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Determinants of adoption of improved dairy farming practices: A comparative study of Nainital and Udham Singh Nagar Districts of Uttarakhand

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Abstract

Dairy farming plays a crucial role in strengthening rural livelihoods, nutritional security, and income generation in India, particularly among small and marginal farmers. However, the adoption of improved dairy farming practices varies across regions due to differences in socio-economic and institutional conditions. The present study was conducted to assess the extent of adoption and identify the determinants influencing the adoption of improved dairy farming practices among dairy farmers in Nainital (hill region) and Udham Singh Nagar (plain region) districts of Uttarakhand.

A total of 160 respondents were selected through a multistage sampling technique, and primary data were collected using a structured interview schedule. The data were analyzed using descriptive statistics, an adoption index, and logistic regression analysis. The findings revealed that farmers in Udham Singh Nagar exhibited a higher level of adoption compared to those in Nainital. Practices such as artificial insemination, vaccination, deworming, and balanced feeding showed relatively higher adoption, whereas scientific housing and record keeping were less adopted, particularly in the hill region.

The logistic regression analysis indicated that education, landholding, herd size, extension contact, training exposure, and access to credit significantly influenced adoption ($p < 0.05$). Among these, training exposure emerged as the most influential factor, with trained farmers being approximately 2.6 times more likely to adopt improved practices.

The study highlights the need for strengthening extension services, enhancing training programmes, and improving access to credit and institutional support to promote sustainable dairy development.

Keywords: Dairy farming, adoption, determinants, logistic regression, Uttarakhand, extension services

1. Introduction

Dairy farming plays a crucial role in the rural economy of India by providing supplementary income, employment, nutritional security, and livelihood resilience to millions of small and marginal farmers. India is the largest milk producer in the world, and the livestock sector contributes significantly to agricultural GDP and rural employment. In this context, dairy development has emerged as a key driver of inclusive rural growth and poverty alleviation (Sorout & Tripathi 2022; Sarkar *et al.*, 2024) ^[21, 18].

In Uttarakhand, dairy farming forms an integral component of mixed farming systems, particularly in hill regions where crop productivity is constrained by undulating terrain and limited irrigation facilities. The dairy sector in districts such as Nainital is largely subsistence-oriented, characterized by small herd sizes, fragmented landholdings, and limited access to modern inputs and services. In contrast, plain regions such as Udham Singh Nagar exhibit relatively commercialized dairy farming systems due to better

infrastructure, market access, and availability of extension services (Negi, 2021; Sapkal *et al.*, 2024) ^[15, 17].

Despite several policy initiatives and development programmes aimed at strengthening the dairy sector, the adoption of improved dairy farming practices—such as artificial insemination, balanced feeding, scientific housing, vaccination, and record keeping—remains uneven across regions. This variation in adoption is influenced by a combination of socio-economic, institutional, and behavioural factors, including education, herd size, access to extension services, training exposure, and financial resources. Recent studies have highlighted that strengthening institutional support, improving access to markets, and promoting technological interventions are essential for enhancing dairy productivity and sustainability (Basaragi & Kadam, 2025; Kuchibhatla *et al.*, 2024) ^[1, 11].

A growing body of literature suggests that the adoption of agricultural innovations is not merely a technical decision but is strongly shaped by the socio-economic and

institutional environment of farmers. Factors such as access to information, extension contact, resource endowment, and policy support significantly influence adoption behaviour. Moreover, regional disparities in infrastructure and institutional access further accentuate differences in adoption levels between hill and plain regions (Kolhal, 2022; Sarkar *et al.*, 2024) [9, 18]. However, empirical studies comparing adoption behaviour across contrasting agro-ecological zones, particularly between hill and plain regions, remain limited.

In this context, the present study titled “*Determinants of Adoption of Improved Dairy Farming Practices among Dairy Farmers: A Comparative Study of Nainital and Udham Singh Nagar Districts*” aims to examine the extent of adoption and identify its key socio-economic and institutional determinants. The study also provides a comparative analysis between hill and plain regions to generate location-specific insights for policy formulation and extension planning. The findings are expected to contribute towards improving extension strategies, strengthening institutional support systems, and promoting sustainable dairy development in diverse agro-ecological settings of Uttarakhand. Accordingly, the study was undertaken with the following specific objectives:

1. To assess the socio-economic profile of dairy farmers in Nainital district and Udham Singh Nagar district.
2. To measure the extent of adoption of improved dairy farming practices among the selected dairy farmers.
3. To compare the level of adoption of improved dairy farming practices between the two districts.
4. To identify the socio-economic and institutional determinants influencing the adoption of improved dairy farming practices.

