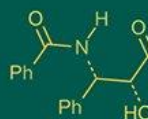


## International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693  
ISSN Online: 2617-4707  
NAAS Rating (2026): 5.29  
IJABR 2026; 10(9): 280-285  
[www.biochemjournal.com](http://www.biochemjournal.com)  
Received: 25-06-2026  
Accepted: 29-07-2026

**Yuvraj Singh**  
Department of Animal  
Nutrition, College of  
Veterinary Science, Guru  
Angad Dev Veterinary and  
Animal Sciences University,  
Ludhiana, Punjab, India

**Gursimranjit Singh**  
Department of Veterinary and  
Animal Husbandry Extension  
Education, College of  
Veterinary Science, Guru  
Angad Dev Veterinary and  
Animal Sciences University,  
Ludhiana, Punjab, India

**Rajankumar H Kalola**  
Department of Animal  
Nutrition, College of  
Veterinary Science, Guru  
Angad Dev Veterinary and  
Animal Sciences University,  
Ludhiana, Punjab, India

**Anurag Kataria**  
Department of Animal  
Nutrition, College of  
Veterinary Science, Guru  
Angad Dev Veterinary and  
Animal Sciences University,  
Ludhiana, Punjab, India

**Guriqbal Singh Brar**  
Department of Animal  
Nutrition, College of  
Veterinary Science, Guru  
Angad Dev Veterinary and  
Animal Sciences University,  
Ludhiana, Punjab, India

**Corresponding Author:**  
**Rajankumar H Kalola**  
Department of Animal  
Nutrition, College of  
Veterinary Science, Guru  
Angad Dev Veterinary and  
Animal Sciences University,  
Ludhiana, Punjab, India

## Constraints faced by dairy farmers in adoption of nutritional technologies in the indo-Pak border region of Punjab

**Yuvraj Singh, Gursimranjit Singh, Rajankumar H Kalola, Anurag Kataria and Guriqbal Singh Brar**

DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i9d.9942>

### Abstract

The present study was conducted to assess the constraints faced by dairy farmers in the adoption of improved nutritional technologies in the border region of Fazilka district, Punjab. The study was carried out from April to June 2026 in five villages located within a 10-km belt along the Indo-Pakistan International border. A total of 100 dairy farmers were selected through random sampling and data were collected using a pre-tested interview schedule. Constraints were assessed for six nutritional technologies namely green fodder, silage, self-prepared concentrate, commercial concentrate, feed additives and supplements, and feed testing. The findings revealed that year-round unavailability of green fodder was the major constraint to green fodder adoption as reported by 84% of the respondents. For silage, inadequate training on silage preparation was the most prominent constraint (74%). Time-consuming preparation was the leading constraint in adoption of self-prepared concentrate (87%), whereas high cost of commercial concentrate was the major constraint for commercial concentrate adoption (74%). High cost of feed additives and supplements was reported by 52% of respondents while inadequate awareness about feed testing was the most frequently perceived constraint to feed testing (77%). Overall, the findings indicate that dairy farmers in the border region face a combination of resource, economic, technical and knowledge-related constraints. Addressing these limitations through locally relevant extension support, training and accessible technical services may facilitate wider adoption of improved nutritional technologies.

**Keywords:** Dairy farmers, nutritional technologies, adoption, constraints, green fodder

### 1. Introduction

India became the world's leading milk producer in 1998, surpassing the United States of America and has continued to be the largest producer of milk since then. India contributes nearly 25% of global milk production (Kona *et al.*, 2025) <sup>[14]</sup>. The livestock sector contributes 5.2% to the GDP of the nation and the dairy sector contributes nearly 66.56% to the livestock sector. Since independence, the livestock sector has remained an integral part of the rural economy. The dairy sector provides regular cash income, nutritional security and employment to farm households. At the national level, 65 to 70% of these households are characterised as landless, marginal and small farmers (Sarkar *et al.*, 2024) <sup>[26]</sup>. It also plays an important role in women's empowerment as women constitute approximately 70% of the workforce engaged in the livestock sector (Shilpa Shree and Prabu, 2019) <sup>[28]</sup>.

