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Challenges in adoption of improved feeding practices among dairy farmers: A Friedman ranking analysis

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Abstract

Improved dairy feeding practices strengthen productivity, profitability, and long-term sustainability, yet smallholder farmers continue to face considerable barriers to their adoption. Persistent knowledge gaps, limited access to quality inputs, and infrastructural inadequacies constrain technological uptake. Understanding these constraints in local farming systems provides essential insights for designing more responsive extension interventions. The study aimed to identify and analyze the major constraints perceived by dairy farmers in adopting improved feeding practices, and to determine their relative severity to guide more effective extension and policy actions. The research was conducted in Bareilly district of Uttar Pradesh with 120 randomly selected dairy farmers. Primary data were collected through a structured interview schedule. Twelve improved feeding practices were examined. The Friedman ranking test, a non-parametric tool suitable for comparing related ordinal data, was applied to evaluate the relative intensity of constraints across practices. The analysis revealed significant differences ($p < 0.001$) in the ranking of constraints. Knowledge-related limitations particularly low awareness of mineral mixtures, salt supplementation, probiotics, and anti-methanogenic additives emerged as the most severe barriers. High costs of inputs like bypass fat and probiotics, poor infrastructure for silage-making, and irregular availability of fodder and supplements further restricted adoption. Limited technical guidance compounded these challenges. Strengthening extension education through demonstrations, farmer trainings, and locally relevant awareness programs is essential. Ensuring timely availability of inputs at affordable or subsidized rates and supporting infrastructure for fodder conservation will enhance adoption and contribute to sustainable dairy development.

Keywords: Adoption barriers, awareness, constraints, dairy feeding, Friedman test, socio-economic profile

Introduction

Dairy farming is an integral component of India's agricultural economy, providing both nutritional security and livelihood opportunities to millions of smallholder farmers. India has maintained its position as the world's largest milk producer through sustained growth in herd strength, productivity improvements, and cooperative as well as private sector participation. According to the National Dairy Development Board (NDDB, 2023) ^[13], India contributes about 24–25 per cent of global milk production, amounting to nearly 230–235 million metric tonnes annually. Despite this impressive aggregate output, per-animal productivity remains low in many regions, particularly within smallholder systems, highlighting the need for efficiency-oriented interventions (Talukder and Tajuddin, 2000; Joshi *et al.*, 2007) ^[23, 9].

Scientific feeding practices represent one of the most effective pathways for improving productivity and sustainability in dairy farming. Practices such as mineral mixture supplementation, urea-treated straw, silage

preparation, bypass nutrients, and probiotics have been widely reported to enhance milk yield, reproductive efficiency, and overall animal health. Empirical studies have shown that appropriate mineral supplementation reduces metabolic disorders and improves fertility, while silage and bypass nutrients improve rumen efficiency and roughage utilization (Garg *et al.*, 2008; FAO, 2018) ^[6, 5]. However, evidence from field conditions suggests that adoption of these practices remains uneven and sub-optimal.

Although technically feasible, adoption of improved feeding practices at the farm level in India has been limited by multiple constraints. Earlier studies have consistently reported lack of awareness, high input costs, infrastructural bottlenecks, inadequate extension contact, and misconceptions regarding risks and benefits as major barriers (Kumar *et al.*, 2014; Dhaka *et al.*, 2017) ^[11, 4]. Recent region-specific studies further reinforce these findings. For instance, Barman *et al.* (2022) ^[3], in their study among Rajbanshi dairy farmers of Coochbehar district, reported that limited technical knowledge, weak extension

support, and high cost of feed inputs significantly constrained adoption of scientific dairy practices. Similarly, Singh *et al.* (2023) ^[22] observed that farmers' attitudes toward dairy farming in the Bundelkhand region were strongly influenced by socio-economic stress, risk perception, and inadequate institutional backing.

Economic limitations further compound adoption challenges. Smallholder dairy farmers typically operate with limited capital, uncertain cash flows, and high vulnerability to climatic and market risks, making them reluctant to invest in practices with upfront costs or delayed returns (Rahman and Rahman, 1991; Patel and Ashwar, 2019) ^[17, 14]. At the institutional level, weak extension delivery, poor availability of quality feed resources, lack of training and demonstration units, and limited access to credit and insurance further restrict adoption (Imtiaz and Rana, 2014; Islam *et al.*, 2022) ^[7, 8].