2. Methodology

2.1. Research Design

The study followed an ex-post-facto research design, as the phenomenon of adoption of improved dairy farming practices had already occurred and the variables under study could not be manipulated. This design is appropriate for identifying relationships between adoption behaviour and its influencing factors among dairy farmers.

2.2 Study Area

The study was conducted in the state of Uttarakhand, covering two purposively selected districts, namely Nainital district and Udham Singh Nagar district. These districts were selected to represent contrasting agro-ecological conditions, where Nainital represents hill and mid-hill farming systems characterized by smallholder mixed farming, and Udham Singh Nagar represents plain regions with comparatively commercialized dairy farming systems.

2.3. Sampling Design

A multistage sampling technique was adopted for the selection of respondents. In the first stage, the two districts were purposively selected based on their relevance to dairy farming and contrasting production systems. In the second stage, two blocks from each district were selected based on higher dairy animal concentration, availability of veterinary and extension services, and milk marketing infrastructure. Accordingly, Haldwani block and Ramnagar block were

selected from Nainital district, while Rudrapur block and Kashipur block were selected from Udham Singh Nagar district. In the third stage, two villages from each selected block were chosen based on the concentration of dairy farming households and accessibility.

2.4. Sample Size and Allocation

The total sample consisted of 160 dairy farmers. Proportionate sampling was used based on the population distribution reported in the Census of India (2011). Accordingly, 59 respondents were selected from Nainital district and 101 respondents from Udham Singh Nagar district. From each selected village, respondents were selected using simple random sampling from the list of dairy farming households.

2.5. Measurement of Variables

2.5.1 Dependent Variable

The dependent variable, adoption of improved dairy farming practices, was measured using an Adoption Index approach. A comprehensive checklist of recommended dairy farming practices was developed based on literature review and expert consultation, covering key domains such as breeding (artificial insemination), feeding (balanced ration and green fodder feeding), health care (vaccination and deworming), housing (scientific housing), and management practices (clean milk production and record keeping).

Each selected practice was treated as a binary response and assigned a score of:

- 1 = Adopted
- 0 = Not adopted

The Adoption Index was computed as:

$$\text{Adoption Index} = \frac{\text{Number of practices adopted by the respondent}}{\text{Total number of recommended practices}} \times 100$$

Based on the computed adoption scores, respondents were categorized into low, medium, and high adoption levels using the mean $\pm$ standard deviation method, which is widely used for classification of respondents in behavioural studies.

2.5.2 Independent Variables

The independent variables included socio-economic and institutional characteristics of respondents such as age, education, family size, landholding, herd size, annual income, extension contact, training exposure, access to credit, social participation, and distance to veterinary services.

2.6. Data Collection

Primary data were collected through a pre-tested structured interview schedule administered through personal interviews with selected respondents. Secondary data were obtained from published reports, livestock census data, and relevant government publications.

2.7. Statistical Analysis

Data were analyzed using descriptive statistics (frequency, percentage, mean, and standard deviation) to describe socio-economic characteristics and adoption levels. Comparative

analysis between the two districts was carried out using appropriate statistical tests. The determinants of adoption of improved dairy farming practices were identified using binary logistic regression analysis. Statistical significance was tested at conventional probability levels ($p < 0.05$).

3. Results and Discussion

3.1 Socio-economic profile of dairy farmers in Nainital district and Udham Singh Nagar district

The data presented in Table 1 indicate that the majority of respondents in both Nainital district and Udham Singh Nagar district belonged to the middle-aged group (36–50 years), accounting for 52.5% and 48.5% respectively. With regard to educational status, a larger proportion of respondents in both districts had attained education up to the

secondary level.

