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Dairy farmer's perception towards climate variability in Bundelkhand region

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Abstract

In 2023-24, a study was undertaken in the Bundelkhand region of India to investigate dairy farmers' perceptions of climate variability. The research employed an analytical and descriptive research design. Specifically, the study was conducted across two districts, namely Banda and Hamirpur, within the Bundelkhand region. Random selection was used to choose two blocks from each district, with a total of 120 respondents randomly selected for participation. The results revealed that large number of dairy farmers in the study area was of middle aged (36-50 years) belonged to medium sized family(5-8 persons) with annual income under medium category (1-3 lacs) and have low level of mass media exposure with marginal to small land holding. They also had less social participation and the experience in dairy was moderate (5-10 years). They perceived a delay in the rainfall due to climate variability and down level of ground water but an increase in the dry season, disease infection and pest infestation and the temperature. The change in feeding schedule for dairy animals and climate variability as an important environmental issue were other important issues. Factor analysis revealed five principal components influencing perception of dairy farmers. Reliability of the perception was 0.72. Correlation analysis indicate that independent variables mass media exposure, dairy experience, age, education, family size, annual income, land holding herd size and risk orientation was positively and significantly associated with climate variability perception.

Keywords: Milk, dairy farmers, climate variability, Bundelkhand

Introduction

Climate change has been identified as one of the most significant long-term issues facing by farmers. Small and marginal farmers play a big role in producing milk by dairy farming in India. Although the effects of climate change on livestock are being seen globally, developing nations like India are particularly vulnerable because a sizable portion of their populations rely on agriculture for a living. It was projected that India had warmed by 0.60 °C over the past century. According to the IPCC's 2007 prediction, the average worldwide temperature is expected to rise by 1.5 to 2.5 °C by 2100, with the average global surface temperature potentially rising by 1.8 to 4.0 °C. Bundelkhand region faces significant climate variability, marked by extreme temperatures, unpredictable rainfall, and water scarcity. The region's agricultural dependency makes it particularly vulnerable to climate change. It also has a significant impact on dairy farming, affecting both livestock health and milk production.

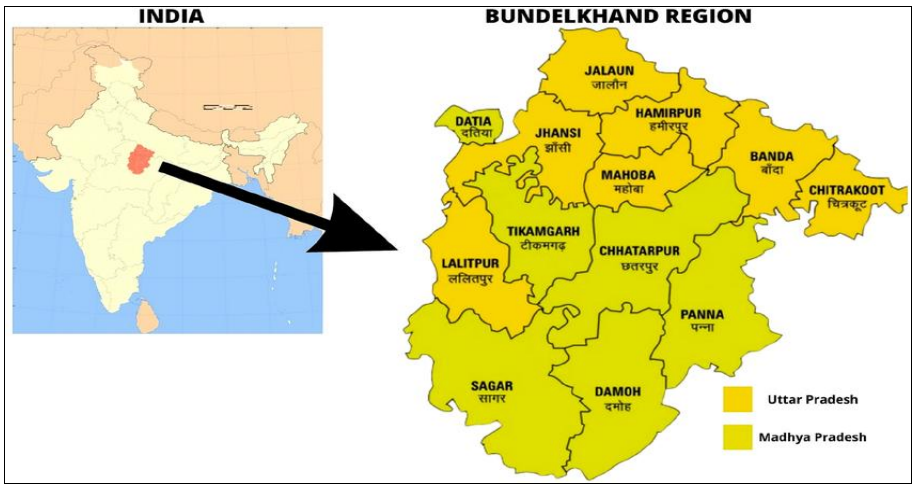
Dairy farming is an important livelihood in Bundelkhand and the climate-induced challenges in the region directly influence the well-being of farmers and their animals. Therefore, it is necessary to expand the focus on food and nutritional security in order to embrace a sustainable living approach. Dairy sector playing very important role in economic progress of the country as it contributes over 3 to 4 percent to agricultural GDP and provides employment in principle or subsidiary status. Climate change has an impact on dairy production both directly, through the cows themselves, and indirectly, through agricultural output and greater susceptibility to diseases and pests. (Gauly *et al*., 2013; Egeru, 2016) [4, 3]. Lactating dairy cows exposed to prolonged periods of high temperatures, elevated humidity, and intense solar radiation face challenges in regulating their body temperature, which increases the risk of heat stress. Such stress negatively impacts the reproductive efficiency of dairy animals. Dairy farmers often encounter uncertainty due to shifts in climatic conditions that cause abrupt environmental changes. In regions with semi-arid climates, like southern India, irregular rainfall and persistent droughts over recent decades have significantly disrupted dairy farming practices. In response to perceived changes in

