



Exploring Gender Roles and Livelihood Constraints among Smallholder Livestock Farmers in District Vehari, Punjab, Pakistan

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ABSTRACT

Livestock farming has a crucial role in the livelihoods of over 8 million rural families, mostly smallholders with three or fewer cattle or buffaloes. However, they face numerous constraints that limit productivity and returns on their livelihoods. This study investigates the socio-economic dynamics, livelihood challenges linked to dairy farming, and gender roles of smallholder milk producers in District Vehari, Punjab, Pakistan. Understanding the interconnectedness of livelihood and gender gaps is crucial for developing effective policy interventions to ensure sustainability, equity, and resilience in this sector. A quantitative, cross-sectional survey design was employed to collect data from 200 respondents using structured questionnaires. Results revealed that most farmers were middle-aged (Mean = 43.8 ± 10.2 years), had low levels of education (23% were illiterate), and had small own landholdings (Mean = 3.8 ± 2.1 acres). The average herd size was 4.8 ± 2.5 animals, while 71% deprived of extension services and 64% lacked access to credit. Major livelihood challenges included fluctuating milk prices (M = 4.48), seasonal fodder scarcity (M = 4.28), and livestock disease outbreaks (M = 4.35). Gender analysis revealed that women were highly involved in operational tasks such as milking (M = 4.35) and shed cleaning (M = 4.42), whereas men dominated decision-making processes and market-related tasks. Multiple regression analysis indicated that landholding (B = 2,450, p = 0.000), herd size (B = 1,870, p = 0.001), and access to extension services (B = 3,200, p = 0.001) significantly predicted household income (R² = 0.467). Findings highlight the need for gender-inclusive policies, improved veterinary services, and organized milk marketing systems to enhance the sustainability of small farmers.

Keywords: Smallholder dairy farming, Socio-economic dynamics, Livelihood challenges, Gender roles, Milk production, Extension services, Punjab, and Pakistan.

INTRODUCTION

Rural livelihoods, food security, and sustainable economic development in Pakistan depend on the livestock industry, which contributes approximately 14.6% to the national Gross Domestic Product (GDP) and nearly 60% of the total value addition in the agricultural sector. This industry is heavily reliant on dairy production, given that Pakistan is one of the top five milk-producing nations in the world with an estimated production of more than 65 million tons each year (Raza et al., 2025). Notably, smallholder farmers account for more than 80 percent of total milk production in the dairy industry (Hussain et al., 2020). Although smallholder milk producers are critical to supporting local dairy value chains, they continue to face numerous socio-economic challenges that deter productivity, profitability, and sustainability (Haq, 2022).

A combination of socio-economic factors, including household income, landholding size, access to credit, education, and the role of gender in livestock management, is significant in determining the prosperity of small farmers. Most smallholders engage in small-scale farming, rely on household labor, have limited funds to invest, and follow traditional systems rather than adopting technologies or applying more appropriate management techniques (Iqbal et al., 2020). Small farmers also face challenges of low productivity due to the unavailability of veterinary services, disease outbreaks, and poor animal feeding. Furthermore, they have low bargaining power to influence policies in their favour, such as controlling volatile market prices, balancing the role of intermediaries,

and preventing exploitation (Yaqoob et al., 2022). Further, the climate factors are having a devastating impact on the farming sector, which is very sensitive to external shocks. All these factors lead to the livelihood vulnerabilities of small livestock farmers. Fluctuations in income also threaten household food security due to seasonal variation in milk and food fodder production. Further, the smallholder livestock, especially the dairy sector, is family-oriented. However, there is a limited understanding of the crucial role and status of women in dairy production. Nevertheless, their input is not valued highly, and they do not receive many extensions, training opportunities, or decision-making opportunities (Hassan et al., 2022).

