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Awareness and Adoption of Nutritional Technologies in Border-belt Dairy Systems of Punjab

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ABSTRACT

The study was conducted from April-June, 2026 within the 10 km belt along the Indo-Pak international border of Fazilkadistrict, Punjab state, India to assess the awareness and adoption of 17 nutritional technologies among 100 dairy farmers across five villages. Data were collected through a pre-tested interview schedule covering socio-personal and socio-economic characteristics and the awareness and adoption status of each nutritional technology. The relationships between selected variables and the awareness and adoption of feeding technologies were also statistically analysed. Results showed that most farmers fell into the medium awareness category, with silage, salt lick, mineral mixture and buffer being the most widely recognised technologies, while balanced feeding and advanced feed additives such as choline and betaine remained largely unfamiliar. A clear gap was observed between awareness and actual adoption.Salt lick, mineral mixture and buffer ranked highest in adoption, whereas silage despite near-universal awareness was seldom adopted on a regular basis. Only 18% of respondents had received formal training, yet trained farmers showed substantially higher awareness and adoption scores than untrained farmers. Education level was positively correlated with both awareness and adoption. Multiple regression analysis identified training, landholding size and milk yield as significant predictors of adoption.The findings highlighted a persistent awareness-adoption gap and emphasised the need for targeted extension services and farmer training programmes to enhance the adoption of nutritional technologies, thereby improving productivity and livelihood security among dairy farmers in this border region.

KEYWORDS: Nutritional technologies, awareness, adoption, border-belt

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1. INTRODUCTION

Livestock plays an important role in the livelihoods of rural people in India by acting as a source of daily cash flow along with providing nutritional security (Verma and Singh, 2026). As per 20th livestock census, India had a livestock population of 193 million cattle and 110 million buffaloes. Within this national framework, Punjab had approximately 25.31 lakh cattle and 40.15 lakh buffaloes (Anonymous, 2019). Punjab is considered one of the leading states in milk production as well as dairying (Singh et al., 2015).

Feeding and nutrition account for nearly 60–70% of the total cost of milk production and are major determinants of dairy productivity. Adoption of improved nutritional technologies enhances milk production, reproductive performance, animal health and farm profitability (Jadoun et al., 2023; Madke et al., 2006). Supplementation of limiting amino acids improves immunity, antioxidative status and metabolic health in ruminants (Rajwade et al., 2026). In addition, improved nutritional technologies contribute to environmental sustainability by reducing enteric methane emissions (Vaidya et al., 2025). However, continued reliance on traditional husbandry practices lowers economic returns (Jadoun et al., 2023). Adoption of novel technologies depends on farmers' awareness, access to technical information, training and extension support (Hundal et al., 2016a; Lohakare et al., 2013). Although dairy farmers generally possess moderate awareness of scientific feeding practices, the adoption of these technologies remains suboptimal (Aparna et al., 2021; Sharma et al., 2023). Education, landholding, herd size, training and access to advisory services are important factors influencing technology adoption (Bhushan et al., 2008).

Janssen and Swinnen (2019) reported that the use of concentrate feed was substantially higher in Punjab (54%) than in Andhra Pradesh (8%). Despite the importance of silage for dairy productivity, dairy farmers in Punjab exhibited limited knowledge regarding silage preparation and quality assessment (Kaur et al., 2026). In the study conducted by Reddy et al. (2024) in Haryana, non-adoption for bypass fat was 88.33% and for mineral mixture supplementation was 77.22% respectively. Jogal et al. (2021) observed complete adoption of feeding green fodder (100%), while silage feeding (0.00%) and urea treatment of paddy straw (13.33%) were the least adopted. Kumar et al. (2011) reported a knowledge index of only 37.84% for scientific feeding practices. Education was found to be positively and significantly associated with the training needs of dairy farmers, suggesting that better-educated farmers possess greater awareness (Patil et al., 2009). Chaudhary et al. (2024) reported that training and mass media exposure