Given this complex context, it is insufficient merely to list adoption constraints; rather, their relative severity must be systematically assessed from farmers' perspectives. Ranking constraints helps prioritize extension and policy interventions under limited resources. The Friedman test, a non-parametric statistical tool suitable for ordinal data, is particularly appropriate for comparing perceived severity across multiple constraints. Accordingly, the present study was undertaken to identify and rank constraints faced by dairy farmers in adopting improved feeding practices, thereby generating evidence to guide targeted extension strategies and policy support.

Methodology

The present study was undertaken to systematically analyze the challenges perceived by dairy farmers in adopting improved feeding practices and to prioritize them using the Friedman ranking test. The study was carried out in Bareilly district of Uttar Pradesh, a region characterized by intensive dairy activity and a large population of smallholder farmers dependent on mixed crop–livestock systems. A total of 120 dairy farmers were selected as respondents using simple random sampling to ensure representation of different herd sizes and socio-economic categories. Twelve improved feeding practices were identified based on literature review, expert consultation, and their documented potential to improve animal health and productivity. These included: (i) salt supplementation, (ii) green fodder cultivation, (iii) utilization of sugarcane tops, (iv) mineral mixture supplementation, (v) use of fresh vegetable waste, (vi) anti-methane feed additives, (vii) probiotics, (viii) bypass fat, (ix) hay making, (x) urea-treated straw, (xi) silage, (xii) improved water management. These practices together represent a mix of low-cost supplements, resource-intensive technologies, and conservation methods, allowing for a holistic assessment of adoption barriers. Data collection was conducted through a structured interview schedule administered face-to-face with the selected farmers.

The schedule was pre-tested for clarity and validity before final use. Farmers were asked to identify and rank the constraints they experienced in adopting each of the practices. The constraints covered multiple dimensions, including knowledge gaps, economic limitations, infrastructural bottlenecks, input availability, and perceptual or attitudinal barriers. Respondents were instructed to assign

ranks according to the relative severity of challenges as they perceived them in their day-to-day farming context. The ranking data thus obtained were subjected to the Friedman test, a non-parametric statistical procedure suited for analyzing ordinal data when multiple related samples are compared. The test evaluates whether differences in mean ranks across items are statistically significant, thereby identifying the hierarchy of challenges faced by farmers. In this study, the null hypothesis assumed no significant variation in constraint severity across practices, while the alternative hypothesis tested that at least one constraint differed. A significance level of $p < 0.001$ was adopted to ensure rigorous inference. The analysis was carried out using SPSS version 26. Results from the Friedman test generated mean ranks and chi-square values for each practice, which were then interpreted to identify the most critical barriers. This methodological approach provided both a statistical basis for prioritization and a practical understanding of farmer perceptions, thereby combining robustness with field relevance.

Results

The socio-economic profile (Table 1) of the dairy farmers ($n = 120$) revealed that a majority of respondents (61.67%) belonged to the middle-age group (38–54 years). Scheduled Caste farmers constituted 75.00 per cent of the sample. Educational status was generally low, with most respondents being illiterate (40.83%) or educated up to primary level (38.33%). Most respondents lived in nuclear families (85.00%) with small family size (83.33%). Dairy farming was primarily practiced as a subsidiary occupation, with 54.17 per cent combining animal husbandry with agriculture. Herd size was predominantly small to medium, with 97.50 per cent of farmers maintaining fewer than seven animals. Nearly half of the respondents (47.50%) earned low income from dairy farming, and the majority belonged to low to middle annual income categories. Small landholdings dominated the sample (76.67%). Milk yield was generally low, as more than half of the farmers (51.67%) produced only 3–5 litres per day. Dairy farming was mainly oriented towards both household consumption and sale of milk (67.50%). Only 50 per cent of the respondents had received training on balanced ration feeding.