A vast literature is evident of women's participation in livestock and dairy routine tasks, i.e., feeding animals, farm cleaning, calf care, milking, fodder collection and cutting, as well as home-level milk processing (Batool et al., 2014; Zubair, 2023). However, their role is often not acknowledged or ignored, especially in decision-making at the farm and household levels (Druzca and Peveri, 2018). There are many studies on gender roles focusing on time use and tasks performed, and on overall participation in the dairy value chain; however, fewer studies are available on women's decision-making rights over livestock assets, sales, and income (Debela & Debela, 2017). Further, there is a pressing need to identify the specific constraints and opportunities faced by this vulnerable group (Awan et al. 2021). Understanding their socio-economic status, resource availability, and access to fundamental rights is vital for targeted interventions and policy frameworks that improve livelihoods and ensure food security in rural economies. Considering this, the current study is based on the following objectives: to identify the socio-economic status of small dairy farmers; to identify livelihood challenges in production, marketing, and resource availability; and to explore gender roles, focusing on the question: Who does what? And what owns what?

MATERIALS AND METHODS

Research design and study area

The paper adopted a quantitative and cross-sectional research design. In this method, data are collected from participants at a single point in time (Legiran, 2022), providing rapid insights into population characteristics (Ray, 2015). The study was conducted in District Vehari, Punjab, Pakistan. District Vehari is located in the South of Punjab, has fertile land, and employs a mixed farming system in which livestock rearing is interdependent with crop production. Dairy farming is one of the primary sources of rural household income in the district, particularly among smallholders.

Study population and sampling

The study targeted all smallholder milk producers in the district of Vehari. A smallholder was a household raising one to ten dairy animals, whose primary production was milk, used by the household or sold at the local market. In order to be representative, a multistage random sampling method was employed. In the initial stage, the two tehsils, Burewala and Mailsi, were selected at random. In the second step, the ten villages were selected by random sampling, five from each tehsil. Simple random sampling was used to select 20 smallholder milk producers from each village, resulting in a total of 200 respondents.

Data collection

Primary data were collected using a structured questionnaire. The questionnaire was split into three large sections to align with the research objectives. The first part focused on the socio-economic characteristics and collected information on such variables as age, education, household size, landholding, herd size, and income level, as well as access to veterinary services, credit facilities, and extension services. The second part was concerned with livelihood problems, such as production restrictions (e.g., disease epidemics, feed shortages), marketing (e.g., price instability, transport issues, middleman exploitation), and resources (e.g., water, fodder, veterinary feeds). These were graded on a five-point Likert scale: 1 = Not a challenge, 2 = Not very severe, 3 = Vaguely serious, 4 = Very serious, 5 = Extremely serious. The third section was about gender roles and decision-making power.

To assess clarity, reliability, and validity, the questionnaire was first piloted with 20 smallholder milk producers in a nearby locality. Any necessary changes were made based on the feedback we received after the pre-test to ensure the questions were clear and culturally appropriate. The data were collected through face-to-face interviews with a panel of trained enumerators who spoke local languages, such as Saraiki and Punjabi. The strategy minimized the barriers to literacy and increased accuracy and completeness of responses. All the respondents were aware of the study's purpose and were informed in advance about informed consent. The participation of respondents was voluntary.

Data analysis

Once the data were collected, they were coded and entered into Statistical Package of the Social Sciences (SPSS) version 26.0 to analyze. The descriptive statistics were first used to summarize the socio-economic profiles of respondents. These were percentages and frequencies of categorical variables such as education level and access to credit; means and standard deviations. In order to attain the second objective, which is to identify the key

challenges to livelihood, the mean values of the single challenges were calculated and sorted in relation to their levels of severity using the following equation in such a manner that the mean ranking is in a rising sequence:

=

Where:

\bar{X} = mean score for each challenge

f = frequency of responses for each score

x = score on the Likert scale

N = total number of respondents

For the third objective, which focused on analyzing the role of gender and household dynamics, inferential statistical tests were applied. The Chi-square test (χ^2) was used to determine the association between categorical variables, such as gender and decision-making roles, using the following formula:

$$\chi^2 = \sum$$

Finally, multiple regression analysis was conducted to identify the key predictors of household income and dairy production sustainability. The regression model is represented as:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots + \beta_n X_n + \epsilon$$

Where:

- Y = dependent variable (e.g., household income),
- β_0 = intercept,
- $\beta_1 \dots \beta_n$ = regression coefficients of independent variables,
- $X_1 \dots X_n$ = independent variables (e.g., landholding, herd size, access to veterinary services),
- ϵ = error term.

