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Perceived Climate Change Risks and Constraints Faced by Dairy Farmers in Odisha

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Abstract: The study examines the key risks perceived by dairy farmers in Odisha and the challenges encountered when implementing climate adaptation strategies such as changing the micro-climate of the cattle shed. About 68% of dairy farmers were aware of climate-related risks in 2022 and struggled to adapt due to economic limitations and lack of access to resources and information. The binary logistic regression analysis indicates that perceived risks, such as animal infertility and disease incidence, significantly affect farmers' decisions to alter their cattle management practices. Conversely, factors like family size hinder their ability to make these changes. Additionally, the extent of adoption is limited by market dynamics, including milk prices and information asymmetry, as prioritized using Garrett's ranking. These barriers impede effective adaptation and emphasize the necessity for comprehensive support systems, including fair pricing for farmers, climate education, enhanced access to information, and awareness campaigns focused on climate change, especially concerning dairy animals.

Keywords: Dairy farmers, Change in microclimate, Disease incidence, Perceived risk

Globally, climate change affects many aspects of human life, society and the natural environment. The impact of climate change has a serious consequence on many sectors of the economy and its ill effects are particularly pronounced in developing countries like India (Rao et al., 2016, Das et al., 2022). There is growing evidence that persons depending on climate-sensitive agriculture and allied sectors would suffer economically due to climate change (Ravindranath 2011, Madhi et al., 2021, Singh and Jatav 2023). The sixth assessment report of the Intergovernmental Panel on Climate Change (IPCC) predicted that it is inevitable to decrease the earth's temperature below 1.5^0 C in any scenario (IPCC AR6 2021). The temperature rise will intensify the climate of extreme events such as cyclones, drought, floods, etc. In this respect, adopting various climate resilient practices becomes more crucial (Acharya et al., 2022, Shanabhoga et al., 2023, Shivakumarappa et al., 2023).

The global warming effect harms the production and productivity of crops and animals (Sirohi and Michaelowa 2007). The incidence of heat stress in dairy animals seriously affects their reproductive and productive performance (Sere et al., 2008). This results in a reduction in both the quality and quantity of milk. In addition to this, an increase in temperature increases the risk of metabolic disorders, lameness, mastitis, and other animal health issues (Sinha et al., 2017). All of these lead to a loss in income due to a decrease in milk quantity and quality, an increase in expenditures due to repeat breeding, an increase in treatment costs, and possibly the death of animals due to a catastrophic incidence (Upadhyay et al., 2009). It necessitated continuous health monitoring of dairy animals. Appropriate adaptation and mitigation techniques may significantly reduce the climate change effect and help farmers sustain productivity during extreme climate changes. The adoption of adaptation techniques to climate change depends on four factors, i.e., (i) how farmers assess the climate change risk that poses in dairying, (ii) the financial position of the farmers, (iii) market assurance in terms of price realization, and (iv) appropriate information on climate, market and production aspects (Anoop et al., 2022).

Dairy farming is an integral part of livelihood in rural Odisha. Over 85 percent of the cattle population in Odisha is owned by landless, marginal, and small farmers who are vulnerable to climate extreme events (Odisha Economic Survey 2021-22). Erratic rainfall, flash floods during the rainy season, heat waves in summer, drought and dry periods every two years, notably in western Odisha, extreme coastal flooding, and cyclones are the main climate-induced dangers in Odisha. Climate change is likely to increase both the frequency and severity of such disasters in the future. The extreme climate occurrences cyclones and flooding are wreaking havoc on Odisha and the majority of districts impacted by both disasters. The super cyclone of 1999 on the Odisha coast killed 55000 cows (CSO 2000) and several such instances have been observed in cyclones like Phailin

(2013), Fani (2019), Amphan (2020). In light of the significance of dairy to small and marginal farmers, determining the perceived effects of climate change on various aspects of dairy farming and constraints in adaptation will aid in the formulation of adaptation policies for future challenges (Kant et al., 2015, Singh and Singh 2023). In the milieu, the study captures perceptions regarding the effect of climate change on dairy animals and various constraints faced by dairy farmers.

MATERIAL AND METHODS

The state of Odisha was chosen for the current study. There are 10 agro climatic zones in Odisha and each of the selected district belongs to a distinct agro climatic zone. Agro-climatic zones greatly influence dairy farmers' productivity and resilience by shaping factors such as fodder availability, livestock breeds, housing, management practices, and climate adaptation strategies. Primary data was collected using stratified random sampling. Six different districts (Balasore, Bargarh, Dhenkanal, Ganjam, Jagatsinghpur, and Sundargarh) and two blocks from each selected district were considered for primary data collection and two blocks from each selected district were considered for primary data collection (Table 1). The 360 dairy households (with strict inclusion criteria of at least three milch animals) were randomly selected from a cluster of villages. The information on perception regarding various climate aspects was collected following a well-structured interview schedule.

