PLANT SCIENCE TODAY
ISSN 2348-1900 (online)
Vol 12(1): 1-7
https://doi.org/10.14719/pst.6067

HORIZON
e-Publishing Group
HePG

RESEARCH ARTICLE

Sustainable fodder crop-feed integration practices: Impact on dairy farm economics and agricultural diversity

Renu Janarthanan J[1]*, C Velavan[1], A Rohini[1], S Maruthasalam[2] & R Pangayar Selvi[3]

[1]Department of Agricultural and Rural Management, Tamil Nadu Agricultural University, Coimbatore 641 003, Tamil Nadu, India

[2]Department of Spices and Plantation Crops, Tamil Nadu Agricultural University, Coimbatore 641 003, Tamil Nadu, India

[3]Department of Physical Science and Information Technology, Tamil Nadu Agricultural University, Coimbatore 641 003, Tamil Nadu, India

*Email: renujayaraman99@gmail.com

OPEN ACCESS

ARTICLE HISTORY
Received: 22 October 2024
Accepted: 25 October 2024
Available online
Version 1.0 : 08 January 2025
Version 2.0 : 12 January 2025

Check for updates

Additional information
Peer review: Publisher thanks Sectional Editor and the other anonymous reviewers for their contribution to the peer review of this work.

Reprints & permissions information is available at https://horizonepublishing.com/journals/index.php/PST/open_access_policy

Publisher's Note: Horizon e-Publishing Group remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Indexing: Plant Science Today, published by Horizon e-Publishing Group, is covered by Scopus, Web of Science, BIOSIS Previews, Clarivate Analytics, NAAS, UGC Care, etc
See https://horizonepublishing.com/journals/index.php/PST/indexing_abstracting

CITE THIS ARTICLE
Renu JJ, Velavan C, Rohini A, Maruthasalam S, Selvi RP. Sustainable fodder crop-feed integration practices: Impact on dairy farm economics and agricultural diversity. Plant Science Today. 2025; 12(1): 1-7. https://doi.org/10.14719/pst.6067

Abstract

The study aimed to identify factors influencing feed purchase among dairy farmers in Tamil Nadu. The study highlights the crucial relationship between fodder crop cultivation and dairy farming economics. Local fodder crops like Hybrid Napier grass (*Pennisetum purpureum*), Sorghum (*Sorghum bicolor*) and Cowpea (*Vigna unguiculata*) play a vital role in supplementing commercial cattle feed, potentially reducing feed costs by 15-20 %. Integrating sustainable fodder cultivation practices with commercial feed usage presents opportunities for improving dairy farm profitability while promoting agricultural diversity. A survey was conducted among 200 dairy farmers in the districts of Ariyalur and Perambalur to gain a deeper understanding of that consumer buying behaviour, cost of production, benefit-cost ratio, factors influence buying behaviour and constraints faced by the farmers while purchasing and using cattle feed, such as the fact that specific feeds are improperly prepared, that costs are prohibitively high and that obtaining credit to pay for feeds is difficult. Key determinants of feed choice include product-related factors, marketing, economic factors, distribution, farm and milk production, labour and Government support. It is concluded that producers, distributors and legislators have insightful information about how to raise feed quality, accessibility and affordability while also boosting the financial viability and sustainability of Tamil Nadus' dairy industry.

Keywords

cattle feed; dairy farmers; determinants; Tamil Nadu

Introduction

Milk production in India has seen remarkable growth, increasing from 17 million tonnes in 1950-51 to 230.58 million tonnes in 2022-23 (1). Despite this progress, India's average milk yield per cow (4.4 litres per day) lags behind the global average of 6.8 litres per day. Tamil Nadu and India's per capita milk availability is 384 grams and 471 grams per day, respectively (2). The recommended per capita requirement of milk for India is 316 g per day; for Tamil Nadu, it is 250 grams per day (3). The Government has implemented various initiatives to address these challenges, such as the National Dairy Plan and the Rashtriya Gokul Mission. These programs aim to increase milk productivity, support dairy cooperatives and promote indigenous bovine breed conservation (4). Dairying offers numerous benefits to rural farming households, mainly marginal and poor farmers. It provides a significant source of income and employment, contributing to their livelihoods and sustenance. The dairy sectors' success is intrinsically linked to fodder crop production and management. The nutritional quality of cattle feed is fundamentally linked to its

