



Perceived Constraints among Dairy Farmers in Eastern India Using Logistic Regression

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HIGHLIGHTS

- The logistic regression model was well-fit, explaining about 32.6 percent of variance in constraints faced.
- Targeted policy interventions like insurance reforms & extension outreach, are needed to promote inclusive dairy sector growth.
- Rural transformation and inclusive development can enhance income security, productivity, and livelihood resilience.

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ABSTRACT

The dairy sector plays a crucial role in sustaining rural livelihoods, especially among the small and marginal farmers, by providing food security, nutrition, and a regular source of income. However, these farmers often face a variety of structural and operational constraints that hinder their growth and economic development. This study investigated the key perceived constraints experienced by selected 270 Marginal-Small (MS) dairy farmers of Eastern Uttar Pradesh in the year 2024, selected through multistage stratified purposive-cum-random sampling, using logistic regression analysis. Among these, the high insurance charges emerged as the most severe factor, increasing the odds of constraint by 17 times. The model was well-fitted as indicated by a Hosmer and Lemeshow test value of 0.201 and Nagelkerke R^2 of 0.326, explaining about 32.6 per cent of variance in constraints faced. The study concludes that targeted policy reforms are needed to address critical bottlenecks in the dairy sector. Overall, the findings reinforce the importance of a need-based and evidence-driven approach for inclusive rural development through dairy enterprise support.

INTRODUCTION

The rural livelihood is dependent on the integration of the crops as well as livestock rearing. To a significant extent it acts as a source of food and nutritional security (Mondal et al., 2022) along with being a promising income source to millions (Pal et al., 2017; Bahubalendra et al., 2025). As India is the largest milk producer (PIB, 2025), and have a significant contribution in agricultural GDP (Gross Domestic Product) and employment, particularly in the rural area. Due to lack of technical knowledge and inadequate literacy

(Ali et al., 2024) to cope up with growing societies and challenges, these enterprises are promising a continuous source of income (Bharne et al., 2025) and thereby facilitating the daily need and hence the rural economy. The rural economy, particularly the marginal-small (MS) category, owning less agricultural land are largely dependent on the animal interventions (Jatav, 2024c). Dairy farmers are the backbone of the dairy sector, fulfilling their own needs and the other non-farming population (Lepcha et al., 2023). Day by day shrinkage of the agricultural land, due to rapid urbanization and fragmentation in households, also pushes families

without any rigid income sources towards the dairy sectors (Maurya et al., 2023). And it is feasible also, since growing population needs nutrition and food (Mishra et al., 2025); which will require growth in the sector too. So, it is a promising sector in the future. Despite such a close tie with the dairy enterprise, the MS farmers face several disadvantages that restrict their economic growth in context of personal and social progress (Singh et al., 2024).

The prominent constraints faced by the MS dairy farmers are continuously suppressing them in income and growth point of view (Sahu et al., 2022). Some of the constraints are, inadequate dry fodder in off season, inadequate knowledge about balance feeding, high cost of concentrates, zero knowledge of latest technologies (Chandran & Podikunju, 2020), unavailability of HV bulls, lack of assistance/trainings from Krishi Vigyan Kendra (Maurya et al., 2024), high insurance charges, excessive paper work for credit, loss/death, infertility, lack of trained medical supervision (Patil et al., 2024), lack of proper marketing facilities (Das et al., 2014). To improve the profitability of dairy husbandry, especially in tribal communities, cultivation of fodder shrubs and trees on wastelands, and developing degraded lands (Singh et al., 2017). There are many more unrecognizable constraints that are unable to reach the proper solutions (Sahoo et al., 2022). These are suppressing the thoughts of other entrepreneurs also, if they are looking to be entering into the field. All of these are due to a lag between the policies intents and their field level implementation. Several schemes are continuously announced by the agencies promising the overall growth of individuals as well as the economy as a whole (Mandi et al., 2022). Institutional support systems are lacking in their reach at the grassroots level (Derville et al., 2023). Removing all these hurdles can push the potential of the enterprise and help in the overall growth. Removing these barriers can unlock the growth potential of small dairy farmers, enhance their livelihoods and contribute to inclusive rural development (Sahu et al., 2021). It also has the potential to generate employment, reduce vulnerability, and empower women in rural households (Acharya et al., 2022).

