



Mapping Dairy Farmers' Preferences for Improved Feeding Practices Using Paired Comparison Method

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HIGHLIGHTS

- The prioritization of improved feeding practices based on dairy farmers' preferences for acceptability at the field level was carried out using the paired comparison method.
- Salt, year-round green fodder production, and sugarcane tops were the most preferred feeding practices among dairy farmers due to their low cost and easy availability.
- Scientific and advanced practices like silage, urea-treated straw, and bypass fat received low preference, mainly due to a lack of awareness and perceived complexity.

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ABSTRACT

Dairy farmers' preferences for improved feeding practices were assessed in Bareilly district of Uttar Pradesh using a pairwise comparison technique. The findings indicate a strong preference for traditional, low-cost interventions. Salt supplementation ranked highest with a scale value of 2.924, followed by year-round green fodder production (2.730) and sugarcane tops (2.281). These results highlight farmers' favour for easily accessible and cost-effective options. Moderately accepted practices included mineral mixtures (1.862) and fresh vegetable waste (1.787), reflecting a cautious openness. However, more scientifically advanced practices such as anti-methane additives, probiotics, bypass fat, hay, urea-treated straw, and silage were less preferred, with scale values ranging from 1.325 to near zero. This lower acceptance suggests either limited awareness or reluctance to adopt more technical and potentially costly feeding practices. To evaluate the consistency of these preferences, an internal consistency check was conducted. The resulting average discrepancy of 0.090 indicates a reasonable level of internal consistency. Overall, the findings provide a clear picture of current dairy feeding practice preferences, with traditional approaches continuing to dominate farmer choices.

INTRODUCTION

Dairy farming plays a vital role in India's agricultural economy, predominantly sustained by smallholder farmers who typically rear one or two milch animals. India is the world's leading milk producer, with an annual production of 239.3 mt and a per capita milk availability of 471 grams/day (NDDB, 2023–24). For millions of

rural families, dairy farming is both a primary and supplementary livelihood source, offering income security and employment in regions with limited job opportunities. Among the key factors influencing the productivity and profitability of dairy farming, nutrition holds paramount importance. Adequate and balanced feeding is essential for optimal milk production, reproductive efficiency, disease resistance, and overall animal well-being.

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Dairy animals require a balanced diet that includes energy-rich feeds, proteins, vitamins, minerals, and an adequate supply of clean water. Proper feeding management not only ensures improved milk yield and better health outcomes but also helps prevent metabolic disorders such as acidosis, milk fever, and ketosis. Effective rumen function, achieved through appropriate feed combinations, enhances nutrient absorption and overall efficiency. Additionally, sustainable feeding strategies contribute to environmental sustainability by reducing methane emissions from enteric fermentation (Kumar *et al.*, 2023). Malnutrition, in contrast, results in poor productivity, increased disease risk, and economic losses for farmers.

To address the challenges of inadequate nutrition, several improved feeding practices have been developed. Chopped sugarcane tops (SCT), when supplemented with oil cake and mineral mixture, provide cost-effective roughage during dry seasons. Urea-treated straws (UTS) enhance low-quality fodder, while hay-making preserves green fodder for lean periods. Fresh vegetable waste (FVW), when properly processed, serves as an economical alternative. Probiotics aid digestion, and salt with area-specific mineral mixtures (MM) correct regional deficiencies. Additional practices like silage preparation, year-round green fodder cultivation (e.g., hybrid Napier), anti-methane additives, and by-pass fat improve productivity and sustainability. Clean drinking water 4-5 liters per liter of milk is essential for animal health and output.

METHODOLOGY

The data for this study were collected from four randomly selected villages namely *Hamirpur*, *Mawai*, *Kalapur*, and *Lakhampur* located in the Bareilly district of Uttar Pradesh. From each village, 15 dairy farmers were randomly selected, resulting in a total sample of 60 participants. Prior to data collection, sensitization programmes on improved dairy feeding practices were conducted in all four villages. Following these sessions, the farmers' acceptance of various improved feeding methods was assessed using the paired comparison technique. As noted by Brown and Peterson (2009), paired comparisons offer a straightforward yet robust method for eliciting binary preferences that can be translated into interval-scale measurements. This method was deemed appropriate for identifying and prioritizing the most widely accepted feeding practices among the respondents. While the summated rating scale remains the most widely used approach in social science research

(Kumar *et al.*, 2015; Singh *et al.*, 2018; Shruti *et al.*, 2019; Kumar *et al.*, 2021; Gupta *et al.*, 2022; Verma *et al.*, 2024), this study adopted the paired comparison methodology due to its suitability for comparative preference assessment. Unlike the scalogram approach of the Guttman scale, which relies on binary response categories such as "agree" or "disagree" (Choudhary *et al.*, 2025), the paired comparison method requires respondents to evaluate all possible combinations of feeding practices and select their preferred option in each pair. This method is based on Thurstone's Law of Comparative Judgment, a psychological scaling approach that allows subjective preferences to be quantified along a psychological continuum (Edwards, 1969). By analyzing the choices made in each pairwise comparison, the relative importance or priority of each feeding practice can be determined.