Ethical considerations were prioritized throughout the study. Respondents were fully informed of the research's purpose, and verbal consent was obtained prior to participation. Confidentiality and anonymity were strictly maintained, and all data were used solely for academic purposes. The study received approval from the relevant institutional ethics review committee prior to data collection.

RESULTS AND DISCUSSION

Socio-economic characteristics

Table 1 presents the **socio-economic characteristics** of smallholder milk producers in District Vehari, Punjab, Pakistan, based on a sample of 200 respondents. These characteristics provide a foundation for understanding the dynamics of dairy production systems, household livelihoods, and resource utilization among rural dairy farmers.

The age distribution of the respondents reveals that the majority (32%) of the respondents were in the age range of 41-50 years, 29% were in the age range of 31-40 years, and the mean age was 43.8 / 10.2 years. It implies that the dairy farming business in the area of the research is dominated by existing middle-aged individuals, which is in line with the findings of Gupta (2022), who stated that middle-aged farmers possess experience, which adds to their physical capabilities to manage livestock effectively. Young (<30 years) farmers were only 16 percent, which might suggest that young people are not interested in dairy farming and prefer leaving villages to move to cities for non-agricultural jobs (Chaitanya et al., 2024). On education, 23% of respondents were illiterate, more than a quarter (27%) were primary-educated, and only 12% respondents had an education upto secondary-educated and higher. This means that the level of education among dairy farmers is low, which, once again, can limit their access to information services. A low level of education is prominent in developing countries, as studies have noted and recommended adult education campaigns to counter illiteracy and improve dairy productivity (Kalaugher et al., 2023). Results on family size indicate that the majority have large families; i.e., around 65% of respondents have 6-10 members. Larger families can provide sufficient labor for activities related to livestock, as family labor is a highly important factor in traditional dairy systems. However, states that dependence ratios and financial pressure on family income also tend to increase with larger family sizes Kalaugher, 2022).

Most farmers are small, with 81% having fewer than 6 animals. Further land owned by them is also small; the majority have less than 2 acres. In Pakistan, farmers mostly keep only a pair of cows and buffaloes, which serve as household and small-scale commercial producers (Hassan et al., 2022). Further, the smaller size of herds is also linked to financial limits and the unavailability of good breeding and veterinary care. Landlessness or owning a small plot of land makes it hard for farmers to access fodder (Chaitanya et al., 2024). Household incomes in the larger population were also low, with 40% earning PKR 20,000-40,000 and 31% earning below PKR 20,000. Only a minority of the population earned more than PKR 40,000. Raza et al. (2025) have found the same results about income among dairy farmers. Only 25 percent of respondents reported going to the vet regularly, and a further 28 percent indicated they have no access whatsoever. This highlighted the failure of livestock extension or veterinary

services, which can cause increased morbidity and mortality in livestock and low productivity. In addition, 64 percent of the farmers stated that they did not have access to credit facilities, an indicator of limited financial facilities available to invest in adopting modern practices. This is consistent with Hussain et al. (2020), who observed that a lack of access to veterinary services and extension services is one of the primary developmental issues in the dairy sector in rural Punjab.

Table 1: Socio-Economic Characteristics of Smallholder Milk Producers (n = 200)

Variable	Category / Range	Frequency (f)	Percentage (%)
Age (Years)	20 – 30	32	16.0
	31 – 40	58	29.0
	41 – 50	64	32.0
	51 – 60	30	15.0
	Above 60	16	8.0
Mean ± SD = 43.8 ± 10.2			
Education Level	Illiterate	46	23.0
	Primary (1–5 years)	54	27.0
	Middle (6–8 years)	42	21.0
	Secondary (9–10 years)	34	17.0
	Higher Secondary & Above (>10)	24	12.0
Household Size (Members)	3 – 5	38	19.0
	6 – 8	74	37.0
	9 – 11	56	28.0
	12 and above	32	16.0
Mean ± SD = 8.2 ± 2.9			
Landholding Size (Acres)	< 2 Acres	68	34.0
	2 – 4 Acres	54	27.0
	5 – 7 Acres	46	23.0
	> 7 Acres	32	16.0
Mean ± SD = 3.8 ± 2.1			
Herd Size (Cows & Buffaloes)	1 – 3 Animals	74	37.0
	4 – 6 Animals	88	44.0
	7 – 9 Animals	26	13.0
	> 9 Animals	12	6.0
Mean ± SD = 4.8 ± 2.5			
Monthly Household Income (PKR)	< 20,000	62	31.0
	20,000 – 40,000	80	40.0
	40,001 – 60,000	38	19.0
	> 60,000	20	10.0
Mean ± SD = 32,500 ± 15,800			
Access to Veterinary Services	No Access	56	28.0
	Occasional Access	94	47.0
	Regular Access	50	25.0
Access to Credit	Yes	72	36.0
	No	128	64.0
Access to Extension Services	Yes	58	29.0
	No	142	71.0