Success in dairy production depends on feeding, housing, breeding and management practices. Among these factors, nutrition plays a pivotal role in determining the production, reproductive performance and health of dairy animals as well as contributing to environmental sustainability (Kavitha *et al.*, 2020) <sup>[13]</sup>. Adequate provision of green fodder can contribute to improved milk production in dairy animals (Mishra *et al.*, 2024) <sup>[19]</sup>. Improved nutritional practices also have the potential to substantially reduce enteric methane emissions from livestock with reductions of up to 60% under certain nutritional interventions (Hristov, 2024) <sup>[8]</sup>. Supplementation with bypass fat and bypass protein has been reported to improve milk yield, nutrient utilisation and immune function (Ganai *et al.*, 2019) <sup>[7]</sup>. Similarly, adequate supplementation of vitamins and minerals can have significant positive effects on immunity, reproduction and production performance (Ahmad *et al.*, 2022) <sup>[2]</sup>.

Despite the potential benefits of improved nutritional technologies, their adoption among dairy farmers may remain limited. Non-adoption of improved nutritional technologies and continued reliance on traditional practices may result in reduced productivity and lower economic returns from dairy production (Kaur & Toor, 2022) <sup>[12]</sup>. Non-adoption of such technologies may be attributed to a range of factors that act as constraints to their adoption. Constraints in the adoption of nutritional technologies may include non-availability of feed, purchasing power limitations, inadequate economic returns, knowledge gaps, poor infrastructure and other technical and institutional factors as reported by various studies (Adhikari *et al.*, 2020) <sup>[1]</sup>.

The dairy sector across the states of India has not developed uniformly over time. States such as Punjab, Kerala, Haryana, Goa and Gujarat are categorised as progressive dairy states (Kale *et al.*, 2016) <sup>[9]</sup>. The dairy sector of Punjab is among the most advanced in terms of technology and genetic potential. Punjab not only ranks first in per capita milk availability but also contributes approximately 6.7% of the total milk production of India while accounting for only 2.53% of the country's dairy animals (Kaur *et al.*, 2022) <sup>[11]</sup>. However, the level of dairy production and modernisation is not uniform across all districts of Punjab. Border regions of developing countries face greater challenges related to infrastructure, accessibility and availability of institutional and technical services compared with mainland regions. Punjab has six districts sharing an international border with Pakistan and Fazilka is one of these border districts (Singh *et al.*, 2022) <sup>[30]</sup>. However, limited literature is available regarding the constraints faced by dairy farmers in the adoption of improved nutritional technologies and practices in Fazilka district. Therefore, the present study was undertaken to assess the constraints faced by dairy farmers in the adoption of improved nutritional technologies in the border region of Fazilka district. The findings of the study may provide useful insights for extension agencies and policymakers in developing appropriate interventions to address the constraints faced by dairy farmers in the region.

## 2. Materials and Methods

The study was conducted in the border region of Fazilka district, Punjab, to explore the constraints faced by dairy farmers in the adoption of nutritional technologies. The study was carried out from April to June, 2026. Fazilka district was selected because of the limited literature available on the constraints associated with the adoption of nutritional technologies among dairy farmers in this region. Furthermore, the area falling within a 10-km belt along the Indo-Pakistan border was purposively selected, as, to the best of our knowledge, limited studies have previously examined the constraints associated with the adoption of nutritional technologies among dairy farmers in this specific region. Five villages namely Bandiwala, Sabuana, Shatirwala, Siwana and Tilanwali, falling within the border belt were randomly selected for the study. 20 respondents from each village were selected randomly, with the inclusion criterion that each respondent owned at least one cattle or buffalo. Thus, a total of 100 respondents were selected. Socio-economic characteristics of the respondents were also recorded. A list of possible constraints affecting the adoption of improved nutritional technologies was prepared based on a review of relevant literature and the