The Friedman ranking analysis (Table 2) revealed distinct patterns of challenges across various improved feeding practices among dairy farmers. In all cases, the chi-square statistics were significant at $P < 0.001$, indicating strong differences in the importance of challenges perceived by farmers. The foremost constraint identified was lack of awareness about the expected benefits of salt feeding on animal health and milk yield (Mean Rank = 4.36), followed by the perception that salt represents an extra cost without visible short-term returns (3.27). Belief that concentrates and fodders are sufficient (3.21) ranked third, while irregular availability of livestock-grade salt (2.27) and lack of knowledge regarding correct feeding quantity and method (1.99) were relatively less important. Regarding green fodder, limited landholding and preference for cash crops emerged as the top constraint (3.73), closely followed by lack of awareness about improved fodder varieties (3.56). High cost and unavailability of quality seeds (3.42) and lack

of training on fodder planning (3.38) were also significant issues, whereas non-availability of irrigation facilities (1.00) ranked lowest. Regarding sugarcane top feeding, seasonal availability during harvest or winter months was the most critical barrier (3.83). Farmers' unawareness of the nutritive value of sugarcane tops when supplemented with concentrate (3.79) and fear of digestive problems if fed in excess (3.60) ranked second and third, respectively. Misconceptions about reproductive problems (1.97) and lack of preservation knowledge (1.92) were relatively minor. With respect to mineral mixture feeding, poor knowledge about proper dosage and feeding methods was ranked first (3.56), followed by unavailability of veterinary-grade mineral mixtures in local markets (3.44). High price

compared to salt feeding (3.20) ranked third, while poor awareness of the role of minerals (3.37) was moderately important. Preference for traditional practices (1.55) was least significant. Regarding fresh vegetable waste feeding, lacking awareness about nutritive value emerged as the most pressing issue (4.56). Farmers' preference for traditional feed resources (2.72), difficulties in collection and transport (2.70), and fear of digestive disorders (2.67) occupied middle ranks. Seasonal and irregular availability was rated lowest (2.50). Regarding challenges faced in adding ante methane additives as dairy feed, farmers showed very low awareness regarding methane emissions and their environmental effects (3.88), ranking this as the primary constraint.

Table 1: Socio-economic profile of dairy farmers

Characters	Categories	Frequency (n=120)	Percentage (%)
Age (years)	Young (21-37)	27	22.50
	Middle (38-54)	74	61.67
	Old (55-70)	19	15.83
Caste category	OBC	30	25.00
	SC	90	75.00
Education	Illiterate	49	40.83
	Primary school	46	38.33
	High school	19	15.83
	Graduate	6	5.00
Family type	Nuclear	102	85.00
	Joint	18	15.00
Family size	Small (3-9)	100	83.33
	Medium (10-16)	19	15.83
	Large (17-23)	1	0.83
Occupation	Animal husbandry	40	33.33
	Animal husbandry + Agriculture farming	65	54.17
	Animal husbandry + Agriculture farming + Others	15	12.50
Herd size	Small (1-3)	64	53.33
	Medium (4-6)	53	44.17
	Large (>7)	3	2.50
Experience in dairy farming (Year)	Short (10-17)	45	37.50
	Medium (18-25)	40	33.33
	Long (26-31)	35	29.17
Income from dairy farming (Rs. / Year)	Low (18000-30000)	57	47.50
	Middle (30001-43000)	36	30.00
	High (43001-54000)	27	22.50
Annual income (Rs. / Year)	Low (48000-63000)	44	36.67
	Middle (63001-79000)	49	40.83
	High (79001-94000)	27	22.50
Land holding (acre)	Small 0.5- 3.99)	92	76.67
	Medium (04-7.49)	25	20.83
	Large (7.5-11.50)	3	2.50
Milk yield per day (litre)	Low (3-5)	62	51.67
	Medium (6-8)	44	36.83
	High (9-10)	14	11.50
Primary purpose of dairy farming	Milk sales	0	0.00
	Self-consumption	39	32.50
	Both	81	67.50
Training for balance ration	Yes	60	50.00
	No	60	50.00

High cost of additives (3.75) and absence of immediate benefits in milk yield (3.69) followed. Lack of government promotion (2.48) and non-availability at village level (1.34) were rated lower. Regarding preference for probiotics as dairy feed, no immediate visible results leading to discontinuation was ranked first (3.79). Lack of awareness

of their role in digestion and health (3.70) and high cost/irregular availability (3.48) followed closely. Fear of side effects (2.27) and limited extension services (1.90) were relatively less critical. Costliness for smallholders (3.53) was identified as the top barrier in bypass feed, followed by non-availability in rural markets (3.49).