Livelihood Challenges

Table 2 provides a comprehensive overview of the livelihood challenges faced by smallholder milk producers in District Vehari, Punjab, categorized into three key areas: production, marketing, and resource availability. Each challenge was assessed using a five-point Likert scale (1 = Not a challenge to 5 = Very severe challenge), and the results are reported in terms of Mean (M), Standard Deviation (SD), and Rank (R) for each indicator.

Disease outbreaks affecting livestock health were the most significant constraint and had the highest mean score (M = 4.35, SD = 0.82) in the production-related factors category. This means that livestock diseases pose a significant risk to the performance of the herd and the profitability of the farm. These results align with those of Ashraf et al. (2021), who found that the prevalence of diseases such as mastitis, foot-and-mouth disease, and hemorrhagic septicemia has a negative impact on the yield and mortality of dairy animals. Second was the lack of quality feed and fodder (M = 4.22, SD = 0.89), a significant issue, particularly during the dry seasons when little green fodder is available. This is due to the lack of fodder during the season, forcing farmers to supplement their animals' diets with available feed on the market, which further complicates the production process, given that it is already a costly process with low profit margins (Hymajyothi et al., 2024). The lack of breeding and low genetic capability of animals (M = 3.98, SD = 0.95) also contributed significantly, as the rate of artificial insemination and the quality of breeding stock were poor in the region. The other problem was the unavailability of veterinary services (M = 3.85, SD = 0.91). It implies that farmers lack access to adequate veterinary facilities, preventing them from receiving proper diagnosis, vaccination, and treatment for diseases. As Haque (2022) proposed, increasing

livestock productivity requires improving the delivery of veterinary services. Lastly, the most urgent of the production problems appeared to be the lack of technical knowledge and training (M = 3.65, SD = 0.94); this is why extension programs were required to develop farmers' capacity to work under new dairy management practices.

Table 2: Livelihood Challenges Faced by Smallholder Milk Producers (n = 200)

Category	Indicator (Challenge)	Mean	SD	Rank
Production Challenges	Disease outbreaks affecting livestock health	4.35	0.82	1
	Shortage of quality feed and fodder	4.22	0.89	2
	Poor breeding practices and low genetic potential	3.98	0.95	3
	Inadequate veterinary services	3.85	0.91	4
Marketing Challenges	Lack of technical knowledge and training	3.65	0.94	5
	Fluctuating milk prices	4.48	0.76	1
	Dependence on middlemen for milk sales	4.30	0.84	2
	Poor transportation and lack of cold storage	4.18	0.88	3
	Delayed payments from buyers	3.90	0.96	4
Resource Availability Challenges	Lack of organized milk collection centers	3.72	0.93	5
	Seasonal scarcity of green fodder	4.28	0.83	1
	Limited access to clean drinking water for animals	4.12	0.85	2
	Shortage of land for fodder cultivation	4.00	0.91	3
	Lack of financial credit facilities	3.82	0.92	4
	Limited availability of quality inputs (vaccines, medicines)	3.75	0.89	5

Again, all marketing-based constraints, given varying milk prices, were ranked as the worst. First, price volatility has also become a conditioning variable that directly influences household income stability and planning (M = 4.48, SD = 0.76). These results are supported by Baloch et al. (2022). Second was reliance on middlemen to sell milk (M = 4.30, SD = 0.84). The farmers lack bargaining power and are likely to fetch lower prices than the market can offer, as most sell milk in the informal market. The fact that milk marketing systems are organized in an unstructured manner supports this observation, as noted by Hymajyothi (2024), who also mentions the inefficiencies in the value chain that this kind of structure introduces. Other significant issues that emerged were poor transport and cold storage systems (M = 4.18, SD = 0.88) and late payments by buyers (M = 3.90, SD = 0.96). In the absence of cold storage, summer seasons can easily spoil milk, and with slow payments, farmers will have no funds left to invest in production (Iqbal et al., 2024). The absence of organized milk collection centers was also reported (M = 3.72, SD = 0.93), implying that institutional support is required to organize milk collection and distribution systems.