objectives of the study. The identified constraints were classified into six major technology-specific categories, namely green fodder, silage, self-prepared concentrate, commercial concentrate, feed additives and supplements, and feed testing. Data were collected from the selected dairy farmers using a pre-tested, structured interview schedule. For each nutritional technology, respondents were presented with the relevant list of possible constraints and were asked to indicate whether they perceived each constraint as a valid barrier to its adoption. For each constraint, responses were recorded dichotomously as 'Yes' or 'No'. The frequency of respondents reporting a particular constraint was calculated within each technology category. The constraints were then ranked in descending order of frequency, with the constraint reported by the highest proportion of respondents receiving Rank I, followed by subsequent ranks (Karthikeyan *et al.*, 2018) <sup>[10]</sup>. The frequency and corresponding percentage of respondents reporting each constraint were calculated and the results were systematically compiled and presented in tabular form.

## 3. Results and Discussion

### 3.1 Socio-economic characteristics

The socio-economic characteristics as well as dairy Farming profile of the respondents from the study are summarised in table 1. Among the respondents, 96% were male and 4% were female. These findings were in contrast to Tudu and Roy (2015) <sup>[31]</sup> where they found that majority (61.2%) of the respondents were female. Regarding age, 30% of the respondents were below 30 years of age, 25% belonged to the 31-40 years age group, and the remaining 45% were above 40 years of age. In another study by Mahesh *et al.* (2020) <sup>[17]</sup> 63% of the respondents belonged to middle age category of age 36-45. In terms of educational qualification, 9% of the respondents were illiterate, while 36%, 31% and 24% had education up to high school(10th), higher secondary(12th) and graduation or above respectively. These finds were same as found by Devansh *et al.* (2023) <sup>[6]</sup> were majority (64.67%) of the respondents studied up to the high school. With respect to landholding, 12% of the respondents were landless, whereas 64%, 18%, and 6% belonged to the small, medium and large landholding categories respectively. Crop farming was the major source of income for most of the respondents, while 5% reported dairy farming as their primary source of income. Dairy and crop farming contributed equally to the income of 18% of the respondents, whereas 11% were primarily engaged in other income-generating activities. Out of the 100 respondents, 18% had received formal training related to livestock production, while the remaining 82% had not received any formal livestock-related training. In the study by Devansh *et al.* (2023) <sup>[6]</sup> only 30% of the respondents received training about livestock.

### 3.2 Dairy Farming Profile of the Respondents

Regarding livestock composition, 49% of the respondents reared only cows, 11% reared only buffaloes and 40% reared both cows and buffaloes. These were in line with the study conducted by Kumar *et al.* (2020) <sup>[15]</sup> where only buffalo rearing farmers were 36.80%, only cow rearing were 53.90% and those who reared both were only 9.30% of the total. In terms of herd size, 50% of the respondents maintained herds of fewer than five animals, while 39% and 7% maintained herds of 5-10 and 11-15 animals

respectively. Only 4% of the respondents maintained herds comprising more than 15 animals. It has been estimated that nearly 75 million farmers in India rear less than 5 milk animals each (Kona *et al.*, 2025) <sup>[14]</sup>. With regard to total milk production, 25% of the respondents reported milk production of less than 10 L/day, whereas 31%, 18% and 7% reported production levels of 10-20, 21-30 and 31-40 L/day respectively. A comparatively higher level of milk production, more than 40 L/day, was reported by 19% of the respondents.

