

Assessment of dairy farmer's perception towards adoption of climate resilient dairy farming practices

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Abstract

The global food system, which nourishes millions of people worldwide, depends on dairy. Extreme weather poses increasing risks to dairy sectors. An accurate perception of a phenomenon helps individuals take necessary actions. Adopting climate resilient dairy farming practices leads to increased resilience and consistency in milk yields despite varying climate conditions. With this view, the current study was carried out in four districts selected through stratified random sampling from different agro climatic zone of Madhya Pradesh according to their vulnerability level. A focused group discussion with a structured interview schedule was developed to collect the data in the year 2023. One hundred sixty dairy farmers were interviewed for final data collection from three- and five-point continuum statements for perception assessment, and the reliability coefficient of all the statements was 0.701. Furthermore, the modified Mann-Kendall trend test also analyzed 30 years (1993-2022) of metrological data. The findings of the study revealed that most respondents have adequate socioeconomic variables to adopt climate-resilient practices and increase system resilience. The trend of the maximum summer temperature increased while the trend of the winter minimum temperature and rainfall decreased over the 30 years. It was observed that 80 % and 78.13 % of the respondents agreed on changes in temperature and rainfall, respectively. Moreover, 44.3 percent of the collective impact is explained by the ten antecedent variables related to the perception of farmers. A critical assessment of farmers' perceptions with metrological data analysis is vital to improving farmers' as well as environmental health. The most important strength of such an approach is to view the bull eye of the persuasive behavior of farmers so that we can match their attitude with their level of understanding which ultimately leads to adoption decision.

Keywords: Dairy, Climate-resilience practices, Perceptions, Trend analysis, Adoption

Introduction

The global food system, which nourishes millions of people worldwide with vital nutrients such as protein, calcium, and vitamin D, depends heavily on dairying. According to estimates by the FAO, approximately 150 million households worldwide are engaged in milk production (Siddiky and Faruque, 2017). The thermoneutral zone (TNZ) of the dairy animals, which is between 16 and 25 degrees Celsius, allows them to maintain a physiological body temperature between 38.4 and 39.1 degrees Celsius. However, in temperate climates, air temperatures above 20–25°C, and in tropical climates such as India, which are 25–37°C, increase heat gain over what the body loses and cause heat stress (Ghezzi, et al., 2024; Silanokove and Koluman, 2015). Extreme weather poses increasing risks to India's agriculture and allied sectors, which include dairy, and contributes 17 % of the country's GDP. Moreover, it has been determined that the dairy industry may have a considerable impact on greenhouse gas emissions; therefore, it is imperative that dairy farmers implement environmentally friendly practices. Climate change and its effects are currently receiving much attention worldwide (Djohy et al., 2013; Ugorets et al., 2021).

An accurate perception of a situation or phenomenon is helpful in taking necessary actions. Receiving and interpreting sensory data is a cognitive process known as perception. It takes two steps to adapt. Prior to taking action to reduce the negative effects of climate change, one must first recognize the associated risks (Tripathi, 2016).

The adoption of climate resilient dairy farming practices leads to increased resilience and consistency in milk yields despite varying climate conditions. These practices in dairy production range from feeding management, housing management, and health management, to providing climate services to dairy farmers to take up primary and secondary dairy product preparation to obtain additional income. Therefore, the onus is on research institutions, governments, and extension agencies to sensitize the farming community to the creeping danger of climate change on the dairy production system and motivate them to adopt practices that would provide a shield against the losses incurred due to potential changes in climate. The major work on the dissemination of climate-resilient dairy farming practices in India was conducted by ATARI and NICRA, which were mentioned in their annual reports. Practices such as hydroponic fodder production technology, silage making, enrichment of feed with Azolla, supplementation of protein and energy along with minerals through urea molasses blocks, supplementation with a mineral mixture at 50gm/day, feeding Bypass fat @100 g/animal/day, feeding bypass protein and vitamin E, selenium and mastitis preventive measures (e.g., Mastiguard, herbal teat dip, KMNO₄ teat dip) were incorporated as adoptive health management practices since climate induced stress and humidity can increase susceptibility to udder and other infections.

Some independent characteristics of the farmers such as education and age were found to influence how they perceived these changes and mitigation actions. Farmers' perceptions of climate change were found to be significantly improved by climate change information (Habtemariam *et al.*, 2016). According to a study performed in India's WDR, most farmers who were surveyed had a moderate perception of climate variability. There was a notable positive correlation between the perception level and education level, social participation, experience in dairying, annual income, extension contact, exposure to the media, and readiness to act. (Kant et al., 2015). It is important to understand how farmers perceive the climate variability in the climate and accordingly what actions they are taking at their own level. The global community is working to reduce future risks and attempt to lessen the current circumstances by implementing robust production systems. Therefore, farmers' perceptions of climate change and climate-resilient dairy farming practices were of utmost importance for their endpoint adoption.