plant-based components and fodder management systems. India's total fodder crop production is 734.2 million tonnes (5). The essential plant species used and cultivated for milk production with their yield per hectare are sorghum 40 tonnes, berseem 25 tonnes, lucerne 21 tonnes, maize 68 tonnes, pearl millet 25 tonnes, oats 40 tonnes, hybrid Napier 400 tonnes, cow pea 17 tonnes, guinea grass 70 tonnes and cluster beans 13 tonnes (6-7). These crops provide essential cattle nutrients and contribute to soil health through nitrogen fixation and organic matter addition. Recent advances in plant breeding and agronomic practices have revolutionized the dairy feed industry. Studies indicate that adequately managed fodder production can reduce feed costs by 35-45 % while maintaining optimal nutritional content (8).

A study discusses the challenges of crossbreeding non-descript zebu cows with exotic dairy cattle breeds in India. While initial crosses significantly increased milk production, subsequent generations have seen a decline in performance due to a lack of planned breeding programs. Maintaining an exotic inheritance level of 50-62.5 % through proper breeding policies, access to high-quality breeding bulls, improved infrastructure and effective extension services is crucial to sustaining the benefits of crossbreeding and achieving higher milk production (9). Additionally, dairying helps to reduce income and employment disparities within rural communities, promoting equitable distribution of resources (10). Commonly purchased cattle breeds with their average milk yield include Red Sindhi, 1700 kg per lactation, Sahiwal 2100 kg per lactation, Gir 1600 kg per lactation, Tharparkar 2500 kg per lactation, Kankrej 3600 kg per lactation, Jersey 8000 kg per lactation and Holstein Friesian, 7000 kg per lactation, with average milk yields ranging from 1700 kg to 8000 kg per lactation (11). Cattle feed brands offer specialized formulations tailored to enhance milk production and overall cattle health, contributing significantly to the growth and development of the state's dairy industry. In Tamil Nadu, several prominent cattle feed brands have emerged to meet the nutritional needs of dairy cattle. Understanding the preferences of Tamil Nadu's dairy farmers is crucial for developing effective cattle feed solutions. Investigating factors influencing their choices of cattle feed brands will help improve quality, affordability and accessibility.

Materials and Methods

Tamil Nadu was chosen for the study due to its strong position in the dairy sector and consistent top-ten rankings in various categories. The state's significant urban market size, particularly for household purchases and large-scale liquid milk procurement, further highlights its importance in the dairy industry. Additionally, Tamil Nadu's relatively high per capita milk consumption in rural and urban areas suggests a robust demand for dairy products within the state. The study was conducted in the Ariyalur and Perambalur districts of Tamil Nadu. These districts were purposively selected due to their low Human Development Index (HDI) values compared to the state average. Dairy farming would help to increase their livelihood and standard of living and these districts also have a significant cattle population and involvement in animal husbandry and dairy farming activities. With a considerable cattle population, the Sendurai and Thirumanur blocks of the Ariyalur district and the Veppur and Alathur blocks of the Perambalur district were chosen for the study. In each block, five villages with significant cattle populations were selected. Ten dairy farmers were determined from each village using a simple random sampling method from cooperative society lists, resulting in 200 farmers. This provides a representative sample for studying consumer buying behaviour, production costs, benefit-cost ratio and factors influencing purchases.

Analytical tools

Benefit-cost ratio

Farmers may be encouraged to use commercial animal feeds if dairy farming is profitable. Hence, the benefit-cost ratio analysis was used to measure the profitability of dairy farming. The benefit-cost ratio is a ratio of total revenue to total cost and is explained in the following formula in Equation 1 (12).

$$\text{Benefit Cost Ratio} = \frac{\text{Gross returns}}{\text{Total cost of production}} \quad \text{(Eqn. 1)}$$

Dairy farming is profitable if the benefit-cost ratio is more significant than one. If the ratio is equal to one, it implies that dairy farming is neither profitable nor loss and if the benefit-cost ratio is less than one, then dairy farming is not profitable.