the climate, farmers have adopted various localized coping strategies. However, these adaptations have often led to reduced livestock productivity, including a decline in herd size, milk yield, and availability of fodder. While there has been extensive research on how crop farmers perceive and respond to climate change, studies focusing on the livestock sector remain limited. This study aims to explore the perceptions of dairy farmers in the Bundelkhand region regarding climate variability and examine how these perceptions are associated with different socio-economic and environmental factors.

Materials and Methods

The Bundelkhand region of Uttar Pradesh was intentionally chosen for this study due to its high vulnerability to climate variability. Approximately 80% of the region's agricultural area is classified as dryland farming. Within this region, Banda and Hamirpur districts were purposively selected, as they fall within the drought-prone zone. From each district, two blocks were selected at random, and two villages were randomly chosen from each block. In each selected village, 15 dairy farmers were randomly surveyed, resulting in a total sample size of 120 respondents across eight villages.

A descriptive research design was adopted to examine how dairy farmers in the Bundelkhand region perceive and respond to changing climatic conditions. Data collection was carried out through a structured and pre-tested questionnaire. The survey instrument included multiple sections aimed at gathering information on farmers' socio-economic profiles, landholding size, dairy farming experience, and perceptions of climate variability observed in recent years. The collected data were systematically tabulated and subjected to statistical analysis using tools such as mean, frequency, standard deviation, range, weighted mean, and exploratory factor analysis to derive meaningful insights and conclusions.



Results and Discussion

Socio Economic Status of Dairy Farmers

The socio-economic characteristics of the dairy farmers were recorded during the survey and are summarized in Table 1. The data revealed that nearly half of the respondents (49.17%) were in the middle-age group (36-50 years), actively engaged in dairy farming. About 30.83% of the participants were young (below 35 years), while the remaining were categorized as older farmers (above 50 years).

Regarding educational background, 25.83% of the farmers were illiterate, while the rest had received varying levels of formal education. Specifically, 14.17% had completed primary education, 9.17% had studied up to junior high school, 26.67% had completed high school, 18.33% had reached the intermediate level, and 5.83% held a graduate degree or higher. Family size distribution indicated that 46.67% of respondents belonged to medium-sized families, while 19.17% had small families, and 34.17% were from large families.

When classified by annual household income, 55.83% of the respondents were in the medium-income group, while 24.17% and 20% were in the low- and high-income categories, respectively. This suggests that dairy farming contributes significantly to household income in the region. In terms of landholding, 39.17% of respondents owned marginal land, followed by 30.83% with small holdings, 17.50% with medium holdings, 10% who were landless, and 2.5% who held large land areas. Experience in dairy farming was also assessed: 57.50% of farmers had a moderate level of experience, while 22.50% had less experience, and 20% had significant experience in the field. These patterns indicate that middle-aged individuals are often drawn to dairy farming as a supplementary livelihood, likely due to limited employment opportunities for educated youth in the region.

In the study of dairy farmers, 30% had medium exposure to the media, 48.33% had low media exposure, and only 21.67% had high media exposure of communication in that research area. In social participation, the engagement of respondent was found in low category (49.17%) followed by medium (35%) and high (15.83%) respectively. From the table 1, 50.83% of the respondents belonged to under medium level. Further, 21.67% and 27.50% of them comes under large and small category of animals owned by dairy farmers respectively. The results pertaining to the training undergone by the dairy farmer revealed that more than three forth of the respondents (77.50%) were not attended any training programmes and 22.50% of the respondents attended training programmes organized by co-operative societies and KVK's etc. 27.50% dairy farmers had a medium risk orientation, 11.67%) had a low risk orientation, and 60.83% had a high risk orientation. It might be because dairy farmers with small and marginal land holdings were less financially stable than economically sound dairy farmers, making them less able to handle risk orientation.