Methodology

Study location

The current study was carried out in purposively selected Madhya Pradesh state due to its substantial contribution to dairying as indicated by the 20th livestock census data. The total bovine population in Madhya Pradesh is 29.05 lakhs of which 18.75 lakh (1st rank in India) are cattle and 10.30 lakh are buffalo (5th rank in India). Milk production in MP reached a volume of approximately 17.99 million tons (3rd rank in India). The state currently represents the 3rd largest dairy market (8.06%) in India, with INR of 975.3 billion in 2022 (IMARC, 2022). From the Madhya Pradesh state, the districts were selected on the basis of their vulnerability from least vulnerable to very highly vulnerable, viz; Jabalpur, Narsinghpur, Rewa, and Shahdol (source: Madhya Pradesh Climate Change portal) (Fig. 1). A focused group discussion with a structured interview schedule was developed to collect the data from September 2023 to January 2024. From each district, 2 blocks and from each block 2 villages were selected and 10 dairy farmers from each village were selected on the basis of their work experience and herd size (a farmer who had a minimum herd size of 4 dairy animals since the last 5 years was selected as a sample for the present study). Hence, a total of 160 farmers were selected for the present study.

Tools of data collection for the present study

Primary data: The interview schedule was finalized after the pilot study and expert suggestion. This final schedule was again tested among progressive farmers, veterinary surgeons/officers, and veterinary representative persons. The schedule was modified again and finally introduced to dairy farmers as per the prerequisite criteria for respondent selection. Finally, 210 farmers were interviewed in 2023, 160 of who responded. The response of the farmers were recorded on 3 points, i.e., agree (2), not agree (1), and neutral (0) continuums against the perception of climatic variables while they were recorded on a 5-point continuum scale starting from strongly agree (5), agree (4), undecided (3), disagree (2) and strongly disagree (1) regarding the adoption of climate-resilient dairy farming practices. The scores for the negative statements are inverted at the time of scoring. Hence, a score of 5 becomes a 1, and a score of 1 becomes a 5. To assess the perception of climate-resilient dairy farming practices adopted by dairy farmers, a total of 19 items were identified via a review of the literature, and expert consultations through pilot studies. For the total 19 items, the perception score was calculated and dairy farmers were categorized into three categories low, moderate, and high. The reliability of all the statements was analyzed by Cronbach's alpha estimation. Independent variables such as age, gender, education, income, land holdings, herd size, work experience, social contact, awareness of climate change impact, mass media exposure, and access to basic services were included. The statistical program SPSS 22.0 was used to analyse the data after coding and tabulation. In the present study descriptive and inferential statistical methods were blended to obtain significant information, and test hypothesis and relationship. Then, the percentage, frequency, weighted mean score, and rank were computed for each component as well as each statement. A descriptive research design was used in order to describe the characteristics of a phenomenon, i.e. farmers' perception of the adoption of climate-resilient practices.

Secondary data: To verify the farmers' responses, i.e., responses drawn from experience or general knowledge about climate change and the adoption of climate-resilient dairy farming practices, long-term climatic parameter data for the four selected districts were obtained from the 'Indian Metrological Department' Pune for the period from 1993 to 2022 (30 years). This period of 30 years has been used to cover the range of farmer experiences regarding the impact of climate change on dairy animals. The grid files of parameters namely; maximum temperature ($T_{\max}$), minimum temperature ($T_{\min}$) $^{\circ}\text{C}$, and rainfall data in mm were downloaded and extracted into Excel files. Trend analysis was performed using the ordinary least squares method. Furthermore, a modified Mann-Kendall trend analysis was utilized to examine the change in trends at a 95% confidence interval, i.e., $p < 0.05$. The Mann-Kendall trend analysis was preferred because the tau and slope values are free of autocorrelation, and the type I error is also reduced by the normalization of the data (Hu et al., 2020). The data were analyzed, and calculations were performed using R-software. Accordingly, positive or negative tau values and Sen slope indicate positive or negative trends, respectively. The null hypothesis was supported because there was no significant trend in the dataset.

Results and discussion

Profile of the respondents

As in the previous literature on the psychology of humans, perception is very important explaining the level of adoption. Furthermore, the adoption of any technology or practice is also determined by the socioeconomic profile of the person. A total of 10 socioeconomic characteristics (independent variables) were selected as per the research objective and are presented in Table 1. The results showed that the average respondent age was 44 years, the respondents were mostly male (80.63%), the respondents had 10th level education (51.25%), the respondents had 10-20 years of dairy experience, and 55% had a medium level of climate change awareness. In terms of social participation, extension contact, and farmer-to-farmer extension, the maximum number of farmers had a medium level. The average land holding was 2.68 ha, with more buffalo reared and 63 percent having a medium herd size (standard animal units). The average income was ₹7.64 lakhs. The majority of the respondents had having adequate socioeconomic variables to adopt climate-resilient practices and increase production system resilience.

Observed climate trends

The trend of the maximum summer temperature (Fig. 2) increased while the trend of the winter minimum temperature (Fig. 3); and rainfall (Fig. 4) decreased over the course of the 30-year study of the climatic parameters of a selected group of districts; from 1993 to 2022. Over time, there was an increase in the highest temperature. The findings of the MK-modified trend analysis (Table 2) also depicted the same results as those indicated by tau and Sen slope values. Farmers' perceptions of the temperature rise are therefore based on their personal experiences, which correlate with the data. Furthermore, a downward trend was observed in the minimum temperature trend over time.