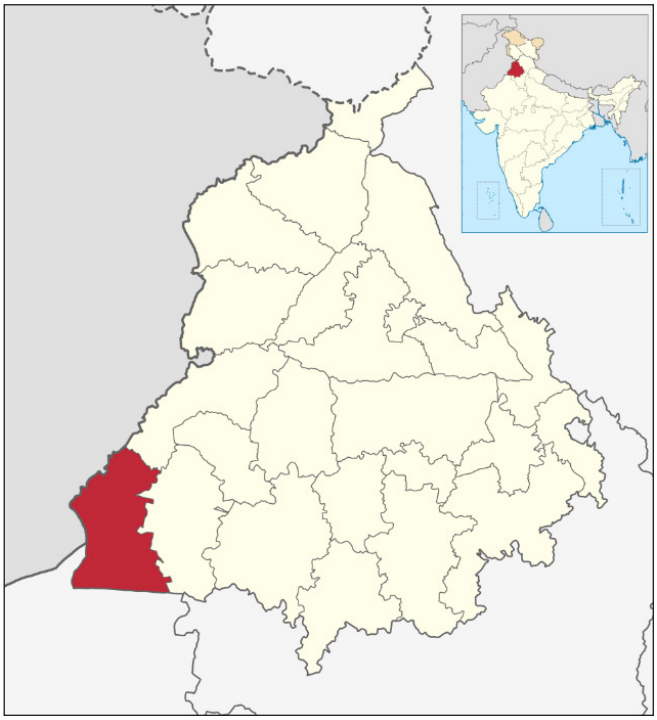


Figure 1: Fazilka district on the map of Punjab, India

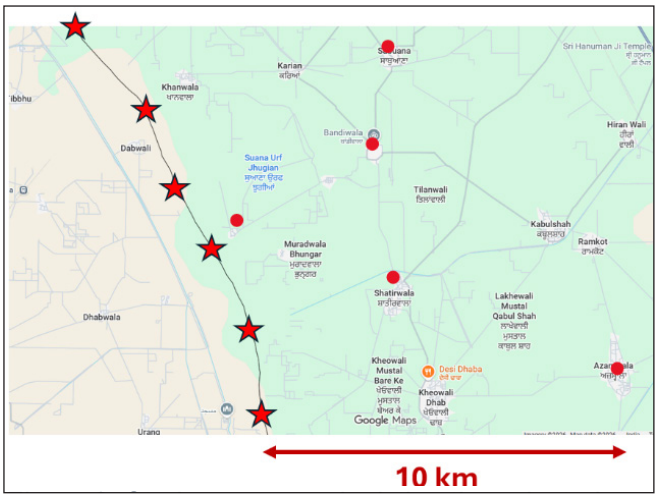


Figure 2: Study area map depicting the selected villages within the 10 Km border belt of Fazilka district, Punjab, India. Villages surveyed in the study are marked by red circles and Indo-Pak international border is indicated by star symbols

were positively associated with the knowledge level of dairy farmers. 85% of trained dairy farmers regularly fed concentrate mixture according to milk production, whereas about half of the untrained farmers did not adopt this practice (Singh et al., 2017).

The farmers of border districts of Punjab, namely Pathankot, Gurdaspur, Amritsar, Tarn Taran, Ferozepur and Fazilka, face a unique set of locational challenges due to relatively weaker infrastructure than the rest of Punjab (Singh et al.,

2022). In the border districts of Punjab, Kaur et al. (2017) reported that 68.75% of women dairy farmers had a medium level of knowledge regarding recommended dairy farming practices, while Singh et al. (2014a) found that only 4.2% of dairy farmers had received livestock management training and 39.2% were willing to undergo training, highlighting the need for stronger extension services in the border region. Limited literature is available on the awareness and adoption of nutritional technologies among dairy farmers in the border belt of Fazilka district, Punjab. Therefore, the present study was undertaken to assess the awareness and adoption of selected nutritional technologies among dairy farmers in this region and to identify the socio-economic factors influencing their adoption.

2. MATERIALS AND METHODS

The present study was conducted from April, 2026 to June, 2026, among the dairy farmers of district Fazilka located at approximately 30.403° N latitude and 74.025° E longitude (Figure 1). A total of 5 villages (Azamwala, Bandiwala, Sabuana, Shatirwala and Siwana) of the district falling within 10 km range from the international border with Pakistan were selected on a random basis (Figure 2). 10 km range was chosen specifically because it is criterion used by the central government for implementing various policies in regions falling under "border-belt". From each village 20 respondents were selected at random with each having at least one milking animal, cow or buffalo. Hence, a total of 100 respondents were selected from the 5 villages. Primary data on awareness and adoption of selected feeding technologies was collected with pre-tested interview schedule. List of 17 feeding technologies was prepared after consulting the experts at Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana. The interview schedule was pre-tested with farmers and revised as needed. The study also included collecting general profile of the respondents i.e. their socio-personal and socio-economic profile. The awareness of each nutritional technology was assigned a score of 1 and non-awareness a 0. The respondents were categorized into three groups of awareness levels based on the mean and standard deviation as shown in table 1 (Hundal et al., 2016b). For the adoption levels of each technology, score of 2, 1 and 0 was given to the regular, occasional and non-adoption of feeding technology and sum of each technology by 100 respondents was used to rank technologies as per adoption (Murai and Singh, 2011). Maximum adoption score that could be obtained by technology was 200 (2 for regular adoption×n(=100)) and minimum was zero. The relationship between selected variables and the awareness and adoption of feeding technologies was also statistically analysed. Spearman's correlation coefficient was used to determine the relationship between education level and awareness and adoption scores, as education was measured on an ordinal scale. The Mann–Whitney U test was employed to compare awareness and adoption scores between trained and untrained respondents. The association between education level and adoption category was examined using the Chi-square (χ^2) test. Multiple linear regression analysis was performed to identify the socio-economic factors influencing the adoption of nutritional technologies.