Table 1: Socio Economic Status of Dairy Farmers

S. No.	Characteristics	Classification	Frequency	Percentage
1.	Age (years)	Young (<35)	37	30.83
		Middle (36-50)	59	49.17
		Old (>50)	24	20.00
2.	Education	Illiterate	31	25.83
		Primary School	17	14.17
		Junior High School	11	9.17
		High School	32	26.67
		Intermediate	22	18.33
		Graduation & Above	7	5.83
3.	Family Size (Numbers)	Small (< 4)	23	19.17
		Medium (5-8)	56	46.67
		Large (> 8)	41	34.17
4.	Annual Income (Rs.)	Low (< 100000)	29	24.17
		Medium (100000-300000)	67	55.83
		High (> 300000)	24	20.00
5.	Land Holding (Acre)	Land less (0)	12	10.00
		Marginal (< 2.5)	47	39.17
		Small (2.5-5.0)	37	30.83
		Medium (5.0-10.0)	21	17.50
		Large (> 10.0)	3	2.50
6.	Dairy Experience (Years)	Less (< 5 years)	27	22.50
		Moderate (5-10 years)	69	57.50
		More (> 10 years)	24	20.00
7.	Mass Media Expoxure (Numbers)	Low (<8)	58	48.33
		Medium (8-12)	36	30.00
		High (>12)	26	21.67
9.	Social Participation (Numbers)	Low (<3.0)	59	49.17
		Medium (3.0-4.5)	42	35.00
		High (>4.5)	19	15.83
10.	Herd Size (Numbers)	Small (<4)	33	27.50
		Medium (4-8)	61	50.83
		Large (>8)	26	21.67
11.	Training	Attended	27	22.50
		Not Attended	93	77.50
12.	Risk Orientation	Low	14	11.67
		Medium	33	27.50
		High	73	60.83

Dairy Farmers' Perception towards Climate Variability

Perception is an important psychological attribute which is affected by factors such as culture, knowledge and access to information. However climate variability perception helps the farmers to adjust to their own situations. An attempt has been made to judge the perception towards climate variability.

All 100% of the respondents identified that "High temperature is an issue in last five years" and they had assigned first rank to it with weighted mean score of 37.40. Approximately 92% respondents perceived that Climate variability is an important environmental issue and provide II rank on the basis of weighted mean score 35.47 "Change in timing of precipitation" was found III major issue on the basis of weighted mean score 32.87 and approximately 82% respondents were in favor of it. The respondents also recognized that "Ground water label goes down due to climate variability" and approximately 67% respondents provided positive answer regarding this statement. In order of importance it was assigned rank 4th with weighted mean score 31.53. "Delay in rainfall due to climate variability" was found next important issue with weighted mean score 29.87 and ranked 5th. 60% respondents were agreed with this statement. Approximate 52% respondent were in favour that there is alteration in nutrient value in plant and it was assigned rank 6th with weighted mean score 28.40. About 60% of the dairy farmers were positively responded that there is increase in number of droughts in recent years. This statement assigned rank 7th with weighted mean score 27.67. Change in investment in dairy business due to climate variability was found 8th important issue by the respondents with weighted mean score 27.33 where approximately 41% dairy farmers showed positive response. Majority (55.83%) of the dairy farmers were perceived that there is change in feeding schedule of dairy animals. The weighted mean score of this statement was 27.13 and ranked 9th. Most (55%) of the dairy farmers felt that "there is an increase in disease infection and insect pest infestation". It was ranked 10th with the weighted mean score of 27.07. 45.83% of the dairy farmers were in favour of the statement "there is change in current farm management practices". The weighted mean score of this statement was 26.73 and ranked 11th. Soil erosion, human's role in climate variability, combat climate variability and climate variability is beneficial for dairy farming were some other major issues identified by the dairy farmers with raked 12th, 13th, 14th and 15th respectively.