RESULTS

Eleven improved feeding practices were identified for dairy farmers in Bareilly district based on expert recommendations. These practices were subsequently subjected to pairwise comparison, wherein each possible combination was presented to the farmers for preference ranking. Using responses from 60 dairy farmers, a paired comparison frequency matrix was constructed to capture their expressed preferences among the 11 feeding practices. For example, 46 farmers preferred the inclusion of salt over round the year green fodder production (preferred by 14), while 56 chose salt over both sugarcane tops and probiotics (each preferred by 4 farmers), as shown in Table 1. Similarly, salt was favoured over mineral mixtures by 52 respondents (versus 8), and over fresh vegetable waste by 54 (versus 6). In addition, salt was prioritized over anti-methane feed additives and bypass fat by 58 respondents each (both alternatives receiving only 2 preferences). A large majority 59 farmers favoured salt over hay, silage, and urea-treated straw.

Overall, salt emerged as the most preferred feeding intervention, with a total score of 557. This strong preference is likely due to its widespread availability, ease of use, and low cost, making it a practical and accessible choice for smallholder dairy farmers.

Likewise, year-round green fodder production received a relatively strong preference in comparative judgments, with 59 farmers favouring it over urea-treated straw, followed by 58 selecting it over anti-methane feed additives, probiotics, and silage. Additionally, 56 farmers preferred year-round green fodder

Table 1. The F matrix for 11 improved dairy feeding practices judged by 60 farmers

S.No.	Practices	Salt	GF	SCT	MM	FVW	AM	Pro	BP	Hay	UTS	Silage
1.	Salt	0	14	4	8	6	2	4	2	1	1	1
2.	GF	46	0	4	8	4	2	2	4	4	1	2
3.	SCT	56	56	0	10	8	4	4	2	4	2	2
4.	MM	52	52	50	0	10	8	8	10	8	8	6
5.	FVW	54	56	52	50	0	6	8	4	4	6	2
6.	AM	58	58	56	52	54	0	10	6	8	4	6
7.	Pro	56	58	56	52	52	50	0	10	6	4	2
8.	BP	58	56	58	50	56	54	50	0	10	6	4
9.	Hay	59	56	56	52	56	52	54	50	0	10	4
10.	UTS	59	59	58	52	54	56	56	54	50	0	10
11.	Silage	59	58	58	54	58	54	58	56	56	50	0
	Total	557	523	452	388	358	288	254	198	151	92	39

production over sugarcane tops, fresh vegetable waste, bypass fat, and hay, while 52 preferred it over mineral mixtures. In the case of sugarcane tops, they were favoured by 58 farmers over bypass fat, urea-treated straw, and silage, and by 56 over anti-methane feed additives, probiotics, and hay.

Mineral mixture emerged as a relatively preferred feeding option, with higher preference scores against fresh vegetable waste (10), anti-methane feed additives (8), probiotics (8), bypass fat (10), hay (8), urea-treated straw (UTS) (8), and silage (6). Similarly, fresh vegetable waste was favoured over anti-methane feed additives (6), probiotics (8), bypass fat and hay (4 each), UTS (6), and silage (2).

In the case of anti-methane feed additives, they were preferred over probiotics (10), bypass fat (6), hay (8), UTS (4), and silage (6). Probiotics, in turn, received higher preference compared to bypass fat (10), hay (6), UTS (4), and silage (2). Bypass fat was more preferred than hay (10), UTS (6), and silage (4). Hay was selected more often than UTS (10) and silage (4). However, in the comparison between silage and UTS, the majority of farmers (50) favoured UTS, while only 10 preferred silage.

