Original Research Article

Metabolic Disorders in Dairy Cattle: An Economic Assessment in Uttar Pradesh, India

ABSTRACT

Aim: Metabolic illnesses such as milk fever and ketosis in dairy cattle significantly impact productivity and production efficiency, thereby hindering farmers' ability to enhance their income. This study aimed to systematically evaluate the financial implications of metabolic disorders in dairy cattle, providing critical insights into their economic burden on dairy farming systems.

Place and duration of study: Kheri district, Uttar Pradesh, 6 months – March 2024 to June 2024

Methodology: A total number of 60 dairy farms were chosen out of which 30 farms were affected by milk fever and 30 by ketosis randomly in Kheri district of Uttar Pradesh. The data on the socio-economic profile of the farmers along with the predisposing factor and the data on direct and indirect economic losses caused by ketosis and milk fever, cost of medicine, cost of veterinary services, cost of supplements and loss in milk yield have been considered.

Results: The average total economic loss was found as Rs 1,736.10 per cow and Rs 2,790.25 per cow due to milk fever and ketosis respectively. The factors associated with the economic losses due to ketosis and milk fever was estimated by fitting multiple linear regression function models. Among the eight factors chosen for model definition, the variables, *viz.,* breed of cow ($P<0.05$), milk yield ($P<0.01$), veterinary care ($P<0.05$) and the days of illness ($P<0.05$) were found to have statistically significant association with the economic losses due to milk fever and Ketosis.

Conclusion: Metabolic illnesses such milk fever and ketosis result in higher financial losses since they lower productivity, raise veterinary expenses, and have an impact on market profitability. The relevance of incorporating economic, health and welfare factors into livestock management practices is highlighted by the fact that treating metabolic diseases not only lessens financial costs but also enhances food security and animal wellbeing.

Keywords**:** *dairy animals- ketosis – milk fever – Uttar Pradesh*

INTRODUCTION

Uttar Pradesh has set a benchmark in Milk production in the country. According to National dairy development board (NDDB), milk production in Uttar Pradesh state was 147.48 lakh metric tonnes in 2000-01, 210.31 lakh metric tonnes in 2010-11, which increased to 330.05 lakh metric tonnes in 2021-22. Selection of genetically improved strains and increase in the potential of the animals over the time leads to increased milk production in all the countries. However, this improvement in health arises out of the cost of higher incidences of post-partum health complications, fertility problems (Hailemariam *et al*. 2014, Ingvartsen 2006) and metabolic production diseases.

Production diseases and infertility problems at the postpartum stage and sometimes during parturition cause an important decline in production potential of the animals, especially in crossbred cattle and result in financial losses associated with it (Bar and Ezra 2005, Martins *et al*. 2013). Production diseases of the dairy cow are a manifestation of the cow's inability to cope with the metabolic demands of high production, and they continue to be a cause of economic loss to the dairy industry and an animal welfare concern (Mulligan and Doherty, 2008). According to Radostits *et al*. (2000) the production diseases comprised of diseases associated with an imbalance between the rate of input of essential dietary nutrients and the output of the production such as milk fever, ketosis, hypomagnesemia and mastitis etc.

Proper maintenance of a dairy cow health during the transition/periparturient period is very crucial for veterinarians and milk producers. The periparturient period of dairy cows refers to the time period of 4 weeks before and 4 weeks after parturition (Singh et al., 2023). It is an important time in the production cycle of the cow, in which bovines are at high risk for the occurrence of most of the production diseases. During the third trimester of gestation, fetal dry weight increases exponentially. Hence during this period there is higher demand for energy, protein, calcium and other nutrients required for the growing foetus. It is now realized that meeting the nutritional requirements of the transition/periparturient dairy cow can greatly impact animal health, production potential, overall longevity, and animal well-being. Therefore, poorly managed cows use maternal reserves under these conditions leading to suppression of the immune system. As a result, metabolic, reproductive and mammary diseases are triggered.

Ketosis

Ketosis is an important post parturient metabolic disease in dairy cattle. Milk production increases sharply and peaks at 4-6 weeks after calving while dry matter intake increases slowly in the postpartum stage of the periparturient, The highest dry matter intake is 8-10 weeks after calving. Hence the energy intake may not keep up with the demand. In response to negative energy balance and low serum glucose, cows will mobilize adipose tissue and leads to formation of ketone bodies and therefore, cause ketosis.