**Table 1: Socio-economic Characteristics and Dairy Farming Profile of the Respondents**

| Variable                            | Classification                        | Percentage (%) |
|-------------------------------------|---------------------------------------|----------------|
| Gender                              | Male                                  | 96             |
|                                     | Female                                | 4              |
| Age                                 | ≤30 years (young)                     | 30             |
|                                     | 31-40 years (middle)                  | 25             |
|                                     | >40 years (old)                       | 45             |
| Educational qualification           | Illiterate                            | 9              |
|                                     | Up to high school (10 <sup>th</sup> ) | 36             |
|                                     | Higher secondary (12 <sup>th</sup> )  | 31             |
| Primary occupation                  | Graduation or above                   | 24             |
|                                     | Crop farming                          | 66             |
|                                     | Dairy farming                         | 5              |
| Landholding                         | Mixed farming                         | 18             |
|                                     | Others                                | 11             |
|                                     | Landless (0 acre)                     | 12             |
| Training                            | Small (≤10 acres)                     | 64             |
|                                     | Medium (11-20 acres)                  | 18             |
|                                     | Large (>20 acres)                     | 6              |
| Herd size                           | Trained                               | 18             |
|                                     | Not trained                           | 82             |
|                                     | <5 animals                            | 50             |
| Total milk production               | 5-10 animals                          | 39             |
|                                     | 11-15 animals                         | 7              |
|                                     | >15 animals                           | 4              |
| Livestock type                      | <10 L/day                             | 25             |
|                                     | 10-20 L/day                           | 31             |
|                                     | 21-30 L/day                           | 18             |
| Year-round unavailability of fodder | 31-40 L/day                           | 7              |
|                                     | >40 L/day                             | 19             |
|                                     | Cows only                             | 49             |
| Both cows and buffaloes             | Buffaloes only                        | 11             |
|                                     |                                       | 40             |

### 3.3 Constraints faced by the respondents in adoption of nutritional technologies

**Table 2: Constraints in adoption of green fodder**

| Constraint                                 | Respondents% | Rank |
|--------------------------------------------|--------------|------|
| Inadequate knowledge of fodder productions | 5            | V    |
| Labour scarcity                            | 32           | IV   |
| Limited availability of grazing land       | 50           | II   |
| Limited land for fodder cultivation        | 40           | III  |
| Transportation constraints                 | 4            | VI   |
| Year-round unavailability of fodder        | 84           | I    |

Regarding the constraints in adoption of green fodder (Table 2), it was observed that the majority (84%) of the respondents reported year-round unavailability of fodder as the main constraint in adoption of green fodder. Same was reported by Adhikari *et al.* (2020) <sup>[1]</sup>, where 100% of respondents reported non-availability of green fodder throughout the year. Transportation constraints were ranked at last (6<sup>th</sup>) as a constraint in adoption of green fodder as

reported by 4% of the respondents only. Limited availability of grazing land, limited land for fodder cultivation and labour scarcity were ranked at 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> rank as reported by 50%, 40% and 32% of the respondents respectively. In a study by Pawar *et al.* (2019) <sup>[23]</sup>, 82.50% respondents mentioned non-availability of land for cultivation of fodder crops as a constraint in adoption of green fodder. Lack of grazing land was reported as constraint by 59% of the respondents in a study by Singh *et al.* (2017) <sup>[29]</sup>. Inadequate knowledge for fodder production was reported as constraint by 63.33% respondents in a study conducted by Patel and Sabapara (2023) <sup>[21]</sup>.

**Table 3: Constraints in adoption of silage**

| Constraint                                | Respondents% | Rank |
|-------------------------------------------|--------------|------|
| Fear of spoilage                          | 29           | VI   |
| High cost of silage preparation           | 53           | III  |
| Inadequate storage infrastructure         | 13           | VIII |
| Inadequate training on silage preparation | 74           | I    |
| Insufficient herd size                    | 63           | II   |
| Labour scarcity                           | 23           | VII  |
| Limited access to silage-making machinery | 36           | IV   |
| Limited availability of quality seed      | 1            | IX   |
| Limited land availability for production  | 34           | V    |