The frequency matrix (F matrix) was converted into a proportion matrix (P matrix) by dividing each frequency by the total number of respondents (60), as shown in Table 2. After preparing the P matrix, the total proportion (P value) was calculated for each improved feeding practice. Next, the Z matrix was derived from the P matrix using values from the standard normal distribution (Z) Table for each paired comparison as shown in Table 3. The total Z score was then computed for each feeding practice, including

negative values. Subsequently, the mean Z score was calculated for each improved feeding practice. To ensure that all values were positive, the lowest (most negative) mean score was added to the mean score of each improved feeding practice. This adjustment resulted in the final scale values for each improved dairy feeding practice, based on the preferences expressed by farmers. Among the practices, salt emerged as the most preferred (2.924), followed by year-round green fodder production (2.730), sugarcane tops (2.281), mineral mixture (1.862), fresh vegetable waste (1.787), anti-methane feed additives (1.325), probiotics (1.233), bypass fat (0.897), hay (0.671), urea-treated straw (UTS) (0.296), and silage, which was the least preferred as represented in Figure 1.

DISCUSSION

The findings from the paired comparison analysis reveal a clear hierarchy of farmer preferences for improved feeding practices, largely influenced by practical accessibility, cost-effectiveness, and familiarity with the options. Salt (2.924), being a traditional and widely available input, emerged as the most accepted feeding intervention, indicating minimal barriers to adoption. Its top ranking reflects a combination of low economic cost and established trust in its effectiveness. Year-round green fodder production (2.730) and sugarcane tops (2.281), both conventional feed resources, also scored high, suggesting that farmers remain inclined toward natural, farm-available or easily accessible feed sources, especially those that do not demand technical know-how or external procurement. This

Table 2. The P matrix corresponding to the F matrix

S.No.	Practices	Salt	GF	SCT	MM	FV	AM	Pro	BP	Hay	UTS	Silage
1.	Salt	0.000	0.233	0.067	0.133	0.100	0.033	0.067	0.033	0.017	0.017	0.017
2.	GF	0.767	0.000	0.067	0.133	0.067	0.033	0.033	0.067	0.067	0.017	0.033
3.	SCT	0.933	0.933	0.000	0.167	0.133	0.067	0.067	0.033	0.067	0.033	0.033
4.	MM	0.867	0.867	0.833	0.000	0.167	0.133	0.133	0.167	0.133	0.133	0.100
5.	FVW	0.900	0.933	0.867	0.833	0.000	0.100	0.133	0.067	0.067	0.100	0.033
6.	AM	0.967	0.967	0.933	0.867	0.900	0.000	0.167	0.100	0.133	0.067	0.100
7.	Pro	0.933	0.967	0.933	0.867	0.867	0.833	0.000	0.167	0.100	0.067	0.033
8.	BP	0.967	0.933	0.967	0.833	0.933	0.900	0.833	0.000	0.167	0.100	0.067
9.	Hay	0.983	0.933	0.933	0.867	0.933	0.867	0.900	0.833	0.000	0.167	0.067
10.	UTS	0.983	0.983	0.967	0.867	0.900	0.933	0.933	0.900	0.833	0.000	0.167
11.	Silage	0.983	0.967	0.967	0.900	0.967	0.900	0.967	0.933	0.933	0.833	0.000
	Total	9.283	8.717	7.533	6.467	5.967	4.800	4.233	3.300	2.517	1.533	0.650