Factor analysis

The text explains that Principal Component Analysis (PCA) identifies and analyses the relationships between multiple variables. It involves reducing the information from several original variables to smaller dimensions or factors while minimizing information loss. Factor analysis is a mathematical technique that describes the relationship between variables (X_1, X_2, ... X_k) by representing them in fewer components, as in Equation 2 (13).

$$Xi = Ai1F1 + Ai2F2 + Ai3F3 + \ldots\ldots + AimFm + ViUi \quad \text{(Eqn. 2.)}$$

Where,

Xi = ith Standardized variable. Where i= 1,2,3……k variables

Aij = Standardized multiple regression coefficients of variable' i' on common factor' j'.

F = Common factor. Where j= 1,2,3…...m Number of common factor.

Vi = Standardized regression coefficient of variable' i' on unique factor.

Ui = The unique factor for variable' i'.

M = number of common factors.

The distinct elements are unrelated to one another and the common ones. The observed variables can be represented as a linear combination of the standard components as in Equation 3.

$$Fi = Wi1X1 + Wi2X2 + Wi3X3 + \ldots\ldots\ldots + WikKXk \quad \text{(Eqn. 3.)}$$

Where,

Fi = Estimate of i^{th} factor

Wi = weight or factor score coefficient

K = number of variables

The process involves finding coefficients for each factor to

maximize their explanatory power. Each subsequent factor is then determined to capture the remaining variation. This results in uncorrelated factor scores and ensures that the most influential factors are independent.

Garrett ranking

The study examined constraints in purchasing and consuming cattle feed. Participants ranked criteria and their rankings were converted into scores using Garrett's ranking technique as in Equation 4 (14).

$$Per\ cent\ position = (100\Sigma(Rij-0.5))/Nj \quad \text{(Eqn. 4.)}$$

Where,

Rij = Ranking given for the i^{th} factor by the j^{th} respondents

Nj = number of variables ranked by the j^{th} respondents

Integration of fodder crop management

The study area demonstrates significant potential for fodder crop cultivation. The predominant soil types in Ariyalur and Perambalur districts, namely red loamy and black cotton soils, are suitable for growing various fodder crops. The average annual rainfall of 800-1000mm supports rain-fed fodder cultivation. Common fodder crops in the region include:

- Hybrid Napier grass (CO-4 variety): Yields 350-400 tonnes/ hectare/year of green fodder.
- Multi-cut sorghum (CO-31 variety): Yields 80-85 tonnes/ hectare/year.
- Hedge Lucerne: Yields 40-45 tonnes/hectare/year.

These crops can potentially reduce commercial feed costs while providing nutritional benefits to cattle.

Results and Discussion

Consumer buying behaviour of cattle feed brands

Understanding consumer preferences is crucial for businesses to develop targeted products and marketing strategies, improve market position and drive innovation in the dairy industry. A study on consumer preferences for cattle feed was conducted using percentage analysis, with results detailed in Table 1. The results bring various interesting patterns and differences across the study area. The table shows that the usage is overwhelmingly for pellet feeds, with 99 % usage. This indicates a firm preference for pellet feeds over mash in the study area. However, the choice of source purchase is different across the study area. Feed distributor shops are the primary source in the study area (40 %). Still, the second-most preferential sources are cooperatives (31.5 %) and feed retail shops (23 %). It is noted that different distribution strategies could work in the study area.