The research region showed a downward trend; according to the analysis of rainfall data. That being said, this was not important. The fact that the majority of dairy farmers surveyed felt that temperatures were rising and rainfall was falling suggests that the farmers in the research area are aware of climate change. Furthermore, the

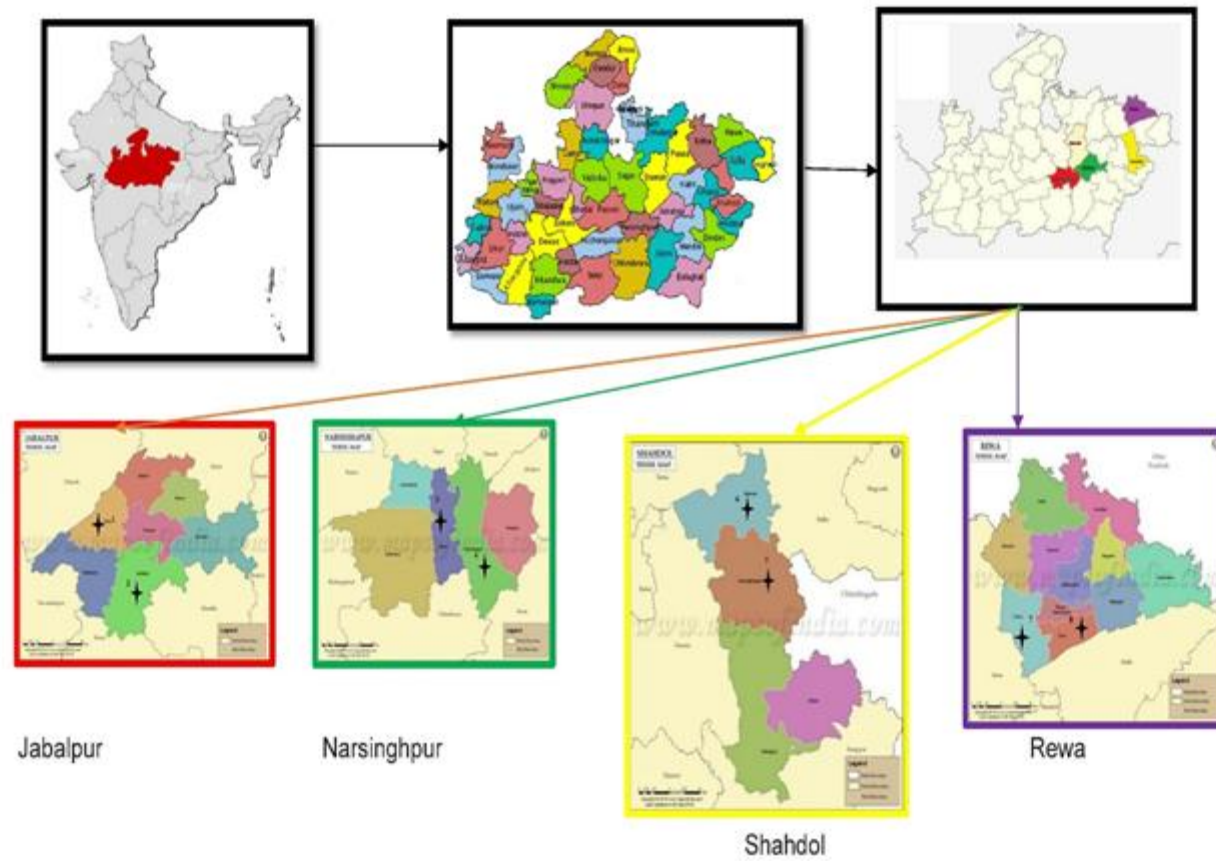


Fig. 1: Map of selected districts for the present study

Table 1: Sociodemographic profile of dairy farmers in the study area

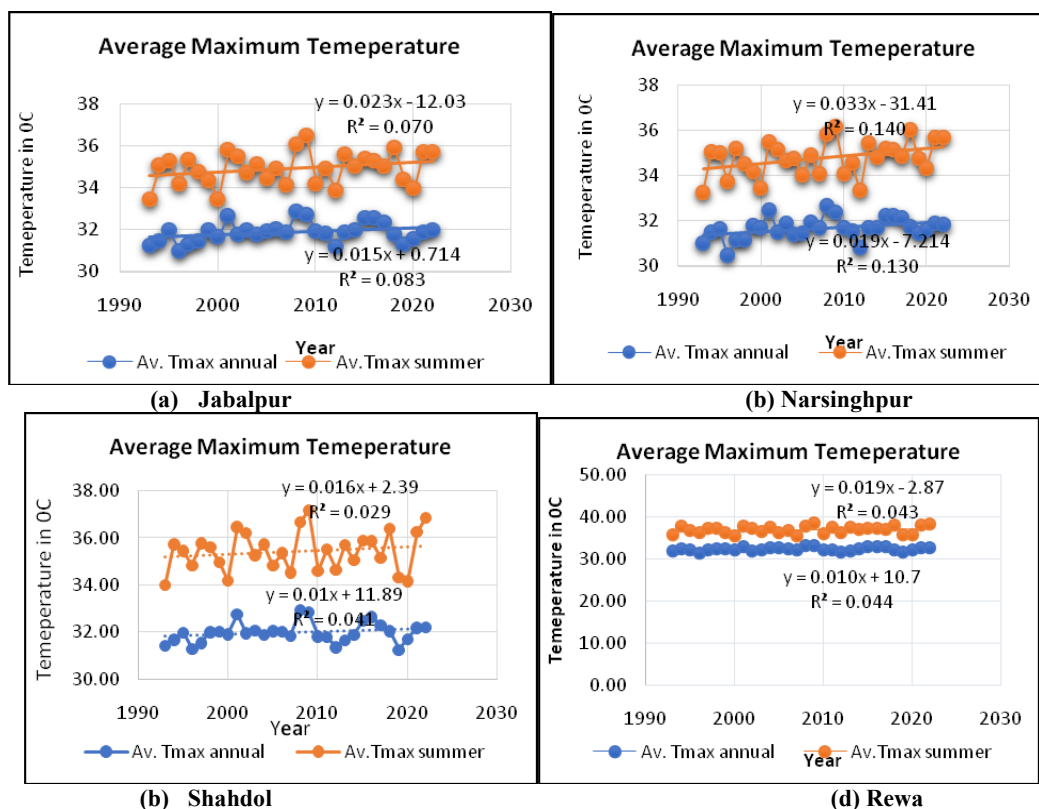
Antecedents' variables	Range	Frequency	Percentage	Mean $\pm$ SD
Age	< 35 yrs	43	26.88	44.1 $\pm$ 10.71
	35–55 yrs	77	48.12	
	> 55 yrs	40	25.00	
Gender	Male (1)	129	80.63	1.04 $\pm$ 0.64
	Female (2)	31	19.37	
Education	Illiterate (0)	11	06.87	2.54 $\pm$ 0.96
	Primary (1)	32	20.00	
	Secondary (2)	82	51.25	
	Higher secondary (3)	23	14.38	
	Graduate & above (4)	12	07.50	
Annual income (lakhs)	Low (2.00–5.18)	53	33.12	7.64 $\pm$ 1.24
	Medium (5.19–8.43)	76	47.50	
	High (8.44–24.00)	31	19.38	
Land holding (ha)	Marginal ($\leq$ 1)	12	07.50	15.04 $\pm$ 3.10
	Small (1–2)	42	26.25	
	Semi Medium (2–4)	56	35.00	
	Medium (4–10)	27	16.88	
	Large ($>$ 10)	23	14.37	
Herd size (SAU)	Small ($<$ 4.86)	37	23.12	12.74 $\pm$ 5.62