Table 1: Categories of respondents

Total Awareness Score	Awareness category
Less than (Mean–1/2 S.D.)	Low
Between (Mean±1/2 S.D)	Medium
More than (Mean+1/2 S.D.)	High

3. RESULTS AND DISCUSSION

3.1. General profile of respondents

3.1.1. Socio-personal profile

The study revealed that the majority of the respondents fell into the "middle" age category (35–50 years) with 46% of the total. Middle-age category was followed by "young" age (<35 years) and old age category (>50 years) with 39% and 15%respectively. Verma and Singh (2026) found in their studythat 16.67%, 55.83% and 27.5% respondents belonged to young, middle and old aged categories respectively. In present study, of the total respondents, 96% were male and 4% were female. Bajwa and Rathore (2025) conducted a study among dairy farmers of Punjab in which 90.8% of the respondents were males. Regarding the educational status of the respondents, nearly one-third (31%) of respondents were educated to senior secondary level followed by nearly one-fifth (19%) of the respondents had a graduate degree. 5% of the respondents had completed their post-graduation studies. Conversely, 9% of the respondents were illiterate, and only 4% had completed primary education. Hundal et al. (2016a) found in his study that 12.5% respondents were graduates. All the respondents belonged to families engaged in livestock rearing for generations, with only the herd size changing over time.

3.1.2. Socio-economic status

Total 66% of respondents reported that they had agriculture as the main source of income and 5% respondents had dairy farming as their main source of income. Farmers that had agriculture and dairy both as equal sources of income accounted for 18% of the respondents. While 11% respondents were engaged in other occupations like labour,shops, etc but reared livestock as part of their household. These findings were in contrast to findings of Brar et al. (2021) where only 12% respondents had farming as their main source of occupation. Land holding categories

were total six in number with 38% respondents falling into semi-medium category, holding 2–4 ha of land. Medium, small and marginal landholders were 22%, 10% and 12% only. Of the total respondents, 12% were landless while 6% belonged to the large landholder category.Verma and Singh (2026) reported that 3.34%, 42.5% and 36.25% respondents belonged to landless, marginal and small landholding categories while semi-medium, medium and large categories lodged 11.66%, 4.58% and 1.67% of the 240 respondents. Nearly two-third of the respondents had small herd size i.e. 62% of respondents had less than total of 6 animals. 29% respondents had medium herd size (6–12 animals) and large herd size respondents were the least with total of 9%only. Similar findings were reported by Aparna et al. (2021), who observed that most dairy farmers (55.8%) belonged to the small herd-size category (≤5 animals). 35% respondents reported that they had total house hold milk production of more than 25 l day^{-1}. Respondents amounting to less than 16 l $day^{-1}$of total milk production were 36% and respondents having medium production (16–25 l day-1) of milk were least with 29%. Table 2 summed up the socio-personal and socio-economic profile of the respondents.

3.2. Institutional training and information network

Of total respondents, only 18%received training about scientific animal production.All trained respondentsreceived training from their nearest training centre in adjoining district - Dairy Training and Extension Centre IFTC, Vill. Abul Khurana, Shri Mukatsar Sahib. In the study by Devansh et al. (2023) respondents thatacquired training about dairy farming accounted to 30%.

As shown in table 3 majority of respondents (70%)obtained information regarding nutritional technologies from local veterinarian followed by fellow farmers (21%) and internet (9%) that included YouTube use mostly.Joshi and Dhaliwal (2019) reported YouTube as the most used social media tool by the farmer community.

3.3. Awareness and adoption of feeding technologies

The study revealed that majority of farmers i.e. 75% had medium level of awareness about the listed feeding technologies. 19% of the respondents fell into the high awareness level category and 6% of respondents fell into low awareness level category as describedin table 4. The findings were in line with study by Singh et al. (2014b) where majority of respondents (41.7%) fell into medium category of awareness levels regarding common toxicities in ruminants.

With respect to awareness about each feeding technology, 98% of the respondents were aware of the silage feeding and 97% respondents were aware of the use of salt lick. Mineral mixture was known to 89% respondents and buffer(sodiumbicarbonate) was known to 87% of the respondents.This was significantly higher than reported byAparna et al. (2021) where 50% and 41.7% respondents were aware of silage and mineral mixture.

Table 2: General profile of respondents (n=100)

Variable	Category	(%)
Age	Young (<35 y)	39.0
	Middle (35–50 y)	46.0
	Old (>50 y)	15.0
Gender	Male	96.0
	Female	4.0
Education	Illiterate	9.0
	Primary school	4.0
	Middle school	15.0
	High school	17.0
	Senior secondary	31.0
	Graduate	19.0
	Postgraduate	5.0
Land holding (ha)	Landless (0)	12.0
	Marginal (≤1.00)	12.0
	Small (1.01–2.00)	10.0
	Semi-medium (2.01–4.00)	38.0
	Medium (4.01–10.00)	22.0
	Large (>10.00)	6.0
Primary occupation	Farming	66.0
	Dairy farming	5.0
	Mixed farming	18.0
	Others	11.0
Herd size	Small (<6 animals)	62.0
	Medium (6–12 animals)	29.0
	Large (>12 animals)	9.0
Total milk production (l day^{-1})	Low (<16 l day^{-1})	36.0
	Medium (16–25 l day^{-1})	29.0
	High (>25 l day^{-1})	35.0