METHODOLOGY

The analysis is confined to the constraint variables of the marginal and small dairy farmers in eastern India particularly in Sant Kabir Nagar district of Uttar Pradesh in the year 2024. Multistage stratified purposive-cum-random sampling was adopted for the selection of districts, blocks, and villages. The study incorporates a quantitative approach in which the information is collected using a questionnaire in survey. Singarimbun study (Singarimbun & Effendi, 1995) was used as a reference. A sample size of 270 dairy farmers was selected using the Slovin formula (Asenahabi & Ikoha, 2023) from the population. At the first step, the reliability and dependability of the information collected with respondents were checked, then the identified variables of constraints with the MS dairy farmers were investigated by logistic regression using the SPSS software. LR is used to examine the relationship between the dependent (Pull back of the dairy farmers) and independent variables (constraints). The logit of dependent variable (Y) is predicted with the selected independent variable (X).

Logit = natural logarithm (ln) of odds of Y

Odds = ratio of probability of constraints to no constraints

Odds can be mentioned as probability of Y happening (Pi) and the probability of Y not happening (1 - Pi).

P_i = Probability of present constraints

$(1-P_i)$ = Probability of absent constraints.

Here, the dependent variable is binary in nature i.e., only two possible values; either Yes or No; and the covariates on the other hand, are used to refer to a group of independent factors.

Equation –

$$\text{logit (Y)} = \ln \frac{P_i}{(1-P_i)} \quad \dots \text{eq (1)}$$

$$= \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} + \mu \quad \dots \text{eq (2)}$$

Where,

$$P_i = (X_1 = x_1, X_2 = x_2, X_3 = x_3, \dots, X_{11} = x_{11})$$

$$= \frac{e^{\alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11}}}{1 + e^{\alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11}}}$$

Y = categorical variable (Pull back of the dairy farmers), X = categorical or continuous variable (Constraints faced by dairy farmers), α = intercept, β_i = regression coefficient, μ = unexplained error term

The variable descriptions used in the study are mentioned in Table 1.

RESULTS

District Sant Kabir Nagar holds most of the marginal and small (MS) farmers, as is likely to most of the other Indian states. Some of the selected respondents fall under the landless category, because of which they rely on allied agricultural practices, of which dairy practice is the most prominent one. Dairy farming ensures daily income and covers nutritional lacunae. But their adoption of this enterprise does not match the growth in relation. It is due to certain constraints faced by them in daily practices.

Table 1. Description of the variables selected for the study

Variables	Description	Units
P_i	Constraints	1 = Constraint exists 0 = No Constraint
α	Constant Intercept	
β_1 to β_{10}	Coeff. of Predictor variables	
β_1	Inadequate dry fodder in off off-season	A = Agree, D =Disagree
β_2	Inadequate knowledge about balanced feeding	A = Agree, D =Disagree
β_3	High cost of concentrates	A = Agree, D =Disagree
β_4	Zero knowledge of the latest Technologies	A = Agree, D =Disagree
β_5	Unavailability of HV Bulls	A = Agree, D =Disagree
β_6	Lack of assistance/training from KVKs	A = Agree, D =Disagree
β_7	High Insurance Charges	A = Agree, D =Disagree
β_8	Excessive Paperwork for Credit	A = Agree, D =Disagree
β_9	Loss/Death	A = Agree, D =Disagree
β_{10}	Infertility	A = Agree, D =Disagree
β_{11}	Lack of trained medical supervision	A = Agree, D =Disagree
μ	Error term affecting the dependent variable	