Milk fever

Milk fever, often appear to be more common when cows are fed grass high in potassium during the dry period instead of conserved fodder. We should not feed high amount of wheat and rice bran as it has high phosphorus concentration (>80g per day). Milk fever is a common cause of sudden death in milch cows. It is also a common cause of dystocia and hence stillbirth. Hypocalcemia or low blood Calcium decreases abomasum contraction which leads to more metabolic disorders. Decrease in muscle tone in most body systems, particularly in the cardiovascular, digestive, reproductive and possibly in the mammary system is observed. Reduced blood flow to the extremities causes characteristic cold ears of a cow suffering from milk fever. Additionally, compared to non-milk fever cows, milk fever cows show a larger drop in feed intake following calving (Goff and Horst, 1997), which exacerbates the negative energy balance that is frequently seen in the early stages of lactation. In addition to it, hypocalcemia slows down the secretion of insulin (Littledike et al., 1970), preventing tissue uptake of glucose which would aggravate lipid mobilization at calving, which put the cow at risk of ketosis.

DATA AND METHODOLOGY

Sampling procedure

This study was conducted in district Kheri which is situated within the Terai lowlands at the base of the Himalayas, with many rivers and lush green vegetation. It is present between 27.6° and 28.6° north latitude and 80.34° and 81.30° east longitudes, and area about 7,680 square kilometres. Wheat, rice, pulses, maize and barley are the major food crops. All types of fodder varieties are also cultivated as animal feed. From a total of seven tehsils of the district, three were selected for the study. From each tehsil, two villages were selected by simple random sampling technique. From these selected villages, 10 livestock farmers were selected randomly from each village. Following this technique, a total of 60 farmers were included in the final sample. Data were collected through a pretested structured interview schedule.

The data on the socio-economic profile of the farmers along with the predisposing factor and the data on direct and indirect economic losses caused by ketosis and milk fever, cost of Medicine, cost of veterinary services, cost of supplements and loss in Milk yield were taken into consideration.

Tools of analysis

<u>Conventional tabular analysis</u>

Conventional average and percentage analysis was employed to analyze the incidence of Ketosis and Milk fever, their predisposing factors and the resulting economic losses in the cattle farms. The collected data were statistically analysed by IBM SPSS version 23.0 for Windows.

To analyze the factors associated with the economic losses due to ketosis and Milk fever the following multiple linear regression models were fitted separately.

$$Y_M = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \mu$$

$$Y_K = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \mu$$

Where,

Y_M / Y_K	=	Economic losses due to Milk fever / Ketosis
A	=	Constant term
β_i's	=	Regression co-efficient
μ	=	Random disturbance term; ($\mu_i \sim 0, \sigma_i^2$)
X_1	=	Age of the cow
X_2	=	Age at First calving
X_3	=	Breed of the cow
X_4	=	Milk Yield of the Cow
X_5	=	History of obstetrical problem
X_6	=	Veterinary care
X_7	=	Days of Illness
X_8	=	System of rearing

RESULTS AND DISCUSSION:

Profile of the animals suffering from milk fever / Ketosis

The study was done purposefully on the affected animals to calculate the economic loss due to Milk Fever and ketosis. A total of 60 animals were taken into the study in which 30 animals were affected by milk fever and 30 animals by ketosis. The study (Table 1) found that the average Age of the animal suffering from milk fever and ketosis are (5.25 ± 2.15) and (5.45 ± 2.65) respectively. It was observed in the study that the farmers had 3 types of breed of cattle i.e. crossbred, purebred and Non-descript. Out of these three, higher incidence was noted in Crossbred cows, which was around 75 per cent. The study found different systems of production a) Housed b) Pastured and c) combined system as per WHOA. According to the study, most of the farmers opted for Artificial Insemination for their cattle.