Table 3: Institutional training and information network of respondents (n=100)

Variable	Category	Percentage (%)
Training status	Training received	18.0
	No training	82.0
Source of knowledge	Local veterinarian	70.0
	Fellow farmers	21.0
	Internet/YouTube	9.0

Table 4:Awareness levels of dairy farmers regarding feeding technologies

Awareness level	Frequency (%) of dairy farmers regarding awareness level
Low (<2.15 score)	6 (6.0)
Medium (2.15–9.79 score)	75 (75.0)
High (>9.79 score)	19 (19.0)

Mean=5.97; S.D=±3.82

The concept of balanced feeding was known to the 37% of the respondents respectively. In another study conducted by Subash et al. (2015), they found out that 51.7% respondents needed more information about balanced ration formulation. Bypass fat, yeast feeding, toxin binder and trace mineral was known to 33%, 25%, 23% and 21%of the respondents. 18% respondents were aware about the bypass protein and 16% respondents were aware of the Uromin lick as feeding technology.In study by Aparna et al. (2021), they found that 19.2% and 17.5% respondents were aware of by-pass protein and by-pass fat.

Feeding technologies such as hay, biotin and urea treatment of straw were known to 14%, 10% and 9% of the respondents respectively. Respondents who were aware of choline, niacin and betaine were 7%, 7% and 5% respectively.

Table 5 summarizes the awareness and adoption extent of nutritional technologies among dairy farmers.Among the technologies studied, salt lick recorded the highest regular adoption (41%), followed by buffer (23%), mineral mixture (20%) and balanced feeding (17%). Deb et al. (2026) reported that 53.33% farmers fed common salt to their animals.Mineral mixture (57%), buffer (48%) and salt lick (44%) were adopted occasionally by a considerable proportion of farmers. In another study by Madke et al. (2006) it was found that 33.3% farmers fed mineral mixture to their animals.

A substantial proportion of respondents were aware of certain technologies but had not adopted them. The highest percentage of aware but non-adopting farmers was observed for silage (74%), followed by buffer (16%), Uromin lick (16%), hay (14%), mineral mixture (12%) and salt lick (12%). Kirimi et al. (2024) reported that silage was adopted by 38.87% of the respondents.

Regular adoption of bypass fat (5%), yeast (3%), toxin binder

Table 5: Extent of Awareness and Adoption of Nutritional technologies among dairy farmers. (n=100)

Sl. No.	Technology	Awareness n (%)		Adoption (%)			Adoption Ranking	
		Aware n (%)	Not aware n (%)	Regular adopter n (%)	Occasional adopter n (%)	Aware but not adopted n (%)	Adoption score (Max=200)	Rank
1.	Silage	98 (98.0)	2 (2.0)	6 (6.0)	18 (18.0)	74 (74.0)	30	V
2.	Salt lick	97 (97.0)	3 (3.0)	41 (41.0)	44 (44.0)	12 (12.0)	126	I
3.	Mineral mixture	89 (89.0)	11 (11.0)	20 (20.0)	57 (57.0)	12 (12.0)	97	II
4.	Buffer (Sodium bicarbonate)	87 (87.0)	13 (13.0)	23 (23.0)	48 (48.0)	16 (16.0)	94	III
5.	Balanced feeding	37 (37.0)	63 (63.0)	17 (17.0)	17 (17.0)	3 (3.0)	51	IV
6.	Bypass fat	33 (33.0)	67 (67.0)	5 (5.0)	18 (18.0)	10 (10.0)	28	VI
7.	Yeast	25 (25.0)	75 (75.0)	3 (3.0)	17 (17.0)	5 (5.0)	23	VII
8.	Toxin binder	23 (23.0)	77 (77.0)	3 (3.0)	10 (10.0)	10 (10.0)	16	IX
9.	Trace minerals	21 (21.0)	79 (79.0)	2 (2.0)	18 (18.0)	1 (1.0)	22	VIII
10.	Bypass protein	18 (18.0)	82 (82.0)	1 (1.0)	6 (6.0)	11 (11.0)	8	X
11.	Uromin lick	16 (16.0)	84 (84.0)	0 (0.0)	0 (0.0)	16 (16.0)	0	XIV
12.	Hay	14 (14.0)	86 (86.0)	0 (0.0)	0 (0.0)	14 (14.0)	0	XIV
13.	Biotin	10 (10.0)	90 (90.0)	0 (0.0)	3 (3.0)	7 (7.0)	3	XI
14.	Urea treatment	9 (9.0)	91 (91.0)	0 (0.0)	0 (0.0)	9 (9.0)	0	XIV
15.	Choline	7 (7.0)	93 (93.0)	0 (0.0)	3 (3.0)	4 (4.0)	3	XI
16.	Niacin	7 (7.0)	93 (93.0)	0 (0.0)	3 (3.0)	4 (4.0)	3	XI
17.	Betaine	5 (5.0)	95 (95.0)	0 (0.0)	0 (0.0)	5 (5.0)	0	XIV