Some of the constraints faced by the dairy farmers include, Inadequate dry fodder in off season, Inadequate knowledge about balance feeding, High cost of concentrates, Zero knowledge of latest Technologies, Unavailability of hybrid variety Bulls, Lack of assistance/trainings from KVKs, High Insurance Charges, Excessive Paper Work for Credit, Loss/Death, Infertility, Lack of trained Medical Supervision. These problems resist the economic progress, yields and the morality of the dairy farmers. All of the above-mentioned issues studied are being grouped into two categories: A = Agree & D = Disagree.

Reliability and dependability test

To evaluate the dependability and consistency of the measurements scores derived from the surveys, this reliability was conducted. It is one of an appropriate statistical tool used in social analysis. The outcome of this tool is depending upon the consistencies between administrations and their effectiveness in what is intended to measure. This Cronbach's alpha test measures consistency of the selected parameters in the questionnaire or scale (Cronbach, 1951). The analysis is based on the values, which ranges from 0 to 1, indicating greater reliability while moving towards 1. In the results the Cronbach's alpha value is 0.620 and the scale is analyzed on the basis of the results obtained.

Table 2. Measure of internal consistency and comparison of means of the variables

Reliability Test		Hotelling's T-squared Test	
Cronbach's alpha (Raw)	0.620	Hotelling's T-squared	11400.896
Cronbach's alpha (Standardized)	0.638	F	1115.002
Variables	12	df ₁	11
		df ₂	270
		Significance	0.000

The differences between the means of any of the groups can be analyzed using the Hotelling's T-squared Test (Table 2). It employs a multivariate analysis, considering more than two variables in one go. Therefore, the dependent variables are considered for this multivariate analysis. The constraints of the dairy farmers are taken into account for it, and those were divided into two sections; one who faced some of the constraints (denoted as 1), while antagonistic to it, who didn't have any issues (denoted as 0). The presumed answers initially were that, there will be no significant difference between the means of the groups having all the dependent variables. Whereas, the alternative hypothesis was taken that, there is a significant difference between means of both the groups.

Factors affecting the dairy farmers

The factors which are affecting the dairy farmers' economic conditions are analyzed by the logistical regression. The factors are

believed to have the significant effect on their socio-economic conditions and are pilling factors against the economic developments and progress. The considered factors include: Inadequate dry fodder in off season, Inadequate knowledge about balance feeding, High cost of concentrates, Zero knowledge of latest Technologies, Unavailability of HV Bulls, Lack of assistance/trainings from KVKs, High Insurance Charges, Excessive Paper Work for Credit, Loss/Death, Infertility, Lack of trained Medical Supervision.

The considered factors are then categorized into two divisions, based on the dependent variables. The variable is considered as 1, if is the affecting variable to the farmers and if not, it is denoted by 0. All the categories of the aforementioned constraints are presented in Table 3; which shows that the model predicted accurately, the farmers categories.

Table 3. Problem classification matrix

Observed	Predicted		
	Overall faced constraints		Percentage corrections
	No constraints	Constraints	
Overall faced constraints			
No constraints	129	28	82.20
Constraints	63	60	48.78
Overall percentage	-	-	67.52

It reveals that 129 out of 157 dairy farmers were those who do not faced any constraints and 60 out of 123 were those who were encountered with the constraints.