Table 2: Dairy Farmers' Perception towards Climate Variability

No.	Statements	Responses					WM	Rank
		SA%	A%	UD%	D%	SD%		
1.	Climate variability is an important environmental issue	51.67	40.00	8.33	0.00	0.00	35.47	II
2.	High temperature is an issue in last five years	67.50	32.50	0.00	0.00	0.00	37.40	I
3.	Ground water label goes down due to climate variability	40.00	26.67	20.83	12.50	0.00	31.53	IV
4.	Increase in number of droughts in recent years	22.50	35.83	16.67	15.00	10.00	27.67	VII
5.	Increase in disease infection and pest infestation	15.83	39.17	20.83	15.83	8.33	27.07	X
6.	Change in feeding schedule of dairy animals	10.83	45.00	22.50	15.83	5.83	27.13	IX
7.	Change in current farm management practices	15.83	30.00	34.17	12.50	7.50	26.73	XI
8.	Change in investment in dairy business due to climate variability	20.00	20.83	44.17	10.83	4.17	27.33	VIII
9.	Change in timing of precipitation	32.50	49.17	15.00	3.33	0.00	32.87	III
10.	Delay in rainfall due to climate variability	31.67	28.33	26.67	8.33	5.00	29.87	V
11.	Alteration in nutrient value in plant	24.17	27.50	31.67	12.50	4.17	28.40	VI
12.	Human plays a big role in climate variability	14.17	25.83	38.33	15.83	5.83	26.13	XIII
13.	Climate variability is beneficial for dairy farming	6.67	10.83	40.83	26.67	15.00	21.40	XV
14.	Soil erosion due to climate variability	20.00	21.67	35.83	15.00	7.50	26.53	XII
15.	To combat climate variability urgent preparedness is not essential	14.17	17.50	34.17	25.83	8.33	24.27	XIV

Factor analysis of the perception towards climate variability

The data on dairy farmers' perceptions of climate variability were thoroughly checked for accuracy, and no significant outliers were identified. Exploratory Factor Analysis (EFA) was conducted to explore the underlying structure of the perception scale. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was found to be 0.721, which exceeds the recommended threshold of 0.5, indicating that the sample was suitable for factor analysis. Additionally, Bartlett's Test of Sphericity was significant ($\chi^2 = 412.7$, df = 91, $p < 0.001$), further confirming the appropriateness of the data for factor analysis.

In accordance with standard factor analysis practices, components with Eigenvalues greater than one were retained, resulting in the extraction of five key factors. These factors collectively accounted for 79.5% of the total variance, which is well above the commonly accepted threshold of 60%, demonstrating a strong explanatory power. The communality values for the perception items ranged from 0.50 to 0.85, suggesting that a substantial proportion of variance in each variable was captured by the extracted factors. The internal consistency of the scale was confirmed with a Cronbach's alpha of 0.72, indicating a reliable measurement instrument.

Table-3 indicates that among the factors, the factor 1 explained maximum variance (32.7%) and had highest Eigen value (3.44). Items A2, A3, A5 and A10 together positively loaded in factor 1. Factor 2 had the items A4, A9 and A12 with positive relationship and explained 17.3% variance. Items A1, A7 and A8 are loaded in factor 3 with positive and negative impact respectively and explained 12.5% variance. The items A6, A11 and A13 loaded in factor 4 and explained 10.3% variance with positive impact. And the items A14 and A15 together positively loaded in factor 5 with explained 6.7% variance. Cronbach alpha reliability coefficients are calculated for each scale and sub-dimension of the scale reliability. Cronbach alpha internal reliability coefficients are found as 0.89 for the factor 1, 0.81 for the factor 2, 0.65 for factor 3, 0.46 for factor 4 and 0.27 for factor 5.