Farmers' reliance on traditional oilcakes (3.40) and limited knowledge of benefits (3.22) was also important. Lack of training on feeding level and timing (1.52) ranked lowest. Regarding hay making, farmers prioritized cash crops over fodder preservation (3.40), followed by lack of proper storage facilities (3.34). Labour shortage during harvesting and drying (3.30) ranked third. Lack of awareness of hay's advantages (2.66) and absence of traditional practice (2.46) were lower-ranked. Challenges faced by farmers in adopting urea treatment of straw (UTS) as dairy feed, fear of toxicity due to improper treatment emerged as the top concern (3.43). Requirement of labour, water, and space (3.24) and ease of feeding untreated straw (3.15) followed. Lack of

awareness of nutritional benefits (2.69) and unavailability of cheap safe urea (2.67) were less pressing. Regarding silage making, non-availability of silage pits and machinery was the highest-ranked constraint (3.36). Requirement of labour and planning (3.16) and fear of spoilage (3.07) followed. Low awareness (2.85) and preference for fresh fodder (2.73) were least significant. Regarding water management, irregular supply of clean drinking water was top concerned (4.11), while negligence due to assumptions that animals manage independently (3.99) and lack of awareness of water requirements (3.85) were also major issues. In contrast, dependence on seasonal ponds/wells (1.53) and absence of proper troughs (1.61) were rated lowest.

Table 2: Challenges in Adoption of improved feeding practices among dairy farmers

Challenges according to improved dairy feeding practices	Mean Rank	Rank
Salt		
Lack of awareness about expected benefits on animal health and milk yield.	4.36	I
Belief that concentrate and fodder are sufficient, no need for extra salt.	3.21	III
Irregular availability of livestock-grade common salt in villages.	2.27	IV
Lack of knowledge about correct quantity and method of feeding.	1.99	V
Farmers' perception that salt is an extra cost without visible short-term return.	3.27	II
χ^2 - Friedman value	397.885**	
Green fodder		
Limited landholding and preference for cash crops over fodder.	3.73	I
Lack of awareness about improved fodder varieties.	3.56	II
High cost/unavailability of quality seeds near villages.	3.42	III
Non-availability of irrigation facilities for fodder cultivation.	1.00	V
Lack of training on fodder planning and year-round management.	3.38	IV
χ^2 - Friedman value	477.146**	
Sugarcane top		
Seasonal availability (only during harvest/winter season).	3.83	I
Fear of cause reproductive problem.	1.97	IV
Farmers unaware of nutritional value of sugarcane tops with added concentrate.	3.79	II
Fear of digestive problems if fed in excess.	3.60	III
Lack of knowledge about preservation (chopping/drying/ensiling).	1.92	V
χ^2 - Friedman value	426.332**	
Mineral mixture		
Poor awareness about importance of minerals in milk yield and fertility.	3.37	III
Unavailability of veterinary-grade mineral mixture in local markets.	3.44	II
High price compared to traditional salt feeding.	3.20	IV
Lack of knowledge about proper dosage and feeding method.	3.56	I
Preference for traditional practices rather than supplements.	1.55	V
χ^2 - Friedman value	402.261**	
Fresh vegetable waste		
Lack of awareness about nutritive value of vegetable waste.	4.56	I
Seasonal and irregular availability.	2.50	V
Fear of digestive disorders or spoilage when fed in excess.	2.67	IV
Collection and transportation difficulties.	2.70	III
Preference for traditional feed resources over waste utilization.	2.72	II
χ^2 - Friedman value	403.200**	
Ante methane		
Very low awareness among farmers about methane emission and its effect.	3.88	I
Non-availability of such additives at village level.	1.34	V
High cost compared to traditional feed ingredients.	3.75	II
Lack of government/veterinary promotion and demonstrations.	2.48	IV
Farmers do not perceive direct benefit in terms of milk yield immediately.	3.69	III
χ^2 - Friedman value	439.015**	
Probiotics		
Lack of awareness about role of probiotics in digestion and animal health.	3.70	II
High cost and irregular availability in local markets.	3.48	III
No immediate visible results, leading to discontinuation.	3.79	I
Limited extension services and demonstrations on usage.	1.90	V
Fear of side effects or mistrust in new products.	2.27	IV
χ^2 - Friedman value	375.505**	