Logistic regression (LR)

The suitability of the factors that were responsible for the pullback of the dairy farmers was checked using Logistic Regression. The factors such as, Inadequate dry fodder in off season, Inadequate knowledge about balance feeding, High cost of concentrates, zero knowledge of latest Technologies, Unavailability of HV Bulls, Lack of assistance/trainings from KVKs, High Insurance Charges, Excessive Paper Work for Credit, Loss/Death, Infertility, Lack of trained Medical Supervision are deployed in this LR model. The usefulness of the test model is understood by the high value of the Likelihood ratio, i.e., 472.355 (> 11). In the same pattern, the R-square value (Nagelkerke R-square) of 0.326 reveals that all the 11 factors collectively explain 32.6 per cent of the variance in the constraints confronted by the dairy farmers. Similarly, when the fitness of the LR model is studied by deploying the Hosmer & Lemeshow Test, it is found that the LR model is appropriate and best-fitted, supported and explained by the p-value of 0.201. From Table 4, we can depict the LR model as–

$$\text{logit (Y)} = -2.499 - 0.301 X_1 + X_2 + 0.305X_3 + 1.654X_4 + 0.209X_5 + 1.229X_6 + 2.779X_7 + 0.650X_8 + 1.249X_9 + 0.438X_{10} + 1.130X_{11} \quad \dots \text{eq (3)}$$

The above logit equation will be used to estimate the predicted value of the overall challenges faced by new farmers:

$$\text{Predicted logit (Y)} = \frac{1}{1 + e^{(-2.499 - 0.301 X_1 + X_2 + 0.305X_3 + 1.654X_4 + 0.209X_5 + 1.229X_6 + 2.779X_7 + 0.650X_8 + 1.249X_9 + 0.438X_{10} + 1.130X_{11})}} \quad \dots \text{eq (4)}$$

Table 4. Results from Logistic Regression

Variables	Coefficient	p-value	Odds ratio
Inadequate dry fodder in off season	-0.301	0.310	0.633
Inadequate knowledge about balance feeding	-1.000	0.375	0.386
High cost of concentrates	0.305	0.526	1.385
Zero knowledge of latest Technologies	1.654	0.030	5.128
Unavailability of HV Bulls	0.209	0.001	0.137
Lack of assistance/trainings from KVKs	1.229	0.009	3.214
High Insurance Charges	2.779	0.000	17.009
Excessive Paper Work for Credit	0.650	0.256	2.009
Loss/Death	1.249	0.050	3.449
Infertility	0.438	0.329	1.584
Lack of trained Medical Supervision	1.130	0.000	3.013
Constant	-2.499	0.000	0.079
-2 log likelihood	472.355	-	-
Omnibus test of model coefficients	77.342	-	-
Cox & Snell R Square	0.167	-	-
Nagelkerke R Square	0.326	-	-
Hosmer and Lemeshow Test	0.201	-	-

Inadequate dry fodder in off off-season

The variable X_1 , which focuses on the constraint of inadequate dry fodder in off-season, has a negative coefficient value i.e., -0.301. The results show a p-value of 0.310 (non-significant) and an odds ratio of 0.633. Although the odds ratio suggests a decreased likelihood of constraint due to this factor, the result is statistically insignificant. This implies that farmers facing fodder scarcity in the off-season are not significantly more constrained than others, possibly due to adaptation strategies like crop residue usage or fodder banks. This result is not statistically significant, which means this problem is not strongly related to whether a farmer is facing serious constraints overall. Farmers may have adapted by using crop residues or purchasing fodder during shortages. Therefore, they may not consider it a major hurdle.

Inadequate knowledge about balanced feeding

The Coefficient of the variable X_2 with its focus on the lack of proper knowledge on balanced feeding, has a Coefficient of -1.000, P-value: 0.375 (Not significant), and Odds Ratio of 0.386. The outcome reveals that there is a reduced probability of farmers who do not know how to feed the chickens efficiently reporting overall constraints; nevertheless, the outcome is not significant. It can be because of the low awareness itself, perhaps farmers do not regard this as a constraint because of knowledge gaps. The value of the odds ratio is less than one, indicating that the individuals who are not aware of the knowledge of balanced feeding practices will fail to appreciate its significance and therefore fail to note it as an issue. Not all farmers have been trained in the management of the feed, and thus they may not even be aware that this is a problem to their milk yield.