Table 2 shows that cash transactions are more familiar, with 76 %. In the study area, most consumers buy the feed two to three times a month, signifying a recurring purchase pattern. Transportation for feed purchase is primarily by motorcycle (77.5 %). In both districts, the majority of consumers travel a distance of 5-10 km for their purchases. It indicates a willingness to travel moderate distances for preferred feed. It could be concluded that most dairy farmers prefer pellet feed and they prefer to purchase through feed distributor shops and purchase through cash rather than credit. Dairy farmers travel 5 to 10 km on motorcycles and purchase twice a month. The quantity procured every month is mainly between 200-400 kg (80 %). The mean value of feed purchase per single purchase differs across the study area. Of most householders' purchases, 45.5 % fell in the range of Rs. 2001 to 4000 and Rs. 4001 to 6000. This implies that householders purchase relatively larger quantities in the study area. Most dairy farmers purchase 200 to 400 kg of cattle feed monthly and their average single purchase value is around Rs 2000 to 4000.

Table 1. Consumer buying behaviour towards cattle feed

Characteristics	Category	Number of sample respondents	Percentage of sample respondents
Feed type	Pellet	198	99
	Mash	2	1
	Total	200	100
Source of purchase	Feed distributor shop	80	40
	Feed retail shop	48	24
	Agrochemical	9	4.5
	Cooperatives	63	31.5
	Total	200	100
Mode of purchase	Cash	152	76
	Credit	48	24
	Total	200	100
Frequency of purchase per month	Less than two times	1	0.5
	Two to three times	190	95
	More than three times	9	4.5
	Total	200	100
Transportation used for purchase	Bi-cycle	34	17
	Motor cycle	155	77.5
	Mini van	11	5.5
	Total	200	100
Distance of purchase (km)	Less than 5 kilometres	9	4.5
	5 to 10 kilometres	157	78.5
	More than 10 kilometres	34	17
	Total	200	100

Table 2. Consumer buying behaviour towards cattle feed

Characteristics	Category	Number of sample respondents	Percentage of sample respondents
Quantity purchased per month (kg)	200 to 400	160	80
	401 to 600	24	12
	601 to 800	7	3.5
	801 to 1000	4	2
	1001 to 1200	4	2
	1201 to 1400	1	0.5
	Total	200	100
Value of feed per single purchase (Rs)	Less than 2000	1	0.5
	2001 to 4000	91	45.5
	4001 to 6000	91	45.5
	6001 to 8000	14	7
	8001 to 10000	1	0.5
	More than 10000	2	1
	Total	200	100

Average cost of milk production

The average expenses incurred for milk production would help estimate the cost and return of dairy farms. The expenditure can be classified into fixed cost and variable, where fixed cost includes the cost of animals, buildings and equipment and variable cost includes labour cost, feed cost and others, feed cost includes green fodder and concentrate (15).

Fixed cost

Most of the animals in the selected farms were non-descriptive and only a small number of native breeds were available. The average number of milking cows per farm was six. The total cost spent for animals can be calculated as follows: the estimated value of the cows' life subtracted from the purchase cost of the animal divided by the number of years of productive life. A cows' assumed productive life is 7 years and beyond that time, the assumed set value is Rs 9000.

In many cases, the buildings had not been built to the required standards, regardless of the farms' management systems. The majority of the time, cement was used to construct the floor, while sheets or cadjans were used for the roof. Most of the time, the water and cement feeders were at the forefront. The average area required for cattle is 40 sq. feet and the construction cost for a cattle shed is Rs 1500 per sq. feet, resulting in a total cost of Rs 360000 per shed. Assuming a 25-year lifespan, the depreciation value is ₹27077.

Variable cost

On average, there was one labourer per farm, who was usually hired and used for a wide range of activities in the milk production process. The average daily wage for the labour is ₹350. The labour cost will be ₹127750. The majority of the farmers in the research used intensive and semi-intensive management techniques. Due to the use of commercially prepared feeds and the implementation of the cut-and-fed approach, the feed cost appears to have been significant under these management systems. On average, the cost incurred on roughage is Rs 25380, on concentrate is Rs 28890 and on cattle feed is Rs 71915. The farmers in the study did not consider veterinary facilities, resulting in relatively low veterinary costs. Finding a veterinary surgeon when needed was challenging. Veterinary expenses included medications and transportation, averaging Rs 650 per month. Most farmers used motorcycles for transportation and other activities, costing an average of Rs 8185.