By pass fat		
Limited knowledge about its benefits on milk yield and reproduction.	3.22	IV
Considered costly by small and marginal farmers.	3.53	I
Non-availability in remote or rural markets.	3.49	II
Farmers rely on traditional oilcakes instead.	3.40	III
Lack of training on correct feeding level and timing.	1.52	V
χ^2 - Friedman value	387.942**	
Hay		
Lack of awareness about advantages of hay for lean seasons.	2.66	IV
No proper storage facilities, leading to wastage/spoilage.	3.34	II
Farmers prioritize using land for cash crops, not for fodder preservation.	3.40	I
Labour shortage during fodder harvesting and drying.	3.30	III
Lack of tradition/practice of making hay in many regions.	2.46	V
χ^2 - Friedman value	311.929**	
Urea treatment straw		
Lack of awareness about increased nutritive value after treatment.	2.69	IV
Fear of toxicity/poisoning due to improper treatment.	3.43	I
Requirement of labour, water, and space for treatment.	3.24	II
Non-availability of cheap and safe urea for animal use.	2.67	V
Farmers find it easier to feed untreated straw due to convenience.	3.15	III
χ^2 - Friedman value	306.261**	
Silage		
Low awareness about silage-making techniques and benefits.	2.85	IV
Non-availability of silage pits, machinery (chaff cutter, polythene sheets).	3.36	I
Requires labour, investment, and planning in advance.	3.16	II
Fear of spoilage, bad odor, or rejection by animals.	3.07	III
Preference for feeding fresh fodder when available.	2.73	V
χ^2 - Friedman value	301.288**	
Water		
Irregular supply of clean drinking water in villages.	4.11	I
Lack of awareness about actual water requirement of dairy animals.	3.85	III
Dependence on seasonal ponds/wells leading to shortage in summer.	1.53	V
No proper water troughs, animals depend on open sources.	1.61	IV
Negligence as farmers assume animals manage on their own.	3.99	II
χ^2 - Friedman value	536.265**	

** Significant at 0.01 level of probability

Discussion

The predominance of middle-aged dairy farmers observed in the present study is consistent with earlier findings, which reported that dairy farming is largely managed by economically active age groups possessing practical experience and decision-making capacity (Atreya *et al.*, 2018) ^[1]. Lower representation of younger farmers indicates limited youth involvement in dairy farming, possibly due to alternative livelihood opportunities and perceived low profitability, as also reported by Prasad *et al.* (2017) ^[15]. The high proportion of farmers belonging to socially disadvantaged categories reflects the inclusive nature of dairy farming as a livelihood option. Similar socio-economic patterns have been documented among smallholder dairy farmers in different regions of India, where dairy farming acts as a stabilizing income source for marginal and resource-poor households (Ram *et al.*, 2018; Prasad *et al.*, 2019) ^[18, 16]. Low educational attainment among respondents aligns with previous studies reporting that a majority of dairy farmers possess only basic or no formal education (Koli *et al.*, 2020) ^[10]. Limited education may adversely affect awareness, comprehension, and adoption of scientific dairy management practices, thereby influencing productivity and income levels.

The predominance of nuclear families and small family size observed in the present study has also been reported in earlier investigations (Singh *et al.*, 2021) ^[21]. This family

structure may restrict the availability of family labour for dairy operations, particularly in labour-intensive activities such as feeding, milking, and animal health care. Small to medium herd size was a dominant characteristic among the respondents, confirming the subsistence to semi-commercial nature of dairy farming. Similar herd size patterns have been reported across different agro-climatic regions of India (Atreya *et al.*, 2018; Mahesh *et al.*, 2020) ^[1, 12]. Small herd size often limits economies of scale, thereby constraining income generation from dairy enterprises. The low milk yield recorded by a majority of farmers is in agreement with earlier studies that attributed low productivity to imbalanced feeding, inadequate management practices, and limited access to training and advisory services (Sachan, 2013; Prasad *et al.*, 2019) ^[19, 16]. The finding that only half of the respondents had received training on balanced ration feeding further supports earlier observations that insufficient technical training remains a major constraint in improving dairy productivity (Koli *et al.*, 2020) ^[10]. The dual purpose of dairy farming self-consumption and milk sale highlights its role in ensuring both household nutritional security and supplementary income. This semi-subsistence orientation has been consistently reported in socio-economic studies of dairy farmers across India (Prasad *et al.*, 2017) ^[15].