In the adoption of silage feeding (Table 3), inadequate training on silage preparation was ranked at first position as it was perceived as constraint by 74% of the respondents. These findings were in line with findings of Sabapara and Fulsoundar (2015) <sup>[25]</sup>, where 64% respondents lacked knowledge on silage preparation. Insufficient herd size and high cost of preparation were the next at 2<sup>nd</sup> and 3<sup>rd</sup> rank as reported by 63% and 53% of the respondents as constraint in adoption silage feeding. In a study by Reiber *et al.* (2010) <sup>[24]</sup>, more than 30% of medium farmers perceived silage as expensive. Following constraints were limited machinery, limited land and fear of spoilage. Nearly 40% of the respondents dependent on loaned equipment for silage making in a study by Bernardes and do Rêgo (2014) <sup>[3]</sup>. Limited availability of quality seed was the least (1%) reported constraint and hence ranked last at 9<sup>th</sup> place. Constraints like labour scarcity and inadequate storage infrastructure was mentioned by 23% and 13% of the total respondents, hence ranked at 7<sup>th</sup> and 8<sup>th</sup> place respectively.

**Table 4: Constraints in adoption of self-prepared concentrate**

| Constraint                               | Respondents% | Rank |
|------------------------------------------|--------------|------|
| High cost of raw materials               | 39           | IV   |
| Time-consuming preparation process       | 87           | I    |
| Inadequate knowledge in feed formulation | 59           | III  |
| Limited access to feed mills             | 8            | VIII |
| Limited availability of raw materials    | 12           | VII  |
| Limited credibility of local feed mills  | 16           | V    |
| Poor raw material quality                | 14           | VI   |
| Small herd size                          | 60           | II   |

In the context of constraints faced in adoption of self-prepared concentrate (table 4), time required for preparation was ranked as the most faced constraint as reported by 87% of the respondents. At 2<sup>nd</sup> and 3<sup>rd</sup> place were placed small herd size and inadequate knowledge in feed formulation by 60% and 59% of the respondents. Then followed other constraints as reported by 39%, 16% and 14% of the respondents, were high cost of raw materials, limited

credibility of local mills and poor raw material quality respectively. In a study conducted by Patel *et al.* (2016) [20], high cost of ingredients was ranked as first constraint as reported by 62.5% of the respondents. Only 12% and 8% of the respondents reported limited availability of raw material and limited access to feed mills as constraints, making them to rank last in the list. Non-availability of machines and lack of technical guidance was reported by 95.3 and 69.3% of the respondents (Chavan, 2015) [4].

**Table 5:** Constraints in adoption of commercial concentrate

| Constraint                               | Respondents% | Rank |
|------------------------------------------|--------------|------|
| Concerns regarding adulteration          | 68           | II   |
| Difficulty in commercial brand selection | 23           | IV   |
| High cost of commercial concentrate      | 74           | I    |
| Inadequate awareness                     | 3            | VI   |
| Lack of perceived effectiveness          | 19           | V    |
| Low perceived economic returns           | 28           | III  |

Most of the respondents (74%) regarded high cost of commercial concentrate as constraint in its adoption as mentioned in table 5. Similar findings were reported by Matre *et al.* (2020) [18], where 80% of the respondents reported high cost of commercial concentrate as constraint in its adoption. Adulteration concerns and low economic return was perceived as constraint by 68% and 28% of the respondents gaining it 2<sup>nd</sup> and 3<sup>rd</sup> rank. Adulteration as constraint was ranked 12<sup>th</sup> among 15 constraints in adoption of concentrate feeding in a study by Kumar *et al.* (2014) [16].