	Medium (4.86–25.23)	102	63.75	
	Large ($>$ 25.23)	21	13.13	
Experience (years)	Low ($<$ 10)	23	14.38	16.50 $\pm$ 8.71
	Medium (10–20)	81	50.62	
	High ($>$ 20)	56	35.00	
Social participation	Low (2.14–4.12)	38	20.87	5.45 $\pm$ 1.28
	Medium (4.13–6.25)	53	46.08	
	High (6.26–8.00)	24	33.05	
Mass media exposure	Low (3.00–5.13)	36	22.50	6.02 $\pm$ 0.12
	Medium (5.14–7.16)	89	55.63	
	High (7.17–9.00)	35	21.87	
Awareness (climate resilient dairy practices)	Low (8.00–14.14)	45	28.13	16.98 $\pm$ 2.14
	Medium (14.15–19.60)	88	55.00	
	High (19.61–24.42)	27	16.87	

***Age** is continuous; mean represents average age of respondents.; ***Education** was coded: Illiterate = 0, Primary = 1, Secondary = 2, Higher Secondary = 3, Graduate & above = 4. Mean reflects average educational attainment; ***Gender** was coded: Male = 1, Female = 2. Mean reflects predominance of male respondents; ***Herd size** was measured in Standard Animal Units (SAU). The corrected mean (12.74 $\pm$ 5.62) now accurately represents the distribution across herd categories.

findings of Sengupta (2022) also showed that Madhya Pradesh experienced an increase in the rate of recurrence of severe, extreme, and exceptional droughts. Severe and widespread droughts have occurred in recent years.