Additionally, miscellaneous expenses were amounting to Rs 3290 per year. Details of the average costs incurred in a milk cycle are in Table 3. From the table, it could be inferred that the average expense incurred for milk production is Rs 341764. This average expense is calculated for a farm having 6 cattle.

Impact of fodder crop integration

Analysis revealed that farmers practising integrated fodder crop management showed 18 % lower commercial feed costs, 12 % higher profit margins, Better soil health indicators, including organic carbon content and Reduced dependency on external feed sources.

Cultivating leguminous fodder crops like cowpea and horse gram contributed to soil nitrogen enrichment, estimated at 30-40 kg N/ha/year, providing additional benefits to subsequent crops.

Table 3 Average cost incurred for milk production by the sample respondents

S. No	Expenditure particulars	Cost (Rs/ year)	Percentage
	Fixed cost		
1	Depreciation of cattle shed	14400	4.57
2	Depreciation of animal	27077	8.60
	Total fixed cost (a)	41477	13.18
	Variable cost		
1	Roughage	25380	8.06
2	Concentrate	28890	9.18
3	Cattle feed	71915	22.85
4	Medical expense	7800	2.50
5	Labour cost	127750	40.60
6	Transportation	8185	2.60
7	Miscellaneous	3290	1.04
	Total variable cost (b)	273210	86.82
	Total (a + b)	314687	100

(Figures in the parentheses indicate percentage to total)

Average revenue in a milk cycle for the sample respondents

The average revenue in a milk cycle for the sample respondents would help to estimate the benefits and costs of dairy farms. The income was calculated as revenue from milk, calf and cow dung. In the study area, 90 per cent of the farmers sell their milk to Government cooperatives, namely Aavin, 8 per cent of the dairy farmers sell their milk to private milk cooperatives like Hatsun Agro, Arokya Milk, Tamil Milk and many more and the remaining 2 per cent sell their milk on their brand. The details of the average revenue milk cycle in a year are given in Table 4. From the table, it could be inferred that the average revenue generated in a year from the farm is Rs 437500. The price realized for a litre of milk was Rs 33 per Litre. Average daily milk yields were 7.75 L/day.

Table 4. Average revenue in a milk cycle for the sample respondents (Rs per year)

S. No	Income particulars	Overall sample
1	Revenue from milk	384000
2	Revenue from calf	16000
3	Revenue from dung	37500
	Total	**437500**

Benefit-cost ratio

The benefit-cost ratio is used to measure the profitability of dairy farming. The benefit-cost ratio uses the total cost of dairy farming and the total revenue generated. Table 5 shows that the benefit-cost ratio is 1.28, indicating that dairy farming is profitable. It could be concluded that the dairy farmers were profitable, which could help the farmers' livelihood. However, a study estimated that BC of 1.61 for the Dairy Cooperative Society (DCS), which is higher than this study result, indicates a profitable investment (16).

Table 5. Benefit-cost ratio

S. No	Average cost incurred	Average revenue generated	B: C Ratio
1	3,41,764	4,37,500	1.28

Factors influencing consumer preference towards major cattle feed in the study area.

In this study, thirty-five factors were given to the sample respondents to determine the significant factors influencing them to purchase cattle feed. The details of KMO and Bartletts' test are shown in Table 6. It could be inferred from Table 6 that the KMO measure of sampling adequacy is 0.68, more than significant level of 0.5. Bartletts' adequacy test has a chi-square value of 4163.39, which is highly significant at 0.000 levels. It could be concluded that factor analysis is recommended as a suitable technique for further data analysis.