Economic Losses due to Milk fever / Ketosis

Economic losses due to milk fever and ketosis occur due to two main reasons (i) Expenditure on treatment of the affected animal (ii) loss in Milk production

Expenditure on Treatment of Affected Animals

The expenditure on treatment of affected animals included the cost of medicine, Cost of veterinary Service, Cost of Supplements and loss in milk production. Table 3 presents the economic losses incurred by the farmers on treating the milk fever affected animals. It could be seen that the farmers lost Rs 1319.80 / cow affected by milk fever. The expenditure was maximum on veterinary service, Rs 530.35 (30.55 Per cent) followed by cost of medicine, Rs 515.2 (29.67 Per cent), and cost of feed supplements, Rs 274.25 (15.80 Per cent). The loss due to treatment of ketosis affected cows was more at Rs 1733.65 per affected animal. The expenditure was maximum on medicine was Rs 930.50 (33.35 Per cent) followed by cost of veterinary service Rs 650.85(23.32 Per cent), and cost of feed supplements Rs 152.30 (5.46 Per cent). Kossaibati and Esslemont (1997) have estimated the cost of treatment for a mild case of milk fever as £ 50, severe case as £ 154 and for a fatal case as £ 2112 in England.

Economic Loss due to Reduced Milk Yield

The quantum of milk loss per affected exotic pure / crossbred cow was large (38.30 litres). In monetary terms, the loss was estimated to be of Rs 416.30 per affected cow in milk fever and Rs 1056.60 in ketosis. The Kossaibati and Esslemont (1997) have reported the economic loss due to milk fever in Holstein cows as 200 litres per animal, costing £ 40, for a mild case and 500 litres per animal, costing £ 100, for a severe case of milk fever. Rajala-Schultz et al. (1999) have studied the effect of milk fever on milk yield in Finnish Ayrshire Cows and have observed that the milk loss varied between 1.1 kg/day and 2.9 kg/day. They have also reported a significant reduction of milk in ketosis-affected Finnish Ayrshire cows.

Total Economic Losses due to Milk Fever / ketosis

The total economic losses due to milk fever are presented in Table 3. The average direct loss per animal due to the treatment of milk fever was Rs 1319.80 and average total loss was Rs 1733.65. The average loss due to reduction in milk yield per affected animal was also higher for cow suffering from ketosis (Rs 1056.60) than for milk fever (Rs 416.30). It needs to be emphasized that treating milk fever affected animals was the first priority of the farmers, since the delay in treatment could further reduce milk yield or even lead to loss of animals. The loss due to milk yield contributed 23.98 per cent and 37.87 per cent to the total loss in Milk fever and ketosis, respectively.

Table 1. Profile of Cows Suffering from Milk Fever / Ketosis

	Milk Fever (n=30)	**Ketosis (n=30)**
Age of the Animal (in Years) Mean ± SD	5.25 ± 2.15	5.45 ± 2.65
Age at First calving (in Years) Mean ± SD	2.85 ± 0.75	2.75 ± 0.65
Milk Yield (in Litres per day) Mean ± SD	13.65 ± 2.55	14.85 ± 2.75
Breed of the Animal (in Numbers and Per cent)		
Crossbreed	21 (70.00)	23 (76.67)
Pure breed	8 (26.66)	7 (23.33)
Non-Descript	1 (3.34)	0 (0.00)

Table 2. Management practices of Cows Suffering from Milk Fever / Ketosis

	Milk Fever (n=30)	Ketosis (n=30)
System of Rearing (in Numbers and Per cent)		
Housed	16 (53.33)	17 (56.67)
Combined	12 (40.00)	12 (40.00)
Pastured	2 (6.67)	1 (3.33)
Grazing (in Numbers and Per cent)		
Yes	14 (46.67)	13 (43.33)
No	16 (53.33)	17 (56.67)
Breeding (in Numbers and Per cent)		
Natural service	4 (13.33)	7 (23.33)
Artificial Insemination	26 (86.67)	23 (76.67
History of Retained Placenta (in Numbers and Per cent)		
Yes	3 (10.00)	5 (16.67)
No	27 (90.00)	25 (83.33)

Table 3. Economic Losses due to Milk Fever / Ketosis

	Milk Fever (n=30)	Ketosis (n=30)
Direct Losses		
Cost of Medicine	515.20 (29.67)	930.50 (33.35)
Cost of Veterinary Services	530.35 (30.55)	650.85 (23.32)
Cost of Supplements	274.25 (15.80)	152.30 (5.46)
Total Direct Losses	1319.80 (76.02)	1733.65 (62.13)
Indirect Losses		
Loss in Milk Yield	416.30 (23.98)	1056.60 (37.87)

Total Losses	1736.10	2790.25

(Figures within Parenthesis indicate per cent to total)

