed suitable for factor analysis, as indicated by a 70.40 per cent feasibility rate. This implies that the total number of partial correlations. Bartlett's test of sphericity provides additional evidence for the appropriateness of data for factor analysis. The calculated Chi-square value of 1262.862 ($p<0.001$) indicates a robust

Table 1. Farmer's awareness towards climate change

S.No.	Statement	Fully aware (%)	Somewhat aware (%)	Not aware at all (%)
1.	Change in the crop cycle due to climate change.	81.87	14.37	3.76
2.	The emergence of new pests and diseases due to climate change.	63.12	31.88	5.00
3.	Frequent occurrence of natural hazards like earthquakes, cyclones, etc.	69.06	25.62	5.32
4.	Excess water in surface water bodies due to climate change.	2.82	38.75	58.43
5.	Decrease in crop productivity due to climate change.	63.44	31.56	5.00
6.	Decrease in the nutritional content of food.	69.37	26.25	4.38
7.	Increase in soil productivity day by day due to climate change.	62.18	33.14	4.68
8.	More decrease in temperature during the summer season.	5.63	28.12	66.25
9.	Frequent occurrence of drought.	61.25	33.12	5.63
10.	Change in rainfall pattern due to climate change.	60.93	35.31	3.76
11.	Frequent occurrence of floods due to climate change.	70.00	25.93	4.07
12.	The decline in groundwater level due to climate change.	60.31	33.43	6.26
13.	Biodiversity losses due to climate change.	66.25	27.50	6.25
14.	The production and productivity of major crops will change due to climatic variability.	57.50	37.81	4.59
15.	The changing climate doesn't impose different health-related issues in my area.	5.32	34.37	60.31

Table 2. Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity

KMO and Bartlett's test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.704
Bartlett's Test of Sphericity	Approx. Chi-Square	1262.862
	df	105
	Sig.	.000

association among the variables. The obtained results jointly validate the suitability of the data set for performing dependable factor analysis.

The scree plot in Figure 1 confirmed the number of awareness factors retained in the Bundelkhand region which is four, the number of factors above the simulated data or where the rate of awareness on the slope is quite minimal.

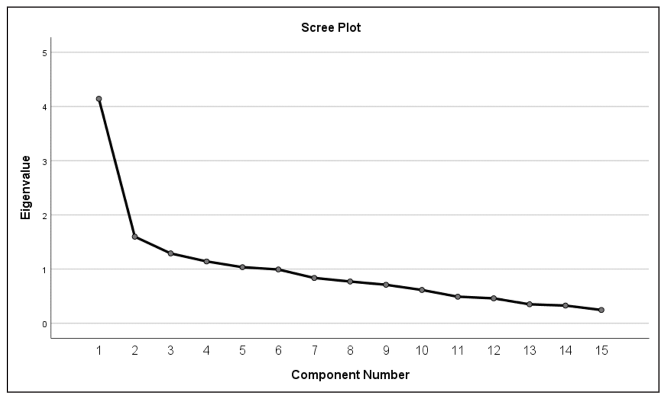

Figure 1. Scree plot of retained factors

Results shown in Table 3, after identifying the number of factors, the factor loadings for each variable were calculated. The results show that variables are grouped across four factors. To be considered significant, the factor loadings must exceed the cut-off value of 0.050, determined for a sample size of 320 at a 5% significance level. Variables with loadings higher than 0.050 were

Table 3. Principle components of farmer's awareness of climate change

Rotated Component Matrix

Reliability of factors	Items	Component 1	2	3	4
0.724	Frequent occurrence of natural hazards like earthquakes, cyclones, etc.	.717			
	Increase in soil productivity day by day due to climate change.	.681			
	Change in the crop cycle due to climate change.	.675			
	Biodiversity losses due to climate change.	.627			
	Frequent occurrence of drought.	.597			
0.619	The emergence of new pests and diseases due to climate change.		.775		
	More decrease in temperature during the summer season.		.746		
	The production and productivity of major crops will change due to climatic variability.		.580		
0.488	Excess water in surface water bodies due to climate change.			.818	
	Change in rainfall pattern due to climate change.			.570	
0.298	The decline in groundwater level due to climate change.				.734
	Frequent occurrence of floods due to climate change.				-.707

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 6 iterations.

deemed significant within their respective factor. To evaluate the intrinsic structure of the awareness of respondents towards climate change principal component analysis was performed by using the maximum variance rotation method.

The maximum variance rotation method is the most commonly used in actual rotation, so this method is used. Four factors were obtained after rotation, among which the first factor, labeled *viz*., natural hazard, soil productivity, crop cycle, biodiversity and drought accounted for 27.614 per cent of the total variance. The second factors were labeled as pest and diseases, temperature and productivity of major crops accounting for 10.653 per cent of the total variance, while the third components of PCA were regarded as excess water and rainfall contributing 8.593 per cent of the total variance. However, 4th factor of PCA contributed only 7.606 per cent of the total variance and was labeled as groundwater levels and floods. The reliability test based on the results of the reliability consistency presented in Table 3 revealed that the internal consistency reliability for the overall factor 1 and 2 were 0.724 and 0.619 which are very good. The coefficient alpha for factors 3 and 4 were 0.488 and 0.298 respectively which are good. This indicated that the responses were consistent and reliable. This implies the proper awareness of climate change among respondents.