It could be inferred from the Fig. 1. scree plot that after the ninth component, the screen plot becomes a straight line and the Eigen is less than one. The first nine principal components have an Eigenvalue that is more significant than one, accounting for the major influential factors in the purchase of cattle feed. The remaining components are relatively unimportant as their eigenvalue is near zero. The components are assigned with suitable names based on their factor and the details are given in Table 7. The components and factors table is provided in the supplementary file. The results of factor analysis showed that the first component was named as product related factors which comprise factors like feed quality, proper labelling, more variety of animal feed, quality packing, acceptability of

Table 6. KMO and Bartlett's test

KMO and Bartletts' test		
Kaiser-Meyer-Olkin measure of sampling adequacy	0.682	
Bartletts' test of sphericity	Approx. Chi-square	4163.391
	Sig.	.000

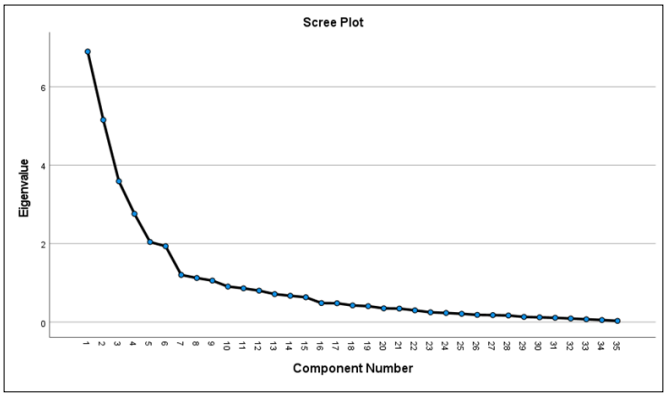

Fig. 1. Scree plot graph.

Table 7 Components and factors

Components	Variance %	Factors
Product related factor	19.705	Feed quality Proper labelling More variety of animal feed Quality packing Acceptability of animal The shelf life of the cattle feed.
Marketing and brand perception factor	14.727	Availability of offers for animal feed Word-of-mouth advice Advertisements in mass media Brand familiarity Easy brand recognition Training and after-sales support
Economic factors	10.261	Price of the cattle feed Price of the fodder Price of the milk Price of the concentrate Credit availability for feed purchase
Distribution and availability factors	7.886	Transportation facility Recommendation of animal feed dealers Preference of dealer Strong retailer network Easy availability of the brand in the market
Farm and milk production factors	5.836	Increase in milk yield Number of animals maintained Size of the farm Stage of the lactation cycle
Opinion factor	5.527	Recommendations of veterinarians Recommendations of the progressive farmer Recommendation of milk society/ company
Labour factors	3.439	Labour availability The wage of the labour
Influencing factors	3.215	Income from other sources Experience in cattle feed Fodder availability
Government factor	3.025	Gov. Subsidiary for dairy farming

animals, the shelf life of the cattle feed with a variance of 19.70 % followed by the second component was named as marketing and brand perception factor which comprises factors like availability of offers for animal feed, word-of-mouth advice, advertisements in mass media, brand familiarity, easy brand recognition with a variance of 14.72 %, the third component was named as economic factors which comprise factors like training and after-sales support, price of the cattle feed, price of the fodder, price of the milk, price of the concentrate, credit availability for feed purchase with a variance of 10.26%.

The fourth was named distribution and availability, which has factors like transportation facility, recommendation of animal feed dealers, preference of dealer, strong retailer network and easy availability of the brand in the market with a variance of 7.88 %. The fifth component was named farm and milk production factors, such as increase in milk yield, number of animals maintained, size of the farm and stage of the lactation cycle with a variance of 5.83 %. The sixth component was named the opinion factor, which includes recommendations from veterinarians, progressive farmers and milk societies/ companies, with a variance of 1.93 %. The seventh component was named the labour factor, which has factors like labour availability and wage with a variance of 3.43 %. The eighth component was named influencing factors, which have factors like income from other sources, experience in cattle feed and fodder availability with a variance of 3.21 % and the ninth component was named the Government factor, which has factors like Government subsidiary for dairy farming with a variance of 3.02 %. It could be evident from the factor analysis that product-related factors, with a variance of 19.70 %, were the most influential factors in the purchase of cattle feed. It could be concluded that all nine components significantly influenced the purchase of cattle feed.