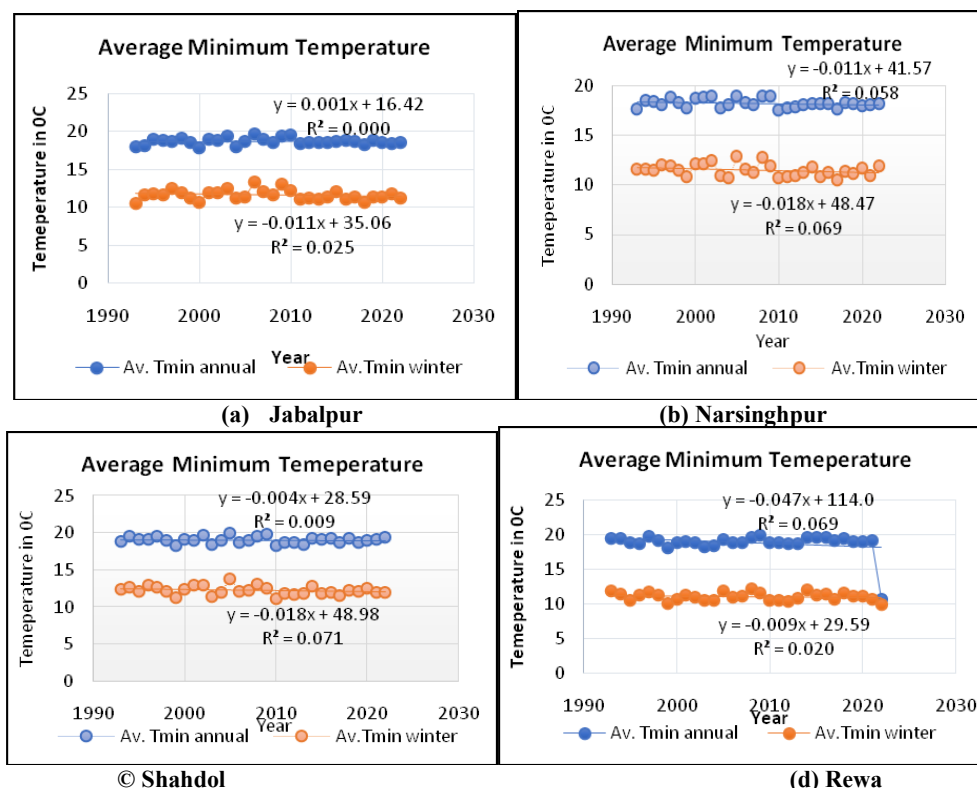
The number of hot days significantly increased in the region. The results of the present study were in line with those of Kant et al. (2015); Ata et al. (2021); Abazinab et al. (2022); Kumar et al. (2023); Patel et al. (2023) and Datta et al. (2022); Mishra et al. (2016) also reported that air temperature increased substantially in the post monsoon (October– December) season. In different parts of India, researchers, such as Singh (2020); Baruah et al. (2021); Jha and Gupta (2021); Kundu and Mondal (2022), and Datta and Behra (2022) have reported the same climatic trends. Similarly, Fosu-Mensah et al. (2012) found that 92% of the respondents perceived an increase in temperature and 87 % a decline in precipitation over the years in Ghana. The findings of Platt et al. (2021) observed an alignment for rising summer temperatures but not rising winter temperatures.

Analysis of climatic parameters using Mann–Kendall (MK) test and Sen's slope revealed that positive values indicate increasing trends, whereas negative values indicate decreasing trends. A significant trend was observed only for maximum temperature (Tmax), with a positive Sen's slope and significant MK test ($p < 0.05$). This aligns with the findings of Platt et al. (2021), where more than 50% of farmers reported an increase in summer temperature. It is important to note that climatic trend outcomes depend on the quality, length of data series, and analytical techniques, which may explain variations across studies.



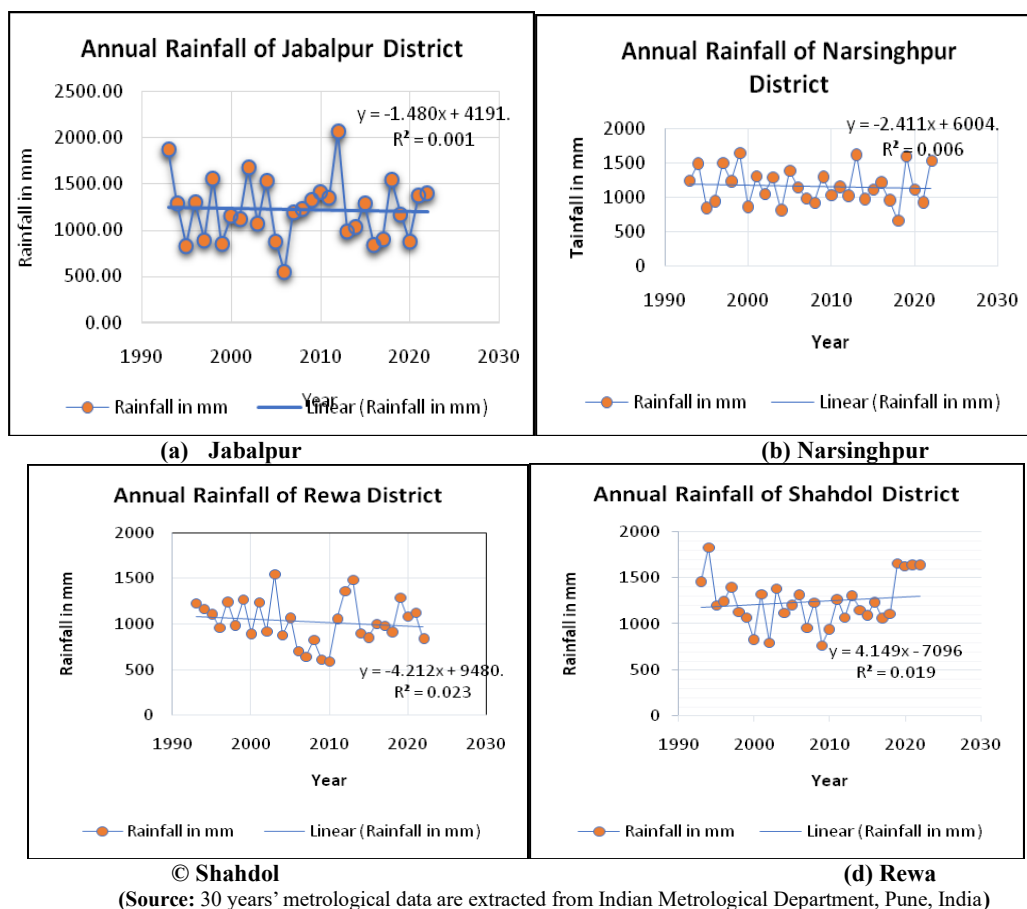
(Source: 30 years' metrological data are extracted from Indian Metrological Department, Pune, India)