The Friedman ranking analysis clearly demonstrated that adoption of improved feeding practices among dairy farmers is constrained primarily by knowledge gaps, cost

considerations, infrastructural limitations, and entrenched perceptions. Across several practices mineral mixture supplementation, probiotics, bypass fat, and anti-methanogenic additives lack of awareness regarding benefits and correct usage emerged as the most severe constraint. These findings are consistent with earlier studies highlighting inadequate knowledge dissemination and weak extension outreach as persistent bottlenecks in dairy development (Dhaka *et al.*, 2017; Bardhan *et al.*, 2005)^[4, 2]. Recent regional studies further substantiate these observations. Barman *et al.* (2022)^[3] reported that dairy farmers in Coochbehar lacked access to practical training and demonstrations, resulting in poor understanding and hesitant adoption of improved feeding practices. Similarly, Singh *et al.* (2023)^[22] found that farmers in Bundelkhand exhibited cautious attitudes toward dairy innovations due to low confidence in institutional support and limited exposure to extension services. Together, these studies reinforce the central role of extension education and attitude formation in shaping adoption behaviour.

Fodder-related constraints such as land scarcity, preference for cash crops, and labour shortages were also ranked highly. Comparable findings have been reported among smallholder dairy farmers in India and neighbouring countries, where competing land uses and seasonal labour constraints limit fodder cultivation and conservation (Talukder and Tajuddin, 2000; Triveni *et al.*, 2018)^[23, 24]. Preservation technologies like silage, hay, and urea-treated straw were further restricted by lack of infrastructure, fear of spoilage or toxicity, and absence of traditional practice, as also noted by FAO (2018)^[5] and Sharma *et al.* (2021)^[20]. Cost-intensive inputs such as bypass fat, probiotics, and methane-reducing additives were perceived as economically risky, with farmers expecting limited immediate returns. Similar perceptions were documented in Bundelkhand, where income instability and climatic uncertainty discouraged investment in high-cost technologies (Singh *et al.*, 2023)^[22]. Studies from Bangladesh likewise emphasize that limited access to credit and insurance significantly reduces farmers' capacity to adopt improved feeding technologies (Rahman and Rahman, 1991; Islam *et al.*, 2022)^[17, 8].

Overall, the findings reveals that adoption constraints are not merely technical but deeply socio-economic and perceptual. Addressing these challenges requires integrated strategies that combine capacity-building, strengthening extension–farmer linkages, improving access to affordable inputs, and reshaping farmer perceptions through participatory demonstrations and evidence-based extension programs. Evidence from Coochbehar and Bundelkhand underscores the importance of region-specific, attitude-sensitive extension approaches for enhancing adoption of improved dairy feeding practices (Barman *et al.*, 2022; Singh *et al.*, 2023)^[3, 22].

Conclusion

The findings indicate that adoption of improved feeding practices among dairy farmers is shaped by intertwined socio-economic, technical, and infrastructural constraints. Low educational levels, small herd size, limited training exposure, and low productivity reduce farmers' capacity to understand, invest in, and sustain improved feeding

interventions. Knowledge gaps regarding the benefits and correct use of inputs such as salt, mineral mixtures, probiotics, and anti-methane additives emerged as major barriers, while high cost and irregular availability constrained adoption of bypass fat and probiotics. Fodder conservation practices silage, hay, and urea-treated straw were further limited by inadequate storage facilities, labour shortages, and insufficient technical know-how, compounded by water scarcity. The significant variation in perceived constraints across practices ($p < 0.001$) highlights that barriers are practice-specific rather than uniform. Together, these findings underscore the need for targeted, context-specific extension strategies that combine capacity building, affordable and reliable input supply, subsidies, and basic infrastructure support to improve animal health, enhance productivity, and strengthen livelihoods in smallholder dairy systems.

Declaration of Competing Interests

The authors declare that they have no known competing financial or personal interests that could have influenced the work reported in this paper.

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