Fodder crop integration and feed quality

Analysis revealed that dairy farmers using integrated feeding systems combining commercial feed with locally grown fodder crops achieved 15 % higher milk yields. Green fodder from Hybrid Napier provided 18-20 % crude protein content, while lucerne contributed essential minerals and vitamins. However, only 35 % of farmers maintained dedicated fodder plots, indicating potential for improvement in farm-grown feed resources.

Constraints faced by dairy farmers in the purchase and usage of different animal feed brands

Consumers face constraints such as cattle feed acceptance, health impact, low milk yield, high price, poor quality, credit availability, packaging, knowledge, market availability and last-mile delivery. These were analyzed using Garrett's ranking technique and presented in Table 8. Adequate and balanced nutrition is essential for maximizing milk production in dairy cattle (17). So, understanding the constraints in the purchase of feed could help us know the importance of feed. It could be inferred from Table 8 that the major constraint faced by the sample respondents in the purchase and usage of cattle feed was a lack of acceptance of feed by cattle, followed by the negative impact on the health of the cattle, less impact of the cattle feed on milk yield, high price of the cattle feed, poor quality of the feed, lack of credit availability for the purchase of cattle feed, improper packaging of feed, poor knowledge of cattle feed, poor availability of cattle feed in the market and poor last-mile delivery.

Conclusion

Cattle farmers in the region strongly prefer pellet feeds over mash, primarily purchased from feed distributor shops using cash. Product-related factors significantly influence their choices, accounting for nearly 20 % of preference variations. Dairy farming in the area is profitable, with a benefit-cost ratio of 1.28. Product lifespan, diversity, labelling, quality control and palatability are crucial factor for purchase of feed. Integrating scientifically managed fodder crop production with commercial feed usage can optimize feed costs and enhance farm sustainability. Future research should prioritize drought-resistant fodder varieties and improved fodder crop management practices to boost profitability. This integration presents a sustainable model for dairy farming in Tamil Nadu, with proper selection and management of fodder crops significantly reducing feed costs while maintaining milk production. Improving feeding systems, including integrating fodder and commercial feeds, is crucial for enhancing cattle production efficiency and milk yield. Farmers face constraints such as cattle acceptance, health impacts, milk yield, prices, quality, credit, packaging, knowledge, availability and last-mile delivery, which must be addressed to improve dairy farming efficiency and profitability.

Acknowledgements

The authors would like to thank all the dairy farmers in the Ariyalur and Perambalur districts, the Joint Directorate of Agriculture and Tamil Nadu Agricultural University for their valuable support and provision of necessary information and facilities for conducting this research.

Table 8. Constraints faced by dairy farmers in the purchase and usage of cattle feed

S. No	Constraints	Garrett score	Ranking
1.	Lack of acceptance of feed by cattle	74.65	1
2.	Negative impact on the health of the cattle	71.55	2
3.	Less impact of the cattle feed on milk yield	65.35	3
4.	The high price of the cattle feed	63.65	4
5.	Poor quality of the feed	60.95	5
6.	Lack of credit availability for cattle feed	51.50	6
7.	Improper packaging of feed	49.95	7
8.	Poor knowledge of cattle feed	48.00	8
9.	Poor availability of cattle feed in the market	41.10	9
10.	Poor last-mile delivery	23.30	10

Authors' contributions

JR and CV conceived and designed the study and performed the experiments; RP analyzed the data, JR and AR wrote and corrected the paper and SM performed a critical reading of the manuscript.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interest to declare.

Ethical issues: None

Declaration of generative AI and AI-assisted technologies in the writing process

While preparing this work, the authors used Gemini AI to improve language. After using this tool/service, the authors reviewed and edited the content as needed and will take full responsibility for the publications' content.