**Table 7:** Constraints in adoption of feed testing

| Constraint                                        | Respondents% | Rank |
|---------------------------------------------------|--------------|------|
| Concerns regarding test-result credibility        | 7            | V    |
| High cost of feed testing                         | 12           | IV   |
| Inadequate awareness about feed testing           | 77           | I    |
| Limited availability of feed-testing laboratories | 61           | III  |
| Low perceived need for feed testing               | 73           | II   |

Regarding the adoption of feed testing (table 7), awareness was the most frequent reported constraint as reported by 77% of the respondents. Low perceived need for feed testing and limited local laboratories was ranked 2<sup>nd</sup> and 3<sup>rd</sup> in the constraints list. Only 12% and 7% of the respondents perceived high cost of feed testing and result credibility as constraints in adoption of feed testing, thus finding the

Difficulty in brand selection and low effectiveness ranked 4<sup>th</sup> and 5<sup>th</sup> respectively as they were reported as constraints by 23% and 19% of the respondents. Inadequate awareness was not perceived as constraint by most of the respondents but by 3% only, gaining it the last rank at 6<sup>th</sup> in the list.

**Table 6:** Constraints in adoption of Feed additives and supplements

| Constraint                                  | Respondents% | Rank |
|---------------------------------------------|--------------|------|
| Doubts regarding product effectiveness      | 26           | III  |
| High cost of feed additives and supplements | 52           | I    |
| Inadequate knowledge of usage               | 43           | II   |
| Inconsistent outcomes after use             | 13           | V    |
| Limited market availability                 | 22           | IV   |

High cost of feed additives and supplements (table 6) was perceived as a constraint in their adoption by almost half (52%) of the respondents and thus ranked as 1<sup>st</sup> in the list based on frequency. Same was reported by nearly 90% of the respondents in a study by Chiphwanya *et al.* (2026) [5]. It was followed by inadequate knowledge of usage, doubt regarding effectiveness and limited availability in local market as constraints reported by 43%, 26% and 22% of the respondents in adoption of feed additives and supplements. Non availability in local market and limited usage knowledge were reported as constraints by 95% and 92.5% of the respondents in a study by Sharma (2015) [27]. Least frequent constraint was inconsistent outcomes, reported by 13% of the respondents and ranked last.

bottom of the list respectively. Lab testing of feed is very pivotal as 58% samples in a study by Patyal *et al.* (2021) [22] exceeded same limits for aflatoxins in the feed. Table 8 summarize the top constraints faced by the dairy farmers of border region of Fazilka in adoption of improved nutritional technologies.

**Table 8:** Top Constraints Faced by Dairy Farmers in Adoption of Nutritional Technologies

| Rank | Nutritional technology    | Constraint                                        | Respondents (%) |
|------|---------------------------|---------------------------------------------------|-----------------|
| I    | Self-prepared concentrate | Time-consuming preparation process                | 87              |
| II   | Green fodder              | Year-round unavailability of fodder               | 84              |
| III  | Feed testing              | Inadequate awareness about feed testing           | 77              |
| IV   | Silage                    | Inadequate training on silage preparation         | 74              |
| V    | Commercial concentrate    | High cost of commercial concentrate               | 74              |
| VI   | Feed testing              | Low perceived need for feed testing               | 73              |
| VII  | Commercial concentrate    | Concerns regarding adulteration                   | 68              |
| VIII | Silage                    | Insufficient herd size                            | 63              |
| IX   | Feed testing              | Limited availability of feed-testing laboratories | 61              |
| X    | Self-prepared concentrate | Small herd size                                   | 60              |

#### 4. Conclusion

The study revealed that the dairy farmers in the border region of Fazilka, Punjab face diverse constraints in adopting improved nutritional technologies. The nature of constraints differed across technologies, with fodder

availability, lack of training, time requirement, high input costs and inadequate awareness emerging as important barriers. The findings suggest that improving adoption cannot depend on a single intervention. Greater emphasis should be placed on practical training, timely availability of

quality inputs, affordable nutritional resources, improved access to technical services and greater awareness regarding feed testing and safe feed use. Extension agencies and other stakeholders should consider the specific needs of farmers while developing interventions for the border region. Such efforts may help reduce adoption barriers and encourage more effective use of improved nutritional practices in dairy farming.