Fig.2: Average annual and summer maximum temperatures of selected districts from 1993-2022



(Source: 30 years' metrological data are extracted from Indian Metrological Department, Pune, India)

Fig. 3: Average annual and summer minimum temperatures of selected districts from 1993-2022



(Source: 30 years' metrological data are extracted from Indian Metrological Department, Pune, India)

Fig. 4: Average rainfall of selected districts from 1993-2022

Table 2: Trend analysis of metrological data by MK modified trend test (30 years 1993-2022)

Districts	Tmax		Tmin		Rainfall	
	Tau	Sen's slope	Tau	Sen's slope	Tau	Sen's slope
Jabalpur	0.172	0.022	-0.131	-0.014	-0.075	-5.68
Shahdol	0.112*	0.019	-0.186	-0.015	-0.011	-1.12
Rewa	0.163*	0.021	-0.121	-0.0110	-0.098	-4.08
Narsinghpur	0.163	0.029	-0.149	-0.0145	-0.089	-4.60

* Significant at 0.05 level of significance

Table 3: Perception of farmers towards climatic variables (n=160)

Variables	Agree	Disagree	Neutral
Change in temperature	128 (80.00)	21 (13.13)	11 (06.88)
Change in rainfall	125 (78.13)	23 (14.37)	12 (07.50)
Change in intensity of rainfall	123 (76.88)	23 (14.38)	14 (08.75)
Decrease in rainfall	129 (80.63)	21 (13.13)	10 (06.25)
Increase in annual max temperature	115 (71.88)	32 (20.00)	13 (08.13)
Increase in summer max temperature	138 (86.25)	14 (08.75)	8 (05.00)
Increase in heat waves numbers	108 (67.50)	27 (16.88)	25 (15.63)
Increase in cold waves numbers	84 (52.50)	35 (21.88)	41 (25.63)

(The data in parentheses indicate percentages)

Table 4: Categorization of dairy farmers on the basis of their perceptual level (n=160)

S.No.	Perception score	Frequency	Percentage	Mean $\pm$ SD
1	Low perceptual level (41- 54.2)	54	33.75	57.53 $\pm$ 6.38
2	Medium perceptual level (54.30-61.36)	61	38.12	
3	High perceptual level (61.37- 72)	45	28.13	

Perception of farmers towards climate change:

Farmers were asked about changes in climatic parameters such as annual maximum and minimum temperature, summer maximum and minimum temperature, and annual rainfall. Responses were categorized as agree, disagree, or neutral.

It was observed (Table 3, Fig 5) that 80 and 78.13% of the respondents agreed on changes in temperature and rainfall, respectively. Furthermore, 76.88% of the farmers perceived that rainfall intensity was altered and a decrease in rainfall was perceived by 80.63% of the respondents. An increase in summer maximum temperature was perceived by the highest percentage of respondents i.e. 86.25%. The perception of increased numbers of heat waves and cold waves was slightly lower, at 67.50 and 52.50%, respectively. The current research findings were in line with those of Sengupta, (2022), Kumar et al. (2023);, Patel et.al. (2023), and Dutta et.al. (2022), who observed that farmers' perception of temperature were appropriate for precipitation. The respondents said that temperature and rainfall were the most important factors for agriculture and livestock production. Interestingly, 6.88 and 7.50% of the farmers said that there was no change in temperature or rainfall, respectively.

Categorization of the farmers on the basis of perception score

A person's ability to understand and analyze phenomena is determined by their perception level and Nwakile et al. (2020) described the perception through which humans evaluate one's surroundings by their sensory experience. The results are depicted in Table 4 and show that most of the respondents (38.12%, 33.75%) had a medium to high perceptual level, whereas, 28.13% of the respondents had a low perceptual level toward climate change and adoption of climate-resilient dairy farming practices. Furthermore, the mean of their perceptual level was 57.53.

Statement-wise response of the respondents toward the perception of the adoption of climate-resilient dairy farming practices

Farmers strongly agreed (total score 525 out of 800 ($160 \times 5 = 800$)) that animal productivity, particularly milk yield and reproductive efficiency, has declined under extreme climatic conditions. They also perceived that shed management practices (e.g., white paint, foggers, fans) and feeding interventions significantly improve productivity under climate stress. Importantly, locally available, low-cost resources were ranked highest in terms of adoption, reflecting farmers' preference for practical and affordable solutions. In contrast, perceptions of adoption of vaccination and deworming schedules and value addition of milk and by-products were relatively low, suggesting these practices are less prioritized.