References

1. Press Information Bureau. Union Minister Shri Parshottam Rupala releases Basic Animal Husbandry Statistics 2023 during the National Milk Day event at Guwahati today [internet]; 2023.[cited 2024 18 Sept]. Available from: https://pib.gov.in
2. National Dairy Development Board. Per capita availability milk by states and UTs [internet]; 2023.[cited 2024 18 Sept]. Available from: https://agri.gujarat.gov.in
3. Government of India, Indian Council of Medical Research. Dietary Guidelines for Indians - A Manual [internet]; 2011.[cited 2024 18 Sept]. Available from: https://www.nin.res.in
4. Government of India, Department of Animal Husbandry and Dairying. Rashtriya Gokul Mission [internet]; 2023. [cited 2024 18 Sept]. Available from: https://agri.gujarat.gov.in
5. Roy AK, Agrawal RK et al. Revisiting national forage demand and availability scenario. In: Roy AK, Agrawal RK, Bhardwaj NR, editors. Indian fodder scenario: redefining state-wise status. Jhansi: ICAR-AICRP on forage crops and utilization; 2019. p. 1-21.
6. Misra AK. Fodder production and utilization strategies for sustainable livestock development in India. Annals of Arid Zone. 2019;58(1)11-2.
7. Agritech portal. TNAU Expert system for cattle and buffalo-Fodder production [internet]; 2023.[cited 2024 18 Sept]. Available from: https://agritech.tnau.ac.in
8. Ressaissi N, Sanchez-Ballesta MT. Badri M. Influence of drought and heat stresses in fodder legumes productivity and nutritive value. Journal of Oasis Agriculture and Sustainable Development. 2023;5 (2):18-26. http://doi.org/10.56027/joasd.092023
9. Wakchaure R, Ganguly S, Para PA, Praveen PK, Kumar A, Sharma S. Development of crossbred cattle in India: a review. International Journal of Emerging Technology and Advanced Engineering. 2015;5 (10):75-7. https://doi.org/10.21746/ijbio.2016.10.006
10. Pouchepparadjou A, Paradis G, Swaminathan N, Venkatesan S, Umamaheswari L. Adoption of dairy farming practices and productivity status of milch cows in the Union Territory of Puducherry. The Indian Journal of Animal Sciences;94(7):642-5. https://doi.org/10.56093/ijans.v94i7.150359
11. Agritech portal, TNAU. Breeds of Cattle Animal Husbandry [internet]; 2023.[cited 2024 18 Sept]. Available from: https://agritech.tnau.ac.in
12. Cantillon M, Hennessy T, Amon B, Dragoni F, O'Brien D. Mitigation of gaseous emissions from dairy livestock: A farm-level method to examine the financial implications. Journal of Environmental Management. 2024;352:119904. https://doi.org/10.1016/j.jenvman.2023.119904
13. John H, Kevin H, Jessica M, Evgenia M. Factors influencing dairy farmers' adoption of best management grazing practices. Land Use Policy. 2018;78:562-71. https://doi.org/10.1016/j.landusepol.2018.07.006
14. Molla A, Abebe A, Balew M, Assefa D, Kehali S. Analysis of farmers' perception and constraints on dairy cooperatives in Amhara region, Ethiopia. International Journal on Food, Agriculture and Natural Resources. 2024;5(2):129-39. https://doi.org/10.46676/ij-fanres.v5i2.331
15. Mandal RK, Kumar S, Ray RK, Kumar A, Kumari S, Bhawar R. Economics of milk production of local cows in Bhagalpur district of Bihar. Economic Affairs. 2024;69(2):873-81. https://doi.org/10.46852/0424-2513.3.2024.12
16. Swarnkar R, Sengar RS, Roy G, Nirala PS, Ogre R. Cost-benefit analysis of Dairy Cooperative members worked under Chhattisgarh State Cooperative Dairy Federation Limited in Raipur district (CG). International Journal of Veterinary Sciences and Animal Husbandry, 2023;8(5):289-91. https://doi.org/10.22271/veterinary.2023.v8.i5Se.782
17. Patel J, Kumar S. Climate resilient agriculture practices-The future of farming. Plant Science Today. 2022;9(3):63-70. https://doi.org/10.14719/pst.1835