Table 3: Orthogonal (VARIMAX) rotational solution

Item	Statement	Component				
		1	2	3	4	5
A1	Climate variability is an important environmental issue			.602		
A2	High temperature is an issue in last five years	.752				
A3	Ground water label goes down due to climate variability	.529				
A4	Increase in number of droughts in recent years		.726			
A5	Increase in disease infection and pest infestation	.562				
A6	Change in feeding schedule for dairy animals				.849	
A7	Change in current farm management practices			-.653		
A8	Change in investment in dairy business due to climate variability			-.681		
A9	Change in timing of precipitation		.783			
A10	Delay in rainfall due to climate variability	.635				
A11	Alteration in nutrient value in plant				.568	
A12	Human plays a big role in climate variability		.641			
A13	Climate variability is beneficial for dairy farming				.965	
A14	Soil erosion due to climate variability					.719
A15	To combat climate variability urgent preparedness is not essential					.892
	Eigen Value	3.442	2.723	1.825	1.238	1.052
	Variance explained (%)	32.7	17.3	12.5	10.3	6.7
	Cronbach alpha	.892	.818	.653	.462	.271

All the factors are summarized and presented separatory in table-4.

Table 4: Category of Factors

Factor Number	Statements	Coefficient
F1	High temperature is an issue in last five years	.752
	Ground water label goes down due to climate variability	.529
	Increase in disease infection and pest infestation	.562
	Delay in rainfall due to climate variability	.635
F2	Increase in number of droughts in recent years	.726
	Change in timing of precipitation	.783
	Human plays a big role in climate variability	.641
F3	Climate variability is an important environmental issue	.602
	Change in current farm management practices	-.653
	Change in investment in dairy business due to climate variability	-.681
F4	Change in feeding schedule for dairy animals	.849
	Alteration in nutrient value in plant	.568
	Climate variability is beneficial for dairy farming	.965
F5	Soil erosion due to climate variability	.719
	To combat climate variability urgent preparedness is not essential	.892

Association between selected independent variables and dairy farmer's perception towards climate variability

Results shown in Table 5, correlation between social participation and dairy farmer's perception towards climate variability was positive and insignificant whereas mass media exposure and dairy experience were positively and significantly correlated at 5% level of significance. Correlation with age, education, family size and annual income, land holding herd size and risk orientation was positively and significantly correlated at a 1% level of significance.

Table 5: Association between selected independent variables and dairy farmer's perception towards climate variability

S. No.	Variables	Correlation Coefficient	p value
1.	Age (years)	0.25	0.0058
2.	Education	0.34	0.0001
3.	Family Size	0.26	0.0041
4.	Annual Income	0.59	0.0000
5.	Land Holding	0.32	0.0003
6.	Dairy Experience	0.19	0.0376
7.	Mass Media Expoxure	0.21	0.0213
8.	Social Participation	0.08	0.3850
9.	Herd Size	0.51	0.0000
10.	Risk Orientation	0.61	0.0000

Conclusion

Climate variability in Bundelkhand poses significant challenges for dairy farmers, affecting livestock health, milk production, water availability, and feed resources. The compounded effects of heat stress, drought, and flooding make dairy farming in the region highly vulnerable. From the study, it was revealed that large number of dairy farmers in the study area was of middle aged (49.17%), belonged to medium sized family (46.67%), whose annual income under medium category (55.83%), and have low level of mass media exposure (48.33%) with marginal to small land holding (70%). They also had less social participation (49.17%) and the experience in dairying was moderate (67.50%). The dairy farmers in the two districts of Bundelkhand region perceived a delay in the rainfall due to climate variability and down level of ground water but an increase in the dry season, disease infection and pest infestation and the temperature. They also perceived the change in feeding schedule for dairy animals and climate variability as an important environmental issue. Since Farmer's perception are influenced by a wide range of factors, including socioeconomic and demographic variations but it need to be given special emphasis with various effective extension approaches. The findings of the present study would be helpful to the researchers, extension personnel, policy makers, and dairy personnel to mitigate the problems and formulate the strategies for improving the production and productivity of dairy animals.

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