High cost of concentrates

The result of the variable X_3 , which concentrates on the high cost of concentrates is a positive coefficient number of 0.305, P

value number 0.526 (significant) and odds ratio of 1.385. Nevertheless, although the odds ratio indicated a more probable occurrence of constraints because of high concentrate prices, the impact is not notable in a significant way. It can mean that cost will be a factor but it does not equally restrict all smallholders. It suggests that there could be more constraints based on high-cost feed but the implication is not profound. Some may opt to use less or switch to cheap methods and this will not have direct effect on constraints immediately.

Zero knowledge of the latest technologies

The results of this factor are each of the coefficient that is 1.654 and significant p-value (0.03) and an odds ratio of 5.128. It is a very important limitation. The farmers who do not know about the modern technologies have five times bigger chances of having severe limitations. This indicates the digital and technical gap in the productive and quality practices and management in dairy farming. Without any knowledge of modern tool, tools, practices in the dairy farm, farmers stand five times more likely to experience major problems.

Unavailability of HV bulls

The consequences of the constraints are: Coefficient = 0.209, a highly significant p-value = 0.001, and 0.137 as the odds ratio. Although the relationship is statistically significant, the value of the odds ratio that is less than one implies the existence of a counterintuitive relationship. This could be a subject of additional research - possibly the variable coding was flipped, or the local practices counteract the effect of this limitation. Although the results are statistically significant, the odds ratio is very small, and it may be due to improper interpretation or coding error.

Lack of assistance/training from KVKs

This variable X_6 which is concerned with the absence of institutional back-ups in the form of Krishi Vigyan Kendras, has a Coefficient of 1.229, p-value: 0.009 (Significant), and Odds Ratio of 3.214. The likelihood of untrained farmers reporting some constraints is 3.2 times that of the trained ones, demonstrating the direct necessity of conducting capacity building and extension revisions. Farmers who do not get aid and training from Krishi Vigyan Kendras have a risk of facing issues more than three times that of others.

High Insurance Charges

This variable X_7 , which focus on the constraint of high insurance charges, has Coefficient of 2.779, p-value: 0.000 (Highly Significant) and Odds Ratio of 17.009. This is the strongest constraint. Farmers perceiving insurance premiums as high are 17 times more likely to experience significant constraints. The current structure of livestock insurance is clearly unaffordable or inaccessible for smallholders, requiring immediate policy revision. Farmers who face high insurance premiums are more likely to face constraints.

Excessive paper work for credit

The present variable X_8 , holds the obtained results of coefficient (0.650), non-significant p-value of 0.256 and odds ratio

of 2.009. Although not statistically significant, the odds ratio indicates a tendency toward higher constraint for farmers facing cumbersome credit formalities. This suggests that institutional bottlenecks still exist, but variability across banks or regions may dilute the statistical effect. X_8 variable is not statistically significant, but still shows a trend toward increased constraints due to complicated loan processes. Small farmers may find formal banking paperwork difficult or time-consuming, leading to delays or denial of credit.

Loss/death

The variable X_9 , has the coefficient of 1.249, p-value (0.050) and odds ratio of 3.449 in the analysis. This factor is on the edge of statistical significance and shows a strong practical effect. Farmers reporting animal loss are 3.4 times more likely to face compounded constraints, revealing gaps in veterinary care, insurance coverage, and risk management. Just at the threshold of significance in this factor farmers who experienced animal death are over three times more likely to face other challenges.

Infertility

This factor has coefficient of 0.438, a significant p-value (0.329), and odds ratio of 1.584. Despite an increased odds ratio, infertility does not show a significant impact in the model. Still, reproductive health issues remain critical at the field level, and may be under-reported or conflated with other problems. While infertility does affect dairy operations, its impact here isn't strong statistically. Farmers might accept delayed pregnancies as normal or lack awareness about fertility treatments.