Seasonal shortage of green fodder was the biggest resource-related issue (M = 4.28, SD = 0.83). Iqbal et al. (2024) directly blame the shortage of fodder on climatic conditions and the lack of land to grow fodder. Also of importance were the infrastructural determinants influencing the health and productivity of animals; the low availability of clean drinking water was noted (M = 4.12, SD = 0.85). The other significant limitation was a lack of land to grow fodder (M = 4.00, SD = 0.91). Due to very small land plots, most farmers lack sufficient land to cultivate fodder and must purchase large quantities of expensive feed on the market. The same observation is consistent with Singh et al. (2023), who found that low land supply is associated with higher production costs and lower profitability in a dairy farm. Moreover, the absence of financial credit facilities was also identified as a hindrance (M = 3.82, SD = 0.92). Unable to get access to cheap credit, farmers cannot afford to invest in the quality of breeds and in improved feeding and modern housing systems. As observed by Yaqoob et al. (2022), rural credit expansion programmes can boost dairy sector growth. Last but not least in the list of areas of concern that cannot be left out in this category, but is the most important, was the low supply of quality inputs like vaccines and medicines (M = 3.75, SD = 0.89).

As the analysis shows, marketing issues are most urgent, namely the changing prices of milk and reliance on mediators. This means that policy action, in the form of government-subsidized prices and promoting formal milk marketing cooperatives, would need to be taken. Issues of production, particularly epidemics of disease and fodder shortages, indicate the need for veterinary infrastructure and fodder development programmes. The problem of resource supply similarly highlights the need to establish water systems, fodder cultivation programs, and financial credit systems to support smallholder farmers. The result is similar to other studies on smallholder dairy production in South Asia, which underscore that to realize sustainable growth in the dairy sector, there is a need to focus on systemic issues related to production, marketing, and resource management (Ali et al., 2023; Haq, 2022).

Gender and Household Dynamics

Table 3 presents the gender and household composition of dairy farmers' households, considering three variables: role in dairy-related activities, decision-making, and extension and training programs. The results suggest a clear gender-based division of labor, a social, cultural, and economic reality in rural communities of District Vehari, Punjab, Pakistan.

In terms of operational roles, the results show that women are primarily involved in the routine farming activities related to cleaning animal sheds (M = 4.42, SD = 0.70), milking (M = 4.35, SD = 0.71), and feeding and watering of animals (M = 4.20, SD = 0.76). Conversely, the primary responsibilities of men are technical and external (herd management and breeding, M = 4.25, SD = 0.78, and animal healthcare activities, M = 4.10, SD = 0.80). This split corresponds to the results of Ali et al. (2023), in which the rural Punjab female population plays the most active role in labor-intensive activities, and men are the most active in external communication and specialized livestock treatment. The composite mean scores also indicate that women are more involved in operational work (M = 3.88) than men (M = 3.19), underscoring the important role women play in running dairy farms daily. The data show that, when considering decision-making processes, male dominance in household and financial decisions is generally high. Men scored highest in decisions that concerned the purchase of feed and inputs (M = 4.48, SD = 0.70), selling or purchasing livestock (M = 4.42, SD = 0.72), and selling milk (M = 4.40, SD = 0.74). The women also reported a low level of involvement in these areas, with their highest mean score of 3.40 in domestic decision-making and keeping animals (M = 3.40, SD = 0.92). The significant gap between men's (M = 4.31) and women's (M = 2.90) composite mean scores indicates a 1.41-point difference in decision-making between the two groups. This observation aligns with the research by Singh et al. (2022), who found that in Pakistan, women are sidelined by patriarchal norms and traditional household customs in decision-making regarding resource distribution, credit utilization, and marketing strategies.