In terms of landholding, a higher proportion of farmers in Nainital district were marginal landholders (61.0%), whereas Udham Singh Nagar district had a comparatively higher proportion of small (42.6%) and medium (19.8%) landholders. The distribution of herd size revealed that most respondents in both districts maintained medium-sized herds (3–5 animals); however, the proportion of farmers owning more than five animals was considerably higher in Udham Singh Nagar (27.7%) than in Nainital (13.5%).

With respect to training exposure, a higher percentage of respondents in Udham Singh Nagar (56.4%) had undergone dairy-related training compared to those in Nainital (32.2%), indicating better access to extension and capacity-building programmes in Udham Singh Nagar.

Table 1: Socio-economic profile of dairy farmers

Variable	Category	Nainital (n=59)	Udham Singh Nagar (n=101)	Total (n=160)
Age (years)	< 35	12 (20.3)	28 (27.7)	40 (25.0)
	36–50	31 (52.5)	49 (48.5)	80 (50.0)
	> 50	16 (27.1)	24 (23.8)	40 (25.0)
Education	Primary	19 (32.2)	22 (21.8)	41 (25.6)
	Secondary	28 (47.5)	52 (51.5)	80 (50.0)
	Graduate & above	12 (20.3)	27 (26.7)	39 (24.4)
Landholding	Marginal (< 1 ha)	36 (61.0)	38 (37.6)	74 (46.3)
	Small (1–2 ha)	17 (28.8)	43 (42.6)	60 (37.5)
	Medium (> 2 ha)	6 (10.2)	20 (19.8)	26 (16.2)
Herd size	1–2 animals	26 (44.1)	23 (22.8)	49 (30.6)
	3–5 animals	25 (42.4)	50 (49.5)	75 (46.9)
	> 5 animals	8 (13.5)	28 (27.7)	36 (22.5)
Training exposure	Yes	19 (32.2)	57 (56.4)	76 (47.5)
	No	40 (67.8)	44 (43.6)	84 (52.5)

3.2 To measure the extent of adoption of improved dairy farming practices among the selected dairy farmers

Table 2 illustrates the extent of adoption of improved dairy farming practices among the selected dairy farmers ($n = 160$). The findings reveal a noticeable inter-district variation, with farmers in Udham Singh Nagar exhibiting a comparatively higher level of adoption than those in Nainital district. A substantial proportion of respondents in Udham Singh Nagar reported adopting key scientific practices such as artificial insemination (77.2%), vaccination (85.1%), deworming (81.2%), and balanced feeding (73.3%), indicating better access to veterinary services, input supply, and extension support.

Table 2: Adoption level of improved dairy farming practices ($n = 160$)

Practice	Nainital (n=59)	Udham Singh Nagar (n=101)	Overall (%)
Artificial insemination	31 (52.5)	78 (77.2)	109 (68.1)
Vaccination of animals	42 (71.2)	86 (85.1)	128 (80.0)
Deworming	38 (64.4)	82 (81.2)	120 (75.0)
Balanced feeding	26 (44.1)	74 (73.3)	100 (62.5)
Fodder cultivation	22 (37.3)	69 (68.3)	91 (56.9)
Clean milk production practices	33 (55.9)	80 (79.2)	113 (70.6)
Scientific housing	19 (32.2)	58 (57.4)	77 (48.1)
Record keeping	14 (23.7)	41 (40.6)	55 (34.4)

Values in parentheses indicate percentages.

In contrast, the adoption of scientific housing (32.2%) and record keeping (23.7%) remained relatively low in Nainital district. Practices related to animal health management, particularly vaccination and deworming, showed comparatively higher adoption across both districts, suggesting greater awareness and perceived immediate benefits. However, practices requiring higher investment and technical knowledge—such as balanced feeding, fodder cultivation, scientific housing, and record keeping—were less commonly adopted in Nainital. This disparity highlights the influence of resource constraints, limited technical exposure, and geographical challenges in hilly regions.

Overall, the findings indicate the need for targeted extension interventions, capacity-building programmes, and improved access to technical support to enhance the adoption of comprehensive dairy management practices, particularly in Nainital district.

3.3 To compare the level of adoption of improved dairy farming practices between the two districts

The results presented in Table 3 indicate a noticeable difference in the adoption levels of improved dairy farming practices between farmers of Nainital district and Udham Singh Nagar district. Nearly half of the respondents in Nainital (47.5%) fell under the low adoption category, whereas a substantial proportion of respondents in Udham Singh Nagar were found in the medium (41.6%) and high adoption (37.6%) categories.