Figure 1. Scale values of improved dairy feeding practices

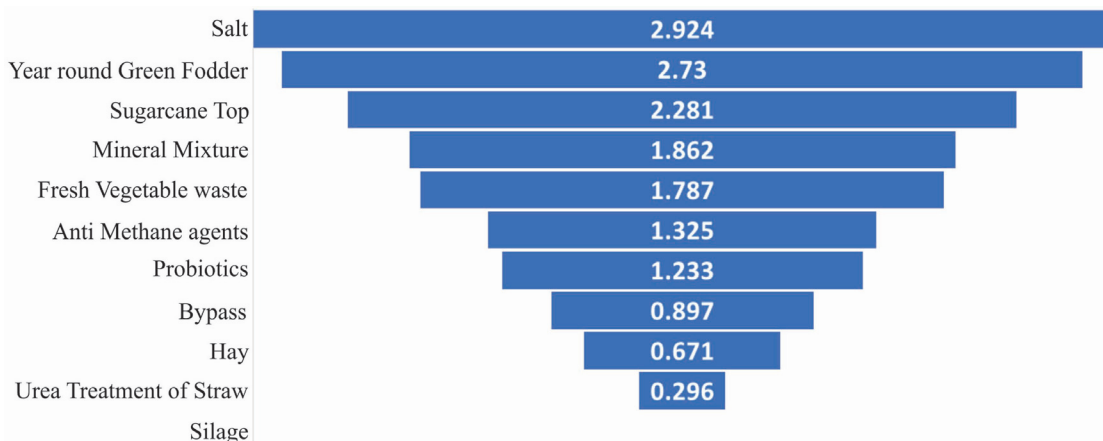


Table 3. The Z matrix corresponding to the P matrix

S.No.	Practices	Salt	GF	SCT	MM	FV	AM	Pro	BP	Hay	UTS	Silage
1.	Salt	0.000	-0.722	-1.499	-1.112	-1.282	-1.838	-1.499	-1.838	-2.120	-2.120	-2.120
2.	GF	0.729	0.000	-1.499	-1.112	-1.499	-1.838	-1.838	-1.499	-1.499	-2.120	-1.838
3.	SCT	1.499	1.499	0.000	-0.966	-1.112	-1.499	-1.499	-1.838	-1.499	-1.838	-1.838
4.	MM	1.112	1.112	0.966	0.000	-0.966	-1.112	-1.112	-0.966	-1.112	-1.112	-1.282
5.	FVW	1.282	1.499	1.112	0.966	0.000	-1.282	-1.112	-1.499	-1.499	-1.282	-1.838
6.	AM	1.838	1.838	1.499	1.112	1.282	0.000	-0.966	-1.282	-1.112	-1.499	-1.282
7.	Pro	1.499	1.838	1.499	1.112	1.112	0.966	0.000	-0.966	-1.282	-1.499	-1.838
8.	BP	1.838	1.499	1.838	0.966	1.499	1.282	0.966	0.000	-0.966	-1.282	-1.499
9.	Hay	2.120	1.499	1.499	1.112	1.499	1.112	1.282	0.966	0.000	-0.966	-1.499
10.	UTS	2.120	2.120	1.838	1.112	1.282	1.499	1.499	1.282	0.966	0.000	-0.966
11.	Silage	2.120	1.838	1.838	1.282	1.838	1.282	1.838	1.499	1.499	0.966	0.000
	Z score	16.157	14.020	9.091	4.472	3.653	-1.428	-2.441	-6.141	-8.624	-12.752	-16.000
	Mean	1.469	1.275	0.826	0.407	0.332	-0.130	-0.222	-0.558	-0.784	-1.159	-1.455
	Mean+1.455	2.924	2.730	2.281	1.862	1.787	1.325	1.233	0.897	0.671	0.296	0.000

Table 4. Theoretical normal deviates corresponding to the scale distances between the practices

S.No.	Practices	Scale value	Silage	UTS	Hay	BP	Pro	AM	FVW	MM	SCT	GF	Salt
1.	Silage	0.000	0.000	0.296	0.671	0.897	1.233	1.325	1.787	1.862	2.281	2.73	2.924
2.	UTS	0.296	-0.296										
3.	Hay	0.671	-0.671	-0.375									
4.	BP	0.897	-0.897	-0.601	-0.226								
5.	Pro	1.233	-1.233	-0.937	-0.562	-0.336							
6.	AM	1.325	-1.325	-1.029	-0.654	-0.428	-0.092						
7.	FVW	1.787	-1.787	-1.491	-1.116	-0.890	-0.554	-0.462					
8.	MM	1.862	-1.862	-1.566	-1.191	-0.965	-0.629	-0.537	-0.075				
9.	SCT	2.281	-2.281	-1.985	-1.610	-1.384	-1.048	-0.956	-0.494	-0.419			
10.	GF	2.730	-2.730	-2.434	-2.059	-1.833	-1.497	-1.405	-0.943	-0.868	-0.449		
11.	Salt	2.924	-2.924	-2.628	-2.253	-2.027	-1.691	-1.599	-1.137	-1.062	-0.643	-0.194	

Table 5. Theoretical proportions corresponding to the theoretical normal deviates

S.No.	Practices	Silage	UTS	Hay	BP	Pro	AM	FVW	MM	SCT	GF	Salt
1.	Silage											
2.	UTS	0.384										
3.	Hay	0.251	0.354									
4.	BP	0.185	0.274	0.411								
5.	Pro	0.109	0.174	0.287	0.369							
6.	AM	0.093	0.152	0.257	0.334	0.463						
7.	FVW	0.037	0.068	0.132	0.187	0.29	0.322					
8.	MM	0.031	0.059	0.117	0.167	0.265	0.296	0.47				
9.	SCT	0.011	0.023	0.054	0.083	0.147	0.17	0.311	0.338			
10.	GF	0.003	0.007	0.020	0.033	0.067	0.080	0.173	0.192	0.327		
11.	Salt	0.002	0.004	0.012	0.021	0.045	0.055	0.128	0.144	0.26	0.423	

aligns with prior observations in rural feeding practices, where simplicity and immediacy outweigh novelty.