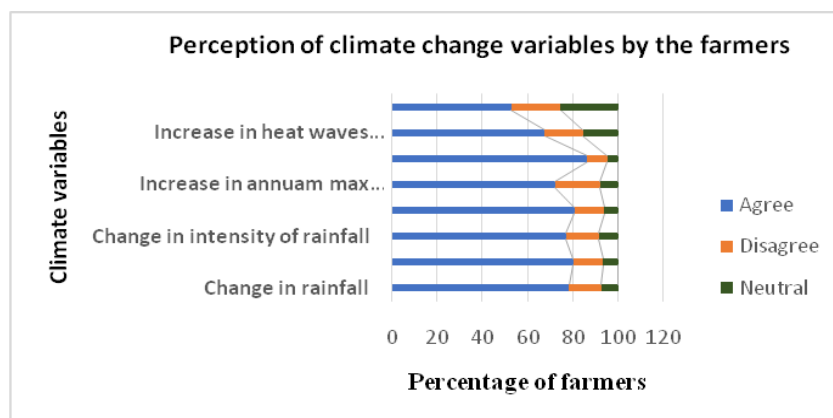


Fig. 5: Perception of climate change variables by the farmers

A study conducted by Fosu-Mensah et al. (2012) in Ghana, also noted that the perceived rise in temperature has been causing the decrease in forest resources (63.3%), a decrease in yield of crop yield, increase in the incidence of infestation, and high pest and disease outbreaks (more than 70%), due to variations in precipitation and temperature over the past 20 years. Furthermore, more than 60% of the farmers agreed that alterations in temperature and rainfall decrease production and revenue. Farmers in the central Himalayan region (65%) mentioned that wheat and rice production has decreased due to climate uncertainty (Shrestha et al, 2022). A recent study by Patel et al., (2023), reported that farmers who perceived the climate change, opted for practices such as shifting of showing dates (87%), increasing irrigation (83%) and changing varieties (86%). Furthermore, practices that save natural resources such as water harvesting, and conservation agriculture were not considered or adopted by the farmers. In contrast, Brody et al. (2012) noted no relationship between climate change knowledge and the willingness to adopt climate

change mitigation practices. Hence, valuable insight into the various dimensions of climate change credence analyzed by such studies, may play an important role in determining the direction of response to climate change. A number of studies support the Panda's (2016) argument that the perception cannot be purely imperfect just because it is depicting less association with the underlying climatic evidence/parameters. Moreover, perception have prominent role in a farmer's decision making even if the actual climate trend did not match with the farmer's view.

Correlation and regression analysis between antecedent characteristics and the perception score of the farmers

Correlation analysis was further performed and the outcome of the study indicates a noteworthy correlation between various aspects of perception and socio demographic variables. Correlation analysis revealed that education ($r = 0.680$, $p < 0.01$) and mass media exposure ($r = 0.295$, $p < 0.01$) were strongly and positively associated with farmers' perception scores at the 1 % level of significance. In addition, herd size ($r = 0.026$, $p < 0.05$), experience ($r = 0.083$, $p < 0.05$), and awareness towards climate resilient dairy practices ($r = 0.216$, $p < 0.05$) showed significant positive correlation at the 5 % level. Other antecedent variables such as age, gender, landholding, income, and social participation did not exhibit any significant correlation with perception. These findings suggest that farmers' perception of climate change is primarily shaped by their educational attainment, exposure to mass media, herd size, farming experience, and awareness of climate resilient practices, while demographic factors like age and gender play a negligible role.

Table 5: Statement wise responses of the respondents to the adoption of climate-resilient dairy farming practices

S.No.	Statements	Total Score	Mean Score	Mean	Rank
1.	Climate change significantly effects the dairy animal's productivity	525	3.28	65.63	02
2.	Climate resilient dairy farming practices can only be followed by resource rich farmers	489	3.06	61.13	12
3.	Animals have innate capacity to adapt to changing climate and there is no need to follow a specific climate resilient practice	492	3.08	61.50	11
4.	Climate resilient practices increase cost of production while profits from increased milk production are minimal	507	3.17	63.38	07
5.	Climate resilient dairy farming practices put additional burden on dairy farmers	508	3.18	63.50	06
6.	Lower socioeconomic position of farmers is hindering the adoption of climate resilient practices in dairy farming	502	3.14	62.75	08
7.	As women majorly involved in dairying hence more women centric trainings should be conducted for better adoption of the practices	501	3.13	62.63	09
8.	Preparation of milk byproducts such as khoa, paneer, ghee etc., is important to make dairying as resilient against climate change	496	3.10	62.00	10
9.	Value addition of milk will be a potential source of income as climate change is posing a threat to the livelihoods of farmers	470	2.94	58.75	17
10.	Indigenous breeds are comparatively more resistant to changing climate, but, their lower milk productivity may little influence in improving adaptive capacity.	478	2.99	59.75	14
11.	Climate resilient practices such as biogas, vermicomposting, panchagavya products, silage making should be promoted on cooperative system	509	3.18	63.63	05
12.	Climate change is just a seasonal variation and no need to take extra feeding and other management practices for animals as they themselves can adapt to it	515	3.22	64.38	03
13.	One needs to have some expertise in identifying the symptoms of impact of climate change on dairy animals	471	2.94	58.88	16
14.	Emphasis should be given to promote climate resilient dairy farming practices made of locally available low-cost resources	526	3.29	65.75	01
15.	Frontline demonstration of the climate resilient dairy farming practices may improve its adoption	481	3.01	60.13	13
16.	Disease testing programme for important disease like mastitis, brucellosis etc., will help in reduction of climate change impact on animals	501	3.13	62.63	09
17.	Animal shed management and feeding management significantly reduced the impact of climate change on dairy animals	514	3.21	64.25	04
18.	Following of Vaccination and deworming schedule will help to maintain resilient capacity of dairy system	472	2.95	59.00	15
19.	ICT –based weather forecast advisory services will help in decision making of farmers to take right decision at right time	478	2.99	59.75	14
	Reliability coefficient of all the statements - Cronbach α	0.701			