## 5. Acknowledgement

The authors express their sincere gratitude to the dairy farmers of Fazilka district, Punjab, for their enthusiastic participation and cooperation during the study.

## 6. Conflict of Interest

The authors declare that they have no conflict of interest

## 7. Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

## References

- Adhikari B, Chauhan A, Bhardwaj N, Kameswari VLV. Constraints faced by dairy farmers in hill region of Uttarakhand. *Indian J Dairy Sci.* 2020;73(5):464-470. doi:10.33785/IJDS.2020.v73i05.012.
- Ahmad M, Waheed MH, Mobashar M, Hussain F, Younis HMB. Effect of different vitamins and mineral premix supplementations on milk yield and composition in dairy cows. *Jammu Kashmir J Agric.* 2022;2(2):23-32. doi:10.56810/jkjagri.002.02.0039.
- Bernardes TF, do Rêgo AC. Study on the practices of silage production and utilization on Brazilian dairy farms. *Journal of Dairy Science.* 2014;97(3):1852-1861. doi:10.3168/jds.2013-7181.
- Chavan SS. Perceived attributes of home made concentrate technique adopted by buffalo dairy entrepreneurs in periurban area of Marathwada region of Maharashtra State [M.V.Sc. thesis]. Nagpur: Maharashtra Animal and Fishery Sciences University; 2015.
- Chiphwanya M, Chingala G, Chiumia D, Chigwa F. Unveiling practices and challenges in trace mineral supplementation: insights from small-scale dairy farms in Malawi. *Tropical Animal Health and Production.* 2026;58:394. doi:10.1007/s11250-026-05185-5.
- Devansh, Kasrija R, Jadoun YS, Sharma RK. An overview of knowledge level of dairy farmers of Punjab regarding genital prolapse condition. *Haryana Vet.* 2023;62(SI-2):100-104.
- Ganai AM, Haq Z, Beigh YA, Sheikh GG. Bypass nutrient technology with recent advances for enhancing animal production: a review. *J Pharmacogn Phytochem.* 2019;SP5:269-275.
- Hristov AN. Invited review: Advances in nutrition and feed additives to mitigate enteric methane emissions. *J Dairy Sci.* 2024;107(7):4129-4146. doi:10.3168/jds.2023-24440.
- Kale RB, Ponnusamy K, Chakravarty AK, Sendhil R, Mohammad A. Assessing resource and infrastructure disparities to strengthen Indian dairy sector. *Indian J Anim Sci.* 2016;86(6):720-725. doi:10.56093/ijans.v86i6.59240.
- Karthikeyan S, Arunmozhi Devi MC, Narmatha N, Uma V, Thirunavukkarasu D. Profile of the dairy farmers and the constraints faced by them in utilizing different dairy service delivery systems. *Int J Agric Sci.* 2018;10(16):7000-7002.
- Kaur H, Kaur I, Singh VP, Wakchaure NS. Economic analysis of different milk products manufacture at farms in Punjab State. *Indian J Dairy Sci.* 2022;75(2):181-189. doi:10.33785/IJDS.2022.v75i02.013.
- Kaur N, Toor JS. Management practices followed by dairy farmers in rural Punjab. *J Livestock Sci.* 2022;13:164-170. doi:10.33259/JLivestSci.2022.164-170.
- Kavithaa NV, Vimal Rajkumar N, Manokaran S. Constraints in dairy farming: a critical analysis among the dairy farmers of Tamil Nadu. *Int J Sci Environ Technol.* 2020;9(3):407-412.
- Kona SSR, Ravikiran G, Sasidhar PVK, Sivakumar AVN, Rao VH. Perspectives in milk production in India. *Theriogenology.* 2025;231:116-126. doi:10.1016/j.theriogenology.2024.10.001.
- Kumar A, Mishra AK, Saroj S, Sonkar VK, Thapa G, Joshi PK. Food safety measures and food security of smallholder dairy farmers: empirical evidence from Bihar, India. *Agribusiness.* 2020;36:363-384. doi:10.1002/agr.21643.
- Kumar N, Bishnoi P, Bishnoi DK, Kumar J. Constraints analysis in adoption of improved dairy farming practices in Haryana, India. *Asian Journal of Dairy & Food Research.* 2014;33(2):136-140. doi:10.5958/0976-0563.2014.00590.9.
- Mahesh, Manjunath, Kumar KA, Kale S, Barikar U, Sreenivas BV. Socio-economic profile analysis of dairy farmers of Yadgir district of Kalyana Karnataka region. *J Pharmacogn Phytochem.* 2020;Sp 9(4):350-353.
- Matre P, Tarde VJ, Sonawane HP. Constraints faced by the dairy farmers in breeding, feeding and management practices. *Gujarat Journal of Extension Education.* 2020;31(1):39-40.
- Mishra S, Dixit S, Singh TP, Tripathi V, Singh J. Production of green fodder: a way to increase milk productivity and strengthen dairy farming in India. *Int J Agric Environ Biotechnol.* 2024;17(4):743-748. doi:10.30954/0974-1712.04.2024.13.
- Patel NK, Ashwar BK, Seikha AS, Modh VR, Khanushiya AF, Chaudhary JD. Constraints experienced by commercial dairy farm owners in Aravalli district of North Gujarat. *Advances in Life Sciences.* 2016;5(12):5106-5109.
- Patel PC, Sabapara GP. Constraints faced by dairy farmers for adoption of improved dairy husbandry practices in Valsad district of Gujarat. *Indian Journal of Animal Production Management.* 2023;37(1):7-11.
- Patyal A, Gill JPS, Bedi JS, Aulakh RS. Assessment of aflatoxin contamination in dairy animal concentrate feed from Punjab, India. *Environmental Science and Pollution Research.* 2021;28:37705-37715. doi:10.1007/s11356-021-13321-x.
- Pawar MM, Ashwar BK, Joshi PC, Patil SS, Madhavatar MP, Thakkar NK, et al. Constraints perceived about fodder production by the dairy farmers of North Gujarat. *Indian Journal of Dairy Science.* 2019;72(5):565-568. doi:10.33785/IJDS.2019.v72i05.016.