The moderate acceptance of mineral mixtures (1.862) and fresh vegetable waste (1.787) suggests growing awareness of balanced nutrition, though constraints related to availability, price, or knowledge may be limiting widespread preference. Meanwhile, scientifically advanced or less familiar practices such as anti-methane feed additives (1.325), probiotics (1.233), bypass fat (.897), hay (0.671) urea-treated straw (.296) and silage received relatively lower

preference scores. These options likely face challenges due to limited awareness, higher costs, or lack of demonstrated benefits at the field level.

Interestingly, urea-treated straw was preferred over silage, indicating a slight tilt toward technologies that require fewer inputs or simpler methods. However, the overall low preference for both implies the need for stronger demonstration-based extension efforts, capacity building, and showcasing of long-term benefits to encourage adoption of such improved practices.

Table 6. Discrepancies between the theoretical proportions of Table 5 and the observed proportions of Table 2

S.No.	Practices	Silage	UTS	Hay	BP	Pro	AM	FVW	MM	SCT	GF	Salt
1.	Silage											
2.	UTS	-0.217										
3.	Hay	-0.184	-0.187									
4.	BP	-0.118	-0.174	-0.244								
5.	Pro	-0.076	-0.107	-0.187	-0.202							
6.	AM	0.007	-0.085	-0.124	-0.234	-0.296						
7.	FVW	-0.004	0.032	-0.065	-0.12	-0.157	-0.222					
8.	MM	0.068	0.074	0.016	0.000	-0.132	-0.163	-0.303				
9.	SCT	0.022	0.01	0.013	-0.05	-0.08	-0.103	-0.178	-0.171			
10.	GF	0.03	0.01	0.047	0.034	-0.034	-0.047	-0.106	-0.059	-0.259		
11.	Salt	0.015	0.013	0.005	0.012	0.022	-0.022	-0.028	-0.011	-0.193	-0.190	
12.	Sum	0.741	0.098	0.701	0.652	0.721	0.557	0.615	0.241	0.452	0.190	

Internal consistency check

An internal consistency check was performed on the scale values derived for the improved dairy feeding practices, which were arranged on a psychological continuum from least to most preferred. This procedure aimed to evaluate the degree of agreement between the observed (empirical) proportions and the theoretically expected proportions derived from the scale values. It aids in determining how uniform the scale’s objects are (Choudhary et al., 2025) and represent precision or accuracy of the measurement (Verma et al., 2025).

To conduct this check, the scale distances between each pair of feeding practices were first calculated to generate theoretical normal deviates, as shown in Table 4. Using these scale distances, a matrix of theoretical proportions corresponding to theoretical normal deviates was generated, presented in Table 5. Next, the discrepancies between the theoretical proportions (Table 5) and the observed proportions (Table 2) were determined as indicated in Table 6.

The discrepancies for all paired comparisons were summed, taking the absolute values into account. Finally, the absolute average discrepancy was computed by dividing the total absolute discrepancy by the number of independent comparisons, calculated as $n(n-1)/2$, where n is 11 in this case. The resulting absolute average discrepancy was found to be 0.090, indicating a reasonable level of internal consistency in the scale.

CONCLUSION

The findings reveal a pronounced preference for traditional, low-cost feeding practices, particularly salt supplementation, year-round green fodder production, and chopped sugarcane tops, which dominate farmer choices due to their familiarity, ease of access, and minimal investment. In contrast, more specialized interventions such as silage, urea-treated straw, anti-methane additives, and bypass fat received lower acceptance, likely reflecting farmers’ perceptions of these methods as complex or economically burdensome. This mirrors patterns observed in other agricultural studies where resource-constrained farmers often prioritize simplicity and practicality over unfamiliar innovations. The internal consistency of the preference scale evidenced by an average discrepancy of 0.090 confirms that the farmers’ comparative responses align closely with theoretical expectations from Thurstone’s paired-comparison model. While

traditional feeding methods continue to dominate the preference landscape among dairy farmers, there is latent potential for the adoption of improved and scientific feeding practices.

DECLARATIONS

Ethics approval and informed consent: Before data collection, sensitization programmes on improved dairy feeding practices were conducted with the prospective participants of the study. Those consented have been included for data collection and analysis purposes.

Conflict of interest: The authors declare 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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