Table 3: Comparison of adoption level of improved dairy farming practices between districts

Adoption Category	Nainital (n = 59)	Udham Singh Nagar (n = 101)	Total (n = 160)
Low adoption	28 (47.5)	21 (20.8)	49 (30.6)
Medium adoption	21 (35.6)	42 (41.6)	63 (39.4)
High adoption	10 (16.9)	38 (37.6)	48 (30.0)

Values in parentheses indicate percentages

The higher proportion of high adopters in Udham Singh Nagar suggests better access to dairy-related infrastructure, extension services, input availability and awareness about scientific dairy farming practices. In contrast, the predominance of low adoption in Nainital reflects limited access to technical guidance, training opportunities and possibly resource constraints faced by farmers in hilly regions.

Overall, the comparative analysis clearly highlights a significant variation in adoption behaviour between the two districts, indicating the need for location-specific interventions to promote scientific dairy practices.

3.4 To identify the socio-economic and institutional determinants influencing the adoption of improved dairy farming practices

The analysis of factors influencing the adoption of improved dairy farming practices, as presented in Table 4, reveals that education, landholding, herd size, extension contact, training exposure, and access to credit had a statistically significant influence on adoption ($p < 0.05$). Among these variables, training exposure emerged as the most influential determinant, with trained farmers being approximately 2.6 times more likely to adopt improved practices compared to their untrained counterparts.

In addition, farmers with larger herd sizes and better access to extension services demonstrated a higher likelihood of adopting scientific dairy practices. Education and landholding size also exerted a positive and significant effect, highlighting the importance of human capital and resource availability in facilitating technology adoption. Although age and annual income showed a positive association with adoption, their effects were not found to be statistically significant.

These findings underscore the pivotal role of training, extension services, and institutional support in promoting the adoption of improved dairy farming practices among farmers.

Table 4: Logistic regression analysis showing determinants of adoption of improved dairy farming practices

Variable	Coefficient (β)	Standard Error	Odds Ratio (Exp β)	p-value
Age	-0.021	0.013	0.979	0.102
Education	0.184	0.069	1.202	0.008
Landholding	0.412	0.171	1.509	0.016
Herd size	0.563	0.187	1.756	0.003
Annual income	0.001	0.000	1.001	0.089
Extension contact	0.631	0.214	1.880	0.004
Training exposure	0.954	0.331	2.596	0.004
Access to credit	0.488	0.246	1.629	0.047
Constant	-2.487	0.912	—	0.006

4. Discussion

4.1 Socio-economic Characteristics of Respondents

The findings revealed that the majority of dairy farmers belonged to the middle-aged group (36–50 years), indicating that dairy farming in both Nainital district and Udham Singh Nagar district is largely undertaken by individuals in their economically active age group. This observation is consistent with earlier studies which suggest that middle-aged farmers tend to be more actively engaged in livestock-based enterprises due to their better decision-making ability, experience, and access to resources (Chand, 2017; FAO, 2021) ^[2, 5].

The predominance of marginal landholders in Nainital reflects the fragmented and subsistence-oriented landholding pattern typical of hill regions. Similar patterns have been documented in hill agriculture systems, where small and marginal farmers dominate, often constraining their ability to invest in improved dairy technologies and inputs (ICAR, 2013; NITI Aayog, 2021) ^[7, 16].

In contrast, the relatively larger landholdings and herd sizes observed in Udham Singh Nagar align with the trends of agricultural commercialization and intensification in the plains of northern India. Studies have shown that farmers in irrigated and resource-rich regions tend to maintain larger herd sizes and adopt improved practices more readily due to better infrastructure, market access, and institutional support (NDDB, 2022; DAHD, 2023) ^[13, 3].

4.2 Adoption of Improved Dairy Farming Practices

The study found that adoption of improved dairy practices was higher in Udham Singh Nagar compared to Nainital. Practices such as artificial insemination, vaccination, balanced feeding, and clean milk production were more commonly adopted in the plains region. This can be attributed to better access to infrastructure, veterinary services, input delivery systems, and market linkages in the plains. Similar findings have been reported in recent studies, which highlight that access to extension services, institutional support, and market integration significantly enhances the adoption of improved livestock technologies (Kumar *et al.*, 2024; FAO, 2022) ^[12, 6].