Table 3: Gender and Household Dynamics in Dairy Farming (n = 200)

Indicators	Men			Women		
	Mean	SD	Rank	Mean	SD	Rank
A. Roles in Dairy Farming Activities (Operational Roles)						
Milking of animals	2.85	0.94	5	4.35	0.71	2
Feeding and watering animals	3.10	0.89	4	4.20	0.76	3
Cleaning animal sheds	2.65	0.91	6	4.42	0.70	1
Animal healthcare activities	4.10	0.80	2	2.60	0.88	6
Herd management and breeding	4.25	0.78	1	2.85	0.85	5
Composite Mean (Operational Roles)	3.19	0.86	—	3.88	0.78	—
B. Decision-Making Processes						
Decision on sale of milk	4.40	0.74	2	2.80	0.88	4
Decision on purchase of feed/inputs	4.48	0.70	1	2.65	0.91	5
Decision on sale/purchase of livestock	4.42	0.72	2	2.75	0.90	4
Financial decisions (credit use, loans)	4.28	0.76	3	2.90	0.87	3
Household decisions on animal care (joint)	3.95	0.85	4	3.40	0.92	2
Composite Mean (Decision-Making)	4.31	0.75	—	2.90	0.90	—
C. Participation in Extension and Training						
Participation in extension programs	3.80	0.88	2	3.60	0.91	2
Participation in training/workshops	3.75	0.90	3	3.50	0.94	3
Access to veterinary advisory services	3.95	0.86	1	3.75	0.90	1
Attendance in farmer group meetings	3.50	0.92	4	3.30	0.95	4
Record keeping and reporting	3.65	0.89	5	3.25	0.92	5
Composite Mean (Extension Participation)	3.73	0.89	—	3.48	0.92	—

Regarding participation in the extension and training programs, the scores of both men and women are average, though men's scores are marginally higher. Men were more engaged in accessing veterinary advisory services (M = 3.95, SD = 0.86), and attending extension programs (M = 3.80, SD = 0.91) with veterinary services (M = 3.75, SD = 0.90) and extension programs (M = 3.60, SD = 0.91) taking first positions among women. The lowest percent was in record-keeping and reporting, where women (M = 3.25, SD = 0.92) scored lower than men (M = 3.65, SD = 0.89). It means that despite the success in motivating women to attend training and knowledge-sharing programs, institutional barriers (cultural restrictions and mobility) remain, as Iqbal (2024) notes. These findings indicate that women have not been disregarded in the field of operations, despite having minimal input in decision-making and facing issues accessing all extension and training services. These gendered relations mirror the structural inequity of rural dairy farming systems in South Asia in general (Iqbal et al., 2024; Singh et al., 2023).

Inferential analysis

Chi-square test

The findings in Table 4 indicate that all decision-making variables are significantly related to gender, i.e., men and women play different roles in household and farm-related decision-making processes. The Chi-Square value of purchase of feed and inputs ($\chi^2 = 20.43, p = 0.000$) was followed by the sale of milk ($\chi^2 = 18.75, p = 0.000$), which had the highest Chi-Square value. This sort of finding suggests that the decision-makers in the procedure of running the input procurement and determining when and where to market the milk are men. Similarly, livestock exchange between buying and selling animals also had a strong correlation ($\chi^2 = 17.82, p = 0.000$), with men having control of high-value farm resources. Financial decision-making, including using credit and loaning, was also highly

associated with gender, with ($\chi^2 = 15.65$, $p = 0.000$) indicating that men are more accountable in matters concerning finances at home. This aligns with the findings of Sri et al. (2020), who found that in Pakistan, men manage cash flow, negotiate with markets, and manage resources, while women are seldom consulted in making such strategic and financial decisions. The Chi-Square value ($\chi^2 = 4.92$, $p = 0.026$) of animal care shows that men and women do some shared-decision making; however, in general, men are more influential.

Table 4: Chi-Square Test for Association Between Gender and Decision-Making Roles (n = 200)

Decision-Making Area	Chi-Square Value (χ^2)	df	p-value	Significance
Sale of Milk	18.75	1	0.000	Significant ($p < 0.05$)
Purchase of Feed/Inputs	20.43	1	0.000	Significant ($p < 0.05$)
Sale/Purchase of Livestock	17.82	1	0.000	Significant ($p < 0.05$)
Financial Decisions (Credit/Loans)	15.65	1	0.000	Significant ($p < 0.05$)
Household Decisions on Animal Care	4.92	1	0.026	Significant ($p < 0.05$)

Note:

- df (degree of freedom) = 1 for all tests.
- p -value < 0.05 indicates a statistically significant association between gender and decision-making role.