Next, the explanation of the perception behavior of farmers is further estimated by regression analysis. The information presented in Table 6, with an R squared value 0.443, implies that only 44.3% of the variability in the perception score of farmers can be explained by the 10 mentioned antecedent variables. Additionally, F statistics of 0.817, at $p < .05$ is no significant different. Only three variables namely; herd size, experience, and awareness of climate-resilient dairy farming practices had significant effects on perception.

From the regression analysis, it may be inferred that herd size, experience, awareness of herd size, experience, and awareness of climate-resilient dairy farming practices play important roles and that these variables are also good predictors of farmers' perceptions of adopting climate-resilient dairy farming practices.

Moreover, the collective impact of the ten antecedent variables, including age, gender, education, land holdings (in hectares), herd size, income (in thousands), experience (in years) social participation, mass media exposure, and awareness of climate-resilient dairy practices, explained a substantial portion of the variance in the perceptions of farmers, amounting to 44.3%. Therefore, based on these findings, the null hypothesis, according to which the antecedent variable of the farmers is not associated with their perception, is rejected. The Durbin-Watson statistic is 1.96 which is between 1.5 and 2.5; therefore, the data are not autocorrelated. The findings of Asrat and Simane, (2017), revealed that the education status, the age of the household's head, the number of crop failures in the past, and variability or changes in temperature and rainfall significantly affect farmers' perceptions of climate change in the wet lowlands of Ethiopia. As expected, farmers' perceptions of climate change are positively correlated with their level of education, indicating that more educated farmers are more likely to be aware of the risks associated with climate change. Moreover, educated farmers have more reasoning capacity and more awareness regarding new technology and hence encourage them to adopt climate-resilient practices with reinvention. In the present study, no agreement was found with respect to sex. In the present study, we found a positive but no significant association whereas, Asrat and Simane (2017) found a positive and significant relationship between gender farmers' perceptions and decision-making regarding adoption. This result is consistent with other empirical findings (Asrat and Simane, 2017; Guteta and Abegaz 2016). These studies' data showed that households headed by men were more likely to adopt new technologies.

Conclusion

The study demonstrates that climate hazards significantly disrupt dairy production, reproductive efficiency and ultimately the economic stability of dairy farmers. By critically assessing farmers' perception alongside meteorological data, we gain valuable insights into how farmers interpret and respond to climate risks. The findings reveals that education, herd size and farming experience together with awareness of climate resilient practices and mass media exposure are the most influential factors shaping farmers' perceptions and adoption behavior. This indicates that better informed farmers with larger herds and longer experience are more likely to recognized climate threats and adopt adaptive measures. Conversely, demographic factors such as age, gender, landholding and income showed no significant influence underscoring the importance of knowledge and exposure over structural attributes. The key lessons from this study is that strengthening educational outreach, awareness programs and communication channels can enhance farmers' adaptive capacity thereby safeguarding food security and livelihoods. Conclusively, dairy farmers in the study area are aware of climate change and actively perceive adoption measures but targeted interventions focusing on knowledge dissemination and experimental learning are essential to accelerate the adoption of climate resilient dairy farming practices.

Table 6: Regression coefficients between antecedent characteristics and perception score of farmers

S.N.	Independent Variables	Dependent variables Total perception score	
		'b'	't'
1	Age (X1)	-.047	-1.168
2	Gender (X2)	1.792	.724
3	Education (X3)	.250	.663
4	Land Holding (X4)	-.519	-1.875
5	Herd size (X5)	.015*	2.270
6	Income in 1000 (X6)	.028	.377
7	Experience (X7)	.441*	.710
8	Social participation (X8)	.011	.057
9	Mass media exposure (X9)	.240	.447
10	Awareness towards climate resilient dairy practices	.144**	.234
	R ²	0.443	
	F	.817	
	Durbin Watson Test	1.96	

*5% level of significance

Authors' Contributions

Pratiksha Thakur and Ruchi Singh conceived of the presented idea and applied the methodology. Pratiksha developed the theory, and data collection and performed the computations. Ruchi Singh, B. Roy, Rashmi Vishwakarma, Hari R., Anil Shinde, and Saurabh Sharma Ankur Khare reviewed the writing up and methodology. Sunil Nayak provided guidance throughout the process. All authors discussed the results and contributed to the final manuscript.

Availability of data and material

The dataset generated during and/or analyzed during the current study are available from the corresponding author upon reasonable request and with the permission of the Department of Veterinary Extension, NDVSU, Jabalpur M.P.

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