In the summer along India's eastern coast, temperatures often reach 40°C, sometimes climbing above 45°C, with humidity levels as high as 80-90%. To combat heat stress in their livestock, dairy farmers change the microclimate of the cattle shed by utilizing electric fans, foggers, sprinklers, straw bedding, and heat-insulating materials. Considering this a binary logistic regression model was used to analyze the influence of the perceived factors on the likelihood of farmers adapting their cattle sheds' microclimate. The dependent variable in this study was binary, indicating whether or not the farmer decided to implement changes in the microclimate of their cattle shed (1 = Yes, 0 = No). The logistic regression model is appropriate for cases where the outcome variable is binary. The probability of adopting a microclimate change (P(Y=1)) is modelled as a function of the independent variables, using the logit function:

$$\text{logit}\,(P) = \log\frac{P(Y=1)}{1-P(Y=1)} = \beta_0 + \beta_1X_1 + \beta_2X_2 + \cdots + \beta_kX_k$$

Where,

P(Y=1) is the probability of the farmer making a change.

β_0 is the intercept

$\beta_1, \beta_2, \ldots, \beta_k$ are the coefficients of the independent variables $X_1, X_2, \ldots, X_k$.

The logistic regression model was estimated using STATA. Odds ratios were computed to interpret the influence of each independent variable on the likelihood of adaptation, with confidence intervals and p-values used to assess statistical significance.

Identifying constraints in adaptation: Garrett's ranking technique has been used to prioritize the constraints in the adoption of management strategies.

$$\text{Per cent position} = \frac{100 \times (R_{ij} - 0.5)}{N_j}$$

Where, R_{ij} is rank given for i^{th} factor by j^{th} individual

Nj is the number of factors ranked by the j^{th} individual

The percent position of each rank was converted into scores. Finally, the mean scores for all the factors are arranged and ranked in descending order to identify the important constraints.

Table 1. GPS locations of the study areas

Districts	Blocks	Latitude	Longitude
Baleshwar	Baliapal	21.65	87.28
	Bahanaga	21.34	86.76
Jagatsinghpur	Jagatsinghpur	20.25	86.17
	Kujang	20.30	86.53
Ganjam	Digapahandi	19.38	84.56
	Rangeilunda	19.26	84.77
Dhenkanal	Dhenkanal	21.11	85.58
	Bhuban	20.89	85.83
Bargarh	Attabira	21.37	83.78
	Barapali	21.18	83.60
Sundergarh	Sundergarh	22.13	84.05
	Gurundia	21.85	84.78

RESULTS AND DISCUSSION

Socio-economic profile: The socioeconomic profile of 360 farmers indicate average age of 47.36 years indicating most are in their mid-40s (Table 2). On average, farmers have completed secondary education with 10.4 years of dairy farming experience. The cattle sheds are predominantly semi-pucca to pucca types. The average herd size is 13.21, though most farmers are smallholders, typically owning 3-4 milch animals. The animals are mainly indigenous cows and crossbreeds, including Haryanvi and Jersey cows.

Perceived risk due to climate change: About 68 percent of the farmers were aware of the risk due to climate change while others were not aware of such issues due to illiteracy

(Table 3). The significant proportion of farmers (63.33%) expressed concerns about a reduction in both the quantity and quality of milk production, primarily attributing it to environmental factors. Furthermore, farmers also observed increased occurrences of animal infertility (61.11%) and heat stress in dairy animals (50.27%). The milk yield of animals negatively correlated with the temperature-humidity index (THI) (Behera et al., 2018). THI above critical level causes heat stress in dairy animals which also increases the chances of animal infertility. There was also a reduction in feed and fodder intake in dairy animals perceived by about 43 per cent of respondents. Heat stress induces behavioral and metabolic modifications, including decreased feed intake and metabolic activity, and consequently a decrease in productivity (Sirohi and Michaelowa 2007). About 47 per cent farmers expressed that there was more incidence of diseases due to after flood effects. During flood the water got contaminated due to deceased animals and the animals which forced to drink that contaminated water got affected. The extreme climatic events like flood and cyclone cause death of the animals and reduce availability of feed and fodder as perceived by 37 and 38 per cent respondents respectively.