Lack of trained medical supervision

This factor has results of coefficient of 1.130, highly significant p-value (0.000) and odds ratio of 3.013. This is a major constraint. Farmers without access to trained veterinary personnel are three times more likely to face difficulties. This supports arguments for strengthening doorstep veterinary care and para-vet outreach in remote areas.

DISCUSSION

While addressing the issues in the dairy enterprises, it was needed to explore and analysed the key constraints that were hindering the growth of small and marginal dairy farmers (Gupta et al., 2020). As per the results, there was a significant difference between the means of both the group variables, because $0.000 < 0.05$ in the significance calculations in the measurement of internal consistency and comparison of means of the variables. The factors which were affecting the dairy farmers economic conditions were analyzed by the logistical regression and it was found that the model was predicting the overall accuracy percentage of 67.52 per cent. The factors such as, Inadequate dry fodder in off season, Inadequate knowledge about balance feeding, High cost of concentrates, zero knowledge of latest Technologies (Kumar et al., 2021), Unavailability of HV (Hybrid Variety) Bulls, Lack of assistance/trainings from KVKs, High Insurance Charges, Excessive Paper Work for Credit, Loss/Death, Infertility (Adhikari et al., 2020), Lack

of trained Medical Supervision (Nagrle, 2015) were deployed in this LR model. The usefulness of the test model was understood by the high value of the Likelihood ratio. The R square value showed that all the 11 factors collectively explained the variance in the constraints confronted by the dairy farmers. The LR model was appropriate and best-fitted, supported and explained by the p-values. The absence of a significant difference between the predicted and observed results indicates that the regression model is suitable for further analysis. Among the factors studied, it was revealed that the few factors viz., dry fodder availability in off-season, inadequate knowledge of balance feeding, high cost of concentrate, excessive paperwork for credit, and infertility, were least affecting the MS dairy farmers (Dhinds et al., 2014). Major concerns were technology aids in the enhancement of productivity, health monitoring and cutting down on expenses. In its absence, small farmers were not be able to get out of their old ways of doing things. Similarly, Lack of good breeding bulls was found added to problems. At the field level it was seen that lack of good access to quality semen or bulls was a factor that constraints productivity. For trainings, Farmers cannot develop better unless they are exposed to new ideas, practices and methods of doing things. So, KVKs were found the main source of farmer education (Kholia & Bhardwaj, 2024). Expensive livestock insurance has always been a burden to the farmers. Many small farmers found avoiding it, leaving them vulnerable to loss from death or disease. In the same way the loss of even one dairy animal was seen as directly reducing the income and increasing emotional and financial stresses (Saravanan et al., 2021). Lastly, the farmers who were not having access to trained veterinary help were three times more constrained. Lack of timely treatment caused worsening health issues in animals, reducing productivity and increasing mortality (Singh et al., 2017).

CONCLUSION

The present study aimed to identify key constraints that hinder the progress of small and marginal dairy farmers, using logistic regression analysis. The findings provide insights into the severity and significance of various challenges in the dairy sector, which directly impact profitability and sustainability of rural livelihoods. Among the numerous challenges studied, five factors emerged as statistically significant and practically crucial. These constraints increase the likelihood of farmers facing multiple hardships, thus creating a cycle of low income, productivity, and poor resilience to shocks. High insurance charges, in particular, showed the strongest influence, suggesting an urgent need to restructure livestock insurance schemes to be more affordable and accessible. From a policy perspective, these results emphasize the importance of farmer education, veterinary infrastructure, accessible credit, technology diffusion, and affordable insurance products. By addressing the challenges, the dairy sector can be a powerful vehicle for inclusive rural development in India.

DECLARATIONS

Ethics approval and informed consent: Informed consent was sought from the respondents of the study and their organizations during the course of the research.

Conflict of interest: The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The authors declare that during the preparation of this work, thoroughly reviewed, revised, and edited the content as needed. The authors take full responsibility for the final content of this publication.

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