Table 4. Association between selected independent variables and farmer's awareness about climate change

S.No.	Variable	Correlation Coefficient ('r' value)	'p' value
1.	Age	.015^{NS}	0.451
2.	Education	.285**	0.001
3.	Land-Holding	.221**	0.002
4.	Farming Experience	.066 ^{NS}	0.914
5.	Socio-Economic Status	.165**	0.172
6.	Information Seeking Behaviour	.213**	0.010
7.	Mass Media Exposure	.138*	0.007
8.	Change Proneness	.083 ^{NS}	0.043
9.	Economic Motivation	.569**	0.000
10.	Scientific Orientation	.695**	0.000

*Significant at 0.05 level of probability, **Significant at 0.01 level of probability, NS= non-significant

Table 5. Multiple regression analysis of the respondents with Awareness of climate change

S. No.	Variable	Regression coefficient (b)	Standard error	't' value
1.	Age	.009	.021	.165 ^{NS}
2.	Education	.073	.142	1.456 ^{NS}
3.	Land-Holding	.029	.322	.476 ^{NS}
4.	Farming Experience	-.022	.023	-.396 ^{NS}
5.	Socio-Economic Status	-.016	.064	-.290 ^{NS}
6.	Information Seeking Behaviour	-.049	.080	-.880 ^{NS}
7.	Mass Media Exposure	.039	.193	.735 ^{NS}
8.	Change Proneness	.000	.196	.008 ^{NS}
9.	Economic Motivation	.323	.119	5.249**
10.	Scientific Orientation	.307	.084	5.073**

R^2= 0.362, F-Value= 11.505, NS= non-significant

*Significant at 0.05 level of probability**Significant at 0.01 level of probability

Results shown in Table 4, at the 5% significance level, the correlation coefficient of mass media exposure was r= .138 which is positively significant at a 5% level of significance while, land-holding, education, socio-economic status, information-seeking behaviour, economic motivation, and scientific orientation was positively and significantly correlated at a 1% level of significance with awareness of farmers about climate change with "r" value-.221, .285, .165, .213, .569 and .695 respectively.

Results showed that (Table 5) for every unit increased in variables *viz.*, economic motivation and scientific orientation there would be an increase in awareness by 5.249 and 5.073 units. Collectively all independent variables account for approximately 36.2 per cent of the variation in awareness regarding climate change, as indicated by the R^2 value.

DISCUSSION

The present study shows that the respondents are experiencing the more visible changes. The study is further supported by the conclusions of Kemausuor et al., (2011), who reported that 93 per cent of respondents believed that the timing of rains is asymmetrical and unpredictable these days. There has been a noteworthy increase in temperature during both the summer and winter seasons (Fahad et al., 2020). Baul et al., (2013) also found similar result, noting that 84 per cent of respondents felt that temperatures have risen. Legesse et al., (2013) observed that 95 per cent of farmers perceived a rise in the frequency of occurrence of droughts, which lends more weight to the study conclusions.

Although most respondents were aware of the most important facets of climate change, more focus is still required on the less apparent implications. This suggests that although the majority of respondents have a modest awareness of climate change, a generous portion still have little awareness, and very few have widespread knowledge. According to Ghanghas et al., (2015); Raghuvanshi & Ansari (2016), the degree of climate change consciousness influences adaptability. Respondents are more likely to implement adaptation strategies and practices to deal with the negative effects of climate change if they are more knowledgeable about climate change, its causes, and its effects.

The results of Adebayo et al., (2012), who found that 96 per cent of farmers were aware of climate change and that only 4 per cent seemed to be unaware of it, further corroborate these findings. In a study on Uttarakhand's perceptions of and coping strategies for climate change, Sogani (2011) revealed that people living in mountainous regions were aware that the weather is changing. In a 2013 study on how people in the Gangetic plains of India supposed, anticipated, and responded to climate change, Tripathi & Singh (2013) reported that just 30 per cent of respondents were aware of the phenomenon. According to Fahad et al., (2020), 73 per cent of the respondents said they were only somewhat aware about climate change.

According to Mandleni & Anim (2011) and Huong et al. (2019), 86 per cent of the respondents were aware of changes in the climate, such as rising temperatures. According to Sofoluwe et al., (2011), 75 per cent of farm households were aware of differences in the climate. According to Kutir et al., (2015), 80.60 per cent of farmers knew about climate change. In their individual studies, farmer family heads in Taraba and Borno states, Nigeria, demonstrated a high level of climate change understanding (Oruonye, 2014; Idrisa et al., 2012). Our results are consistent with those of Mustafa et al. (2018), who found that, on average, all independent variables contributed to 42.4 per cent variation in climate change awareness.

CONCLUSION

Farmer's awareness levels are influenced by a wide range of factors, including socioeconomic and demographic variations. The study's findings indicate that most of the respondents in the examined districts were cognizant of climatic changes. The results indicate that the farmers who faced the most negative impacts from climate change were more aware of seasonal climatic fluctuations. Land ownership, education, socio-economic level, information-seeking behaviour, economic motivation, and scientific orientation were the main factors influencing farmers' comprehension of climate change. Therefore, to address the issue of climate change, we must first use different media to increase farming communities' awareness on climate change to promote the adaptation of agricultural practices. The findings demonstrated that respondents understood that human activity was disrupting the natural equilibrium, leading to climate change. Accompanying this understanding were the capacity to deal with ecological problems acceptably and the readiness to take non-destructive measures to mitigate the adverse consequences of climate change.

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