Table 4. Factors associated with the Economic Losses due to Milk Fever / Ketosis

Sl. No.	**X_i**	**Variables**	**co-efficient (t-statistics)**	
			Milk Fever	**Ketosis**
	A	Constant	736.674** (5.356)	912.539** (14.932)
1	X_1	Age of the cow	2.304 (1.982)	2.982 (2.087)
2	X_2	Age at First calving	2.021 (2.094)	1.837 (1.029)
3	X_3	Breed of the cow	0.213* (2.921)	0.328* (2.829)
4	X_4	Milk Yield of the Cow	10.231** (16.765)	12.506** (19.432)
5	X_5	History of obstetrical problem	0.459 (1.093)	0.397 (1.815)
6	X_6	Veterinary care	1.092* (2.528)	1.620* (2.719)
7	X_7	Days of Illness	56.459** (29.045)	69.019** (39.276)
8	X_8	System of rearing	1.832 (1.079)	2.027 (0.928)
Dependent variable = Economic Losses in Rupees				
R^2			0.826	0.912
Adjusted R^2			0.814	0.876
F statistics			83.602**	95.413**
N			30	30

The factors associated with the economic losses due to ketosis and milk fever was estimated by fitting multiple linear regression function models. The results of the multiple linear regression model fitted to find the relationship between the factors and the total economic loss are presented in Table. For milk fever, the model showed a good fit with the adjusted R^2 of 0.814, indicating that 81.4 per cent of variation in the dependent variable was explained by the independent variables used in fitting the model. The ANOVA also showed that the model was statistically significant with a 'F' value of 83.602 (P<0.01). Among the eight factors chosen for model definition, the variables, *viz.,* breed of cow (P<0.05), milk yield (P<0.01), veterinary care (P<0.05) and the days of illness (P<0.05) were found to have statistically significant association with the economic losses due to milk fever. Among these measurements, all the variables were found to be positively associated with the economic losses due to milk fever. Similar results were observed for the multiple linear regression model fitted to assess the factors associated with the economic losses due to ketosis.

CONCLUSION

The field study of dairy animals in Uttar Pradesh indicated that the dairy farmers of the state lose tremendous amount of money due to easily preventable metabolic disease. It could be seen that the farmers lost Rs 1319.80 per cow affected by milk fever excluding the milk Loses which is 416.30 per cow. Direct Loses in ketosis is 1733.65 per cow along with loss in milk production which is Rs 1056. per cow. Factors which have direct correlation with the incidence of milk fever and ketosis are high milk yield per day, breed of the cow, system of rearing, method of service (i.e Natural service or AI).Cows which are heavy milk yielder or cross breeds (Jersey and Holstein Friesian with indigenous cattle)suffers from hypocalcemia because of excessive loss of calcium in the colostrum and impairment in absorption of calcium in the body. Nowadays farmers go for cross-breeding of our indigenous cattle with Jersey and Holstein Friesian to increase the milk yield, actually, these Jersey breeds are highly prone to Hypocalcemia, they are genetically predisposed, and the intestinal absorption of calcium is less when compared to other breeds of cattle, so that is why it is highly prone to Hypocalcemia. According to the survey, cows which are reared in intensive system are more prone to hypocalcemia because of the disturbance in Calcium, Phosphorus, Potassium and the Dietary Cat-ion, An-ion balance. If the animal is in the dry period, the farmer may be supplementing high Calcium in the diet with the aim of to prevent Hypocalcemia before calving but it acts opposite by causing less stimulation to Parathyroid hormone secretion, ultimately, excess calcium decreases the Parathormone needed, thereby cause Hypocalcemia.
To prevent Production diseases (milk fever, ketosis) and the consequent huge economic loss to dairy farmers, the following suggestions are made:

- Education of dairy farmers to give a balanced mineral mixture during a dry period as well as after calving.
- Reduce the excess calcium feeding and excess phosphorous feeding before calving.
- After calving sufficient calcium should be supplemented in the form of a mineral mixture.
- Prophylactic feeding of sodium propionate at the rate of 110 grams per day for six weeks from calving will also prevent the occurrence of ketosis.
- Propylene glycol can be given at the rate of 356 ml per day for 10 days after calving, in order to prevent ketosis in the immediate postpartum period.

Disclaimer (Artificial intelligence)

Author(s) hereby declare that No generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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