(3%), trace minerals (2%) and bypass protein (1%) remained low, while no respondent reported regular adoption of betaine, biotin, choline, niacin, hay, urea treatment or uromin lick.Devasena et al. (2015) reported in the study that hay making was practiced by 24% of the farmers while no farmerpracticed urea treatment of the straw for feeding the animals. Table 5 also summarises the adoption score and ranking based on number of respondents using it regularly or occasionally. Salt lick emerged as the most widely adopted technology with the highest adoption score (126), followed by mineral mixture (97) and buffer supplementation (94). These technologies also recorded the highest proportion of regular adopters, indicating their greater acceptance and integration into routine feeding practices. Balanced feeding ranked fourth with an adoption score of 51, suggesting moderate adoption among the respondents.

In contrast, several technologies exhibited low adoption despite their potential benefits. Silage, bypass fat and bypass protein recorded adoption scores of 30, 28 and 8 respectively, indicating limited utilization at the farm level. Furthermore, advanced feed additives such as choline, biotin and niacin showed negligible adoption, while betaine, hay, uromin lick and urea treatment scored zero.Dhayal et al. (2015) reported the adoption of urea treatment by 2%respondents only.

3.4. Socio-economic determinants of awareness and adoption of feeding technologiesamong farmers

3.4.1. Influence of education and trainingon feeding technology awareness and adoption

The results revealed a significant positive association between education level and both awareness and adoption scores of feeding technologies as shown in Table 6. Spearman's rank correlation analysis indicated that education was positively correlated with awareness score (rs = 0.627, $p< 0.001$) as well as adoption score (rs = 0.654, $p< 0.001$). These findings suggest that farmers with higher educational attainment possessed greater knowledge of improved feeding technologies and were more likely to adopt them. These findings were similar to those reported by Sharma et al. (2023) where education had positive correlation with knowledge level of the farmers. Education may enhance the ability of farmers to access, comprehend and utilize technical information, thereby facilitating technology uptake (Lohakare et al., 2013).

Table 6: Correlation of education with awareness and adoption scores

Variable	Spearman's correlation coefficient (rs)	*p*-value
Education vs Awareness score	0.627	<0.001
Education vs Adoption score	0.654	<0.001

Training alsohad a significant influence on both awareness and adoption of feeding technologies. Farmers who had received training exhibited substantially higher mean awareness scores (9.83) compared to untrained farmers (5.11). Similarly, trained farmers recorded a higher mean adoption score (9.39) than those who had not received training (4.23). The differences were statistically significant ($p< 0.001$). These findings underscore the importance of capacity-building programmes and extension interventions in promoting awareness and adoption of improved feeding practices.Sharma et al. (2014) and Rajesh Kumar et al. (2013) also reported similar findings where training had positive effect on knowledge and adoption of progressive dairy farming technologies including nutritional technologies (Table 7).

Table 7: Effect of training on awareness and adoption scores

Variable	Training received (n=18)	No Training (n= 82)	p-value
Awareness score (Mean)	9.83	5.11	<0.001
Adoption score (Mean)	9.39	4.23	<0.001

The association between education level and adoption category was examined using the Chi-square test. A significant association was observed between educational attainment and adoption level (χ^2=28.74, p=0.004)as depicted in table 8. The proportion of high adopters increased consistently with educational level. While none of the illiterate and primary-educated respondents belonged to the high adoption category, 47.4% of graduates and 80.0% of postgraduates were classified as high adopters. Conversely, the majority of illiterate and primary-educated respondents were concentrated in the low adoption category. These findings further reinforced the role of education in enhancing the adoption of feeding technologies.Usadadiya et al. (2023) reported significant positive relationship between education level and adoption of clean milk practices by the dairy farmers.

3.4.2. Statistical predictors of Adoption of feeding technologies

Multiple regression analysis was performed to identify the factors influencing adoption of feeding technologies. The regression model was statistically significant (F=17.30, $p<$ 0.001) and explained 64.0% of the variation in adoption scores (R^2=0.640) as summarised in table 9.

Among the variables studied, training received (β=4.659, $p<0.001$), total milk yield (β=0.049, p=0.007) and landholding size (β=0.094, p=0.036) exerted a significant positive effect on adoption. Farmers who had undergone training, maintained larger landholdings and achieved higher milk yields were more likely to adopt improved feeding technologies.Bhushan et al. (2008) also reported

Table 8: Association between education level and adoption of dairy feeding technologies

Education level	Low adoption	Medium adoption	High adoption	Total
Illiterate	7 (77.8)	2 (22.2)	0 (0.0)	9
Primary	3 (75.0)	1 (25.0)	0 (0.0)	4
Middle	8 (53.3)	5 (33.3)	2 (13.3)	15
High school	8 (47.1)	6 (35.3)	3 (17.6)	17
Senior secondary	9 (29.0)	12 (38.7)	10 (32.3)	31
Graduate	3 (15.8)	7 (36.8)	9 (47.4)	19
Post graduate	0 (0.0)	1 (20.0)	4 (80.0)	5
Total	38	34	28	100
Chi-square test results				
Statistic	Value			
χ^2	28.74			
df	12			
p-value	0.004			