Lower adoption of capital-intensive practices such as scientific housing and systematic record keeping in Nainital can be attributed to limited financial resources, difficult terrain, and infrastructural constraints. Farmers in hilly regions often face challenges related to input accessibility, credit availability, and technical know-how, which restrict the adoption of improved practices. Similar observations have been reported in recent literature, where resource limitations and weak institutional support systems were identified as key barriers to technology adoption in hill agriculture (Singh *et al.*, 2020) ^[19].

4.3 Comparison of Adoption Between Districts

The results indicate that a significantly higher proportion of farmers in Udham Singh Nagar fall under the medium and high adoption categories, whereas low adoption predominates in Nainital. This disparity can be attributed to better access to extension services, veterinary infrastructure, credit facilities, and organized milk marketing systems in the plains region. Similar regional disparities in dairy

development have been reported by Singh *et al.* (2018) ^[20], who emphasized that institutional support and market linkages play a crucial role in enhancing dairy productivity and the adoption of improved practices

4.4 Determinants of Adoption of Improved Dairy Practices

The logistic regression analysis identified education, landholding, herd size, extension contact, training exposure and access to credit as significant determinants of adoption. The positive influence of education suggests that educated farmers are better able to access and utilize information related to improved dairy technologies, which aligns with the findings of (Feder 1985) ^[4], who emphasized the role of human capital in technology adoption.

Training exposure and extension contact were found to significantly influence adoption behaviour, supporting the findings of Sri & Suhasini (2020) ^[22], who highlighted the critical role of extension systems in promoting agricultural innovations. The positive effect of herd size indicates that farmers with larger herds are more likely to invest in improved practices to enhance productivity and profitability. This is consistent with the observations of Kaur, P. (2019) ^[8] who reported that herd size significantly influences adoption decisions in dairy farming.

Access to credit also emerged as a significant determinant, underscoring the importance of financial support in facilitating investment in improved dairy technologies. This finding corroborates the work of (Korir *et al.*, 2023) ^[10], who argued that financial constraints remain a major barrier to technology adoption among smallholder farmers.

5. Conclusion

The study revealed significant differences in the adoption of improved dairy farming practices between the hill district of Nainital and the plain district of Udham Singh Nagar. Farmers in Udham Singh Nagar exhibited higher adoption levels, particularly for practices such as artificial insemination, vaccination, deworming, and balanced feeding, while scientific housing and record keeping remained less adopted, especially in Nainital. Logistic regression analysis identified education, landholding, herd size, extension contact, training exposure, and access to credit as significant determinants of adoption, with training exposure emerging as the most influential factor. The findings emphasize that strengthening farmer training, extension services, and institutional support, along with improving access to credit, can substantially enhance the adoption of improved dairy farming practices. Location-specific interventions are therefore essential to bridge regional disparities and promote sustainable dairy development in Uttarakhand

6. Policy Implications

- Improve training programs for farmers, since training experience proved to be the most important factor for adoption.
- Provide better extension support in terms of making field visits and demonstration services in order to improve awareness regarding advanced dairy techniques.
- Provide easy access to cheap institutional finance

facilities so that farmers can have money to invest in dairy technologies.

- Work on designing region-specific dairy development plans, particularly focusing on solving problems facing farmers in hills such as Nainital.
- Strengthen the system of veterinary and input supply so that the necessary breeding, health, and feeding facilities could be made available.
- Encourage the adoption of low cost scientific practices like record keeping, balanced feeding, and scientific housing.
- Better coordination between the Department of Animal Husbandry, dairy cooperatives, KVKs, and other extension institutions for the dissemination of dairy technologies.
- Focus on developing infrastructure and marketing facilities for hills so that there would be less disparity in the adoption of dairy technologies among different regions.

7. Limitations

- Limited to two districts of Uttarakhand only, thus results cannot be generalized for other areas.
- Use of cross-sectional/ex-post-facto research design, which restricts identification of cause-and-effect relationship between adoption of the technology and its causes.
- Self-reported responses of the adopters, which could lead to recall/response biases.
- Limitation to socio-economic and institutional causes, as behavioral and psychological reasons for adoption were not considered.

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