24. Reiber C, Schultze-Kraft R, Peters M, Lentjes P, Hoffmann V. Promotion and adoption of silage technologies in drought-constrained areas of Honduras. *Tropical Grasslands*. 2010;44:231-245.
25. Sabapara GP, Fulsoundar AB. Adoption level of improved dairy husbandry practices and constraints in rural areas of Surat district. *Indian Journal of Animal Production Management*. 2015;31(3-4):1-5.
26. Sarkar A, Gupta H, Dutta A. Sustainable dairy sector of an emerging economy: an empirical quest based on India. *Agric Syst*. 2024;218:103970. doi:10.1016/j.agry.2024.103970.
27. Sharma M. Bottlenecks in adoption of feeding practices for dairy animals in district Kapurthala. *J Krishi Vigyan*. 2015;3(2):12-18. doi:10.5958/2349-4433.2015.00004.5.
28. Shilpa Shree J, Prabu M. An outlook on growth of dairy sector and its contribution to Indian economy. *Int J Livest Res*. 2019;9(6):240-247. doi:10.5455/ijlr.20190304061536.
29. Singh AK, Gupta J, Singh M, Patel D. Constraints faced by the dairy farmers in adopting good farming practices in Uttar Pradesh. *International Journal of Agricultural Science and Research*. 2017;7(4):123-130.
30. Singh J, Kingra HS, Saini R, Kaur M, Mavi HK. Economic status of farming in border districts of Punjab. *J Krishi Vigyan*. 2022;10(2):68-77.
31. Tudu NK, Roy DC. Demographic profile and management practices of dairy farmers in Nadia district of West Bengal. *Int J Inf Res Rev*. 2015;2(3):521-524.