Table 9: Multiple regression analysis of factors affecting technology adoption among dairy farmers

Variable	Regression coefficient (β)	Standard error	t-value	*p*-value
Age (years)	-0.014	0.072	-0.19	0.850
Dairy farming experience (years)	0.014	0.064	0.22	0.825
Landholding (ha)	0.094	0.044	2.14	0.036
Herd size (No. of animals)	0.088	0.114	0.77	0.441
Total milk yield (l day^{-1})	0.049	0.017	2.78	0.007
Training received	4.659	0.882	5.28	<0.001

positive association between increased landholdings and adoption level of advanced feeding practices along with other advanced dairy farming technologies. In contrast, age, dairy farming experience and herd size did not exhibit a statistically significant influence in the regression model. The association between age and knowledge of dairy management practices was found not to be statistically significant as reported by Arora (2006).

4. CONCLUSION

Dairy farmers in the border belt of Fazilka district possessed a moderate level of awareness regarding nutritional technologies.A considerable gap existed between awareness andadoption. Education, institutional training, landholding size and total milk yield were significant determinants of technology adoption.

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5. REFERENCES

Anonymous, 2019. 20th Livestock Census. Ministry of Fisheries, Animal Husbandry and Dairying, Department of Animal Husbandry and Dairying, Government of India, New Delhi. Available from: https://www.dahd.gov.in/sites/default/files/2019-12/20thLivestockCensusReport.pdf. Accessed on: 10th July, 2026.

Aparna, Kansal, S.K., Singh, J., Hundal, J.S., 2021. Dairy cattle nutrition technologies: Pre and post intervention awareness and its retention in relation with independent variables. Journal of Community Mobilization and Sustainable Development 16(1), 1–10. Available from: https://mobilization.org.in/pdf/Journal%20of%20Mobilization%20Vol.%2016(1)%20January-April,%202021%20book%209.4.2021.pdf.

Arora, A.S., 2006. Socio-economic and communication variables associated with the level of knowledge and degree of adoption of improved dairy husbandry practices in U.S. Nagar District of Uttaranchal. Indian Journal of Dairy Science 59, 337–343. Available from: https://www.semanticscholar.org/paper/Socio-economic-and-communication-variables-with-of-Arora-Kumar/28359c8dc4650472b76f90707548f4ae92499b86.

Bajwa, G.S., Rathore, R., 2025. Awareness and adoption of dairy promoting schemes among dairy farmers in Punjab. International Journal of Bio-resource and Stress Management 16(7), 01–06. DOI: https://doi.org/10.23910/1.2025.6240.

Bhushan, B., Singh, S.K., Umang, Agrawal, N., Dutt, T., Kumar, P., Sharma, A., Ahlawat, S.P.S., 2008. Role of land holding patterns for adoption of dairy husbandry practices in rural areas of Bareilly district in India. Journal of Applied Animal Research 34(2), 185–188. DOI: https://doi.org/10.1080/09712119.2008.9706968.

Brar, R.P.S., Singh, S., Kaur, G., Preet, G.S., 2021. A survey of livestock farmers in rural Punjab on common animal

health and hygiene practices. The Pharma Innovation Journal 10(6), 380–384. Available from: https://www.thepharmajournal.com/archives/2021/vol10issue6S/PartF/S-10-6-39-521.pdf.

Chaudhary, V.M., Patel, U.M., Ghasura, R.S., 2024. Knowledge of dairy farmers about scientific dairy farming practices. Gujarat Journal of Extension Education 38(1), 192–196. DOI: https://doi.org/10.56572/gjoee.2024.38.1.0031.

Deb, D., Kalita, G., Paul, A., Goswami, R., Buragohain, R., Das, H., 2026. Assessment of dairy cattle management practices followed by cooperative dairy farmers in North-Eastern Hilly State, Tripura. International Journal of Bio-resource and Stress Management 17(3), 01–10. DOI: https://doi.org/10.23910/1.2026.6872.

Devansh, Kasrija, R., Jadoun, Y.S., Sharma, R.K., 2023. An overview of knowledge level of dairy farmers of Punjab regarding genital prolapse condition. Haryana Veterinarian 62(SI-2), 100–104. Available from: https://www.luvas.edu.in/haryana-veterinarian/download/sept-2023-new/article-24.pdf.

Devasena, B., Ramana, J.V., Eswara Prasad, P. and Rama Prasad, J., 2015. Technology adoption regarding feeding management of crossbred cattle reared in crop-livestock system in Chittoor district. Haryana Veterinarian 54(1), 56–60. Available from: https://www.luvas.edu.in/haryana-veterinarian/download/harvet2015/16.pdf.