The binomial logistic regression analysis examining how farmers' perceived risks influence their decisions to modify the microclimate of their cattle sheds (Table 4). Several factors significantly affect these decisions, including education, herd size, and access to climate information. Higher education levels and larger herds are associated with a greater likelihood of implementing changes, possibly due to a better understanding of climate impacts and resource management. Conversely, family size has a negative and significant effect, suggesting that larger families may face constraints in time or resources, making them less likely to adjust their practices. Among the perceived risks, the problem of animal infertility (coefficient = 0.19) and the incidence of diseases) are particularly influential, indicating that farmers are motivated to take action in response to these serious concerns. However, perceived risks related to reductions in milk quantity and quality, as well as the unavailability of feed and fodder, do not significantly influence decision-making. This discrepancy may reflect a lack of awareness or information regarding the long-term impacts of these risks. Overall, the model accounts for 50% of the variability in farmers' decisions (Pseudo R^2 = 0.50) and is statistically significant (LR χ^2 = 228.35, n = 360), underscoring the importance of these factors in shaping cattle management practices in response to climate risks.

Farmers in the study area face challenges in getting profitable prices for their milk due to the underdeveloped

Table 2. Socioeconomic profile of the farmers

Particulars	Average (n=360)
Age (years)	47.36 (7.37)
Education (0=illiterate, 1= primary, 2= secondary,3= graduation & above)	1.91 (0.77)
Experience in dairy farming (years)	10.40 (2.21)
Type of cattle shed (Kutcha=0, Semi-pucca=1, pucca=2)	1.36 (1.34)
Herd size (number)	13.21 (3.96)

Figures in the parenthesis represent the standard deviation

Table 3. Farmers perceived risk due to climate change

Perceived risks	Frequency (N=360)
No awareness on climate change effects to dairy animals	248 (68.88)
Reduction in milk quantity and quality	228 (63.33)
Problem of animal infertility/repeat breeding	220 (61.11)
Incidence of heat stress in animal	181 (50.27)
Incidence of diseases become more	170 (47.22)
Reduction in feed and fodder intake by the animal	158 (43.88)
Unavailability of feed and fodder	138 (38.33)
Reduction in longevity of animal	134 (37.22)

Figures in the parenthesis represent the percentage of the total respondents

Table 4. Effect of farmers' perceived risk on farmers' decision to change in microclimate of the cattle shed

Variables	Coefficient	Standard Error
Age	0.0023	0.0024
Education	0.059**	0.024
Herd Size	0.017***	0.004
Experience	0.003	0.008
Sources of climate information	0.055***	0.01
Family size	-0.046***	0.013
Perceived Risks (Yes=1, No=0)		
Reduction in milk quantity and quality	0.02	0.05
Incidence of heat stress in animal	0.08	0.05
Problem of animal infertility	0.19***	0.04
Reduction in feed and fodder intake by the animal	0.05	0.039
Incidence of diseases	0.08**	0.038
Reduction in the longevity of animal	-0.01	0.039
Unavailability of feed and fodder	0.002	0.039

Pseudo R^2=0.50, LR χ^2 = 228.35***, n=360

Table 5. Constraints faced by dairy farmers

Constraints	Overall	
	Garret score	Rank
Unsatisfactory milk prices	60.39	I
Lack in information	58.79	II
Paucity of money	54.46	III
Increase in prices of feed and fodder	54.31	IV
No Training	49.83	V
Non-availability of critical inputs	46.71	VI
Non-availability of credit	43.20	VII
Non-availability of labor	32.33	VIII

dairy market, as mentioned by Kale et al. (2016) (Table 5). Low milk yields are common, partly due to the prevalence of non-descriptive indigenous cattle. Rising feed and fodder prices by further reduce productivity (Acharya et al., 2022). About 65.27% of farmers belong to cooperative societies, benefiting from subsidized feed, while non-members struggle with rising concentrate costs. Many farmers rely on dry fodder and concentrate, with little cultivation of green fodder in the area. Irregular milk payments and poor bargaining power are also issues, alongside a lack of information and financial resources. To enhance climate adaptation, training on insurance policies and credit facilities is needed, with key barriers including low milk prices, poor animal productivity, and limited awareness among farmers.

CONCLUSIONS

The study provides valuable insights into the perceived risks of climate change and constraint among dairy farmers. A significant proportion (68%) were aware of climate-related risks, yet many face challenges in adapting to these threats, primarily due to economic constraints and limited access to resources and information. The analysis indicates that specific perceived risks—particularly animal infertility and increased disease incidence—significantly influence farmers' decisions to modify the micro climate of the cattle shed. However, factors such as family size negatively affect their ability to implement these changes. Despite the awareness of potential reductions in milk quantity and quality did not significantly motivate action, possibly indicating lack of understanding of the long-term impacts of these risks. Farmers also face considerable constraints while adapting which include unsatisfactory milk prices, lack of information, and rising feed costs. These barriers hinder effective adaptation and highlight the need for comprehensive support systems. Therefore, policy measures should be directed towards assuring remunerative prices to the farmers, educational programs on climate risks, improving access to climate information, and creating awareness camps about climate change and its consequences, especially for dairy animals.

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