Dhayal, B.L., Meena, J.P., Patel, M.L., Mehta, B.M., 2015. A study on knowledge and adoption level of improved animal husbandry practices by milk producers in Vadodara district of Gujarat. Agriculture Update 10(2), 144–148. Available from: https://researchjournal.co.in/upload/assignments/10_144-148.pdf.

Hundal, J.S., Chahal, U.S., Kansal, S.K., Bhatti, J.S., 2016a. Role of training in changing knowledge level among dairy farmers of Punjab. Haryana Veterinarian 55(2), 220–223. Available from: https://www.luvas.edu.in/haryana-veterinarian/download/harvet2016-dec/25.pdf.

Hundal, J.S., Sodhi, S.S., Gupta, A., Singh, J., Chahal, U. S., 2016b. Awareness, knowledge, and risks of zoonotic diseases among livestock farmers in Punjab. Veterinary World 9(2), 186–191. DOI: https://doi.org/10.14202/vetworld.2016.186-191.

Jadoun, Y., Singh, J., Hundal, J., Kasrija, R., Kansal, S., Sharma, R., Kaur, N., 2023. Effect of mineral mixture supplementation on productive and reproductive performance of buffaloes. Indian Journal of Animal Nutrition 40(3), 283–287. DOI: https://doi.org/10.5958/2231-6744.2023.00035.x.

Janssen, E., Swinnen, J., 2019. Technology adoption and value chains in developing countries: Evidence from dairy in India. Food Policy 83, 327–336. DOI: https://doi.org/10.1016/j.foodpol.2017.08.005.

Jogal, K.V., Trivedi, S.M., Lakhlani, C.D., 2021. Adoption of improved animal husbandry practices by dairy farmers. Indian Journal of Animal Sciences 91(12), 1115–1117. DOI: https://doi.org/10.56093/ijans.v91i12.119840.

Joshi, D., Dhaliwal, R.K., 2019. Utilization of social media by farming community: A case from Punjab state. Indian Journal of Extension Education 55(1), 47–52. Available from: https://epubs.icar.org.in/index.php/IJEE/article/view/109260.

Kaur, S., Verma, H.K., Singh, J., Dash, S.K., Kansal, S.K., 2017. Knowledge level of women dairy farmers about various farming practices in border area of Punjab. Journal of Animal Research 7(6), 1051–1059. DOI: https://doi.org/10.5958/2277-940X.2017.00157.7.

Kaur, K., Singh, J., Hundal, J.S., Chadda, A., Kasrija, R., Kaur, P., 2026. Dairy farmers' knowledge and practices in silage-making vis-a-vis assessment of silage quality and silo structures at field level in Punjab (India). Indian Journal of Dairy Science 79(2), 192–200. DOI: https://doi.org/10.33785/IJDS.2026.v79i02.013.

Kirimi, A.K., Nyarindo, W.N., Gatimbu, K.K., 2024. Is adoption of modern dairy farming technologies interrelated? A case of smallholder dairy farmers in Meru county, Kenya. Heliyon 10(19), e38157. DOI: https://doi.org/10.1016/j.heliyon.2024.e38157.

Kumar, S., Kumar, B., Hindustani, S., Sankhala, G., 2011. Knowledge level of dairy farmers in operational area of Krishi Vigyan Kendra about improved dairy farming practices. Research Journal of Agricultural Sciences 2(1), 122–124. Available from: https://www.academia.edu/16976715/knowledge_level_of_dairy_farmers_in_operational_area_of_krishi_vigyan_kendra_about_improved_dairy_farming_practices.

Lohakare, A.C., Gawande, S.H., Khandait, V.N., Basunathe, V.K., 2013. Socio-economic, psychological characteristics of the cattle owners and their relationship with adoption of animal husbandry practices in Vidarbha region of Maharashtra. Research Journal of Agricultural Sciences 4(3), 359–362. Available from: https://www.researchgate.net/publication/332711317_socio-economic_psychological_characteristics_of_the_cattle_owners_and_their_relationship_with_adoption_of_animal_husbandry_practices_in_vidarbha_region_of_maharashtra.

Madke, P.K., Murkute, J.S., Upadhye, S.V., Vedpathak, C.P., 2006. Adoption of scientific feeding practices by dairy farmers. Indian Journal of Animal Research 40(2), 155–157. Available from: https://arccarticles.

s3.amazonaws.com/webArticle/articles/ijar1402014.pdf.

Murai, A.S., Singh, B.K., 2011. Differential adoption of scientific dairy farming practices and related constraints. Indian Research Journal of Extension Education 11(2), 46–49. Available from: https://api.seea.org.in/uploads/pdf/v11209.pdf.

Patil, A.P., Gawande, S.H., Nande, M.P., Gobade, M.R., 2009. Assessment of knowledge level of dairy farmers in Nagpur district and the co-relation between socio-economic variables with their training needs. Veterinary World 2(5), 199–201. Available from: https://www.veterinaryworld.org/Vol.2/May/Assessment%20of%20knowledge%20level%20of%20dairy%20farmers%20in%20Nagpur%20dis.pdf.

Rajesh Kumar, B., Baskaran, D., Saraswathi, S., Theophilus Anand Kumar, C., 2013. Impact of training program in adoption of cattle feed computation by Farmer Interest Groups (FIGs) of Tamil Nadu. Tamilnadu Journal of Veterinary and Animal Sciences 9(4), 264–271. Available from: https://krishikosh.egranth.ac.in/server/api/core/bitstreams/c2858c5a-65f1-4b05-bec8-21ce4ad1d3f3/content.

Rajwade, N., Kumari, K., Archana, Pal, P., Gendley, M.K., Gade, N.E., Dubey, M., 2026. Effect of dietary supplementation of rumen protected methionine and lysine on immunity status and trace mineral profile in Sahiwal female calves. International Journal of Bio-resource and Stress Management 17(3), 01–06. DOI: https://doi.org/10.23910/1.2026.6879.

Reddy, D.A., Garai, S., Veldandi, A., Maiti, S., Meena, B.S., 2024. Exploring the determinants of higher level of adoption of climate-resilient dairy farming practices. Indian Research Journal of Extension Education 24(3), 111–119. DOI: https://doi.org/10.54986/irjee/2024/apr_jun/111-119.

Sharma, M., Singh, G., Keshava, 2014. Impact evaluation of training programmes on dairy farming in Punjab state. Indian Research Journal of Extension Education 14(1), 105–108. Available from: https://www.researchgate.net/publication/279178297_impact_evaluation_of_training_programmes_on_dairy_farming_in_punjab_state.

Sharma, S., Singh, H., Pavan, S., 2023. Socio-economic determinants of dairy farmers' knowledge on dairy farming practices in Uttar Pradesh, India. Journal of Extension Education 35(1), 6940–6950. DOI: https://doi.org/10.26725/jee.2023.1.35.6940-6950.

Singh, P., Hundal, J.S., Singh, U., Bhatti, J.S., Gupta, A., 2014a. Bovine herd management practices in border area of Punjab. Veterinary Practitioner 15(2), 349–351. Available from: https://www.vetpract.in/themes/uploads/contents/5e8610f7385f0df7c8f626dd508cb136.pdf.

Singh, J., Hundal, J.S., Verma, H.K., Kansal, S.K., 2014b. Awareness among dairy farmers of Punjab about common toxicities in ruminants. Haryana Veterinarian 53(2), 130–132. Available from: https://www.luvas.edu.in/haryana-veterinarian/download/harvet-Dec2014/14.pdf.

Singh, J., Kingra, H.S., Saini, R., Kaur, M., Mavi, H.K., 2022. Economic status of farming in border districts of Punjab. Journal of Krishi Vigyan 10(2), 68–77. DOI: https://doi.org/10.5958/2349-4433.2022.00013.7.

Singh, P., Bhatti, J.S., Hundal, J.S., Kansal, S.K., 2015. Constraints faced by farmers in adoption of dairy as entrepreneurship. Haryana Veterinarian 54(1), 67–69. Available from: https://www.luvas.edu.in/haryana-veterinarian/download/harvet2015/19.pdf.

Singh, P., Rampal, V.K., Sharma, K., Dhaliwal, N.S., 2017. Extent of adoption of improved dairy management practices (IDMPs) by the dairy farmers of Malwa region of Punjab. Journal of Community Mobilization and Sustainable Development 12(1), 8–14. Available from: https://www.researchgate.net/profile/dibyanshu-shekhar/publication/326625818_level_of_participation_and_perceived_constraints_of_women_in_panchayati_raj_institutions/links/5b59a4fbaca272a2d66c25bc/level-of-participation-and-perceived-constraints-of-women-in-panchayati-raj-institutions.pdf#page=14.

Subash, S., Gupta, J., Prasad Babu, G., 2015. Information needs assessment and prioritization of dairy farmers. Journal of Krishi Vigyan 4(1), 51–55. DOI: https://doi.org/10.5958/2349-4433.2015.00059.8.

Usadadiya, N.H., Prajapati, R.R., Parikh, N.L., 2023. Relationship between dairy farmers' characteristics and their adoption of clean milk practices. Gujarat Journal of Extension Education 36(1), 72–74. DOI: https://doi.org/10.56572/gjoee.2023.36.1.0014.

Vaidya, M., Patodkar, V.R., Kuralkar, P., Amrutkar, S., Panchbhai, G., Gupta, M., Kapale, P., Singh, S.V., 2025. Assessing enteric methane emissions in ruminants: A comparative study of the GreenFeed technique. International Journal of Bio-resource and Stress Management 16(3), 01–09. DOI: https://doi.org/10.23910/1.2025.5970.

Verma, K., Singh, J., 2026. A study of socio-economic profile and communicable behaviour pattern of beneficiary and non-beneficiary dairy farmers of Punjab. International Journal of Veterinary Sciences and Animal Husbandry 11(1S), 42–48. DOI: https://doi.org/10.22271/veterinary.2026.v11.i1sa.2939.