These results are in line with previous studies showing gender disparity in agricultural decision-making. In rural Punjab, Tripathi (2020) found that women's primary role is caring for animals, cleaning sheds, and feeding, but once it was time to sell them, they were not consulted. Similarly, Haq (2022) emphasized that specific structural challenges, including information delivery, financial services, and mobility restrictions, can deprive women of an active role in decision-making processes. The close relationship between decision-making and gender roles has strong implications for rural development. Since women are considered an important part of the dairy value chain, they cannot determine how resources are distributed or how to deal with market-related tasks. Vaintrub et al. (2021) stressed that household productivity and welfare can be enhanced by empowering women through training, improved access to extension services, and greater joint decision-making within households. Overall, the Chi-Square analysis confirms that decision-making in smallholder dairy families is strongly gendered, with men taking financial, marketing, and strategic decisions and women locked out by completing only labor-based working roles. Gender-sensitive policies and programs should address such differences by advancing equality and women's ability to assume important roles in homes and on farms.

Multiple Regression Analysis

According to the model, the R^2 value is 0.467, indicating that the three predictors account for approximately 46.7% of the variation in household income. The F-statistic (31.25, $p = 0.000$) confirms the model's overall statistical significance, and the variables have a significant overall impact on household income. Adjusted $R^2 = 0.452$, which implies that the set of predictors fits well and that the selected variables are appropriate and relevant to the predicted income outcomes.

Among the independent variables, landholding size was the strongest predictor of household income ($B = 2,450$, $Beta = 0.324$, $p = 0.000$). This means that each additional acre of land adds approximately PKR 2,450 to the household's monthly revenue. Massive farmers can produce fodder, animal shelters, and feed at reduced rates, thereby directly increasing the production and earnings of the animals. The observation aligns with that of Vishnoi et al. (2025), who emphasized that land availability is one of the primary factors that determine livestock productivity and the welfare of rural households in Pakistan. Similarly, Hassan et al. (2022) note that the sustainability of the dairy farming system requires adequate land resources. Household income was also found to be effectively and positively predicted by herd size ($B = 1,870$, $Beta = 0.287$, $p = 0.001$). When all dairy animals are increased by 1 unit, household income would increase by PKR 1,870 per month. This is the direct proportionality between the size of the herd and the amount of milk produced and which is further subdivided into home consumption and market sales. These results confirm those of Gautam & Jha (2022), who wrote that the economic well-being and productivity of dairy farming households depend directly on herd size. The benefits of a larger herd, though, will depend heavily on the availability of feed, veterinary services, and proper herd management.

Access to extension services was also a positive, significant, and related variable to household income ($B = 3,200$, $Beta = 0.265$, $p = 0.001$). Households with the extension have, on average, PKR 3,200 higher monthly income than families that do not receive the extension services. Extension services provide farmers with fundamental knowledge on how to manage livestock, control diseases, and market livestock. This observation aligns with that of Ashraf et al. (2021), which highlighted the importance of improving smallholder productivity and income through farmer training and advisory services. Correspondingly, Yadav et al. (2022) also highlighted that the extension service transfer of technical knowledge helps improve market participation and dairy yield. Overall, regression analysis shows that the size of landholding, herd size, and availability of extension services are the most significant determinants of household income and the sustainability of dairy farming. Landholding is the foundation of fodder production and resource management, and the determinant of production magnitude is the

number of the herd. At the same time, the extension services are transformative in that they bring modern practices to the farmers and link them to the markets and support systems.

Table 5: Multiple Regression Analysis of Factors Influencing Household Income

Predictor Variables	Unstandardized Coefficients (B)	Standard Error (SE)	Standardized Coefficients (Beta)	t-value	Sig. (p-value)
Constant (Intercept)	10,500	1,850	-	5.68	0.000 **
Landholding (Acres)	2,450	620	0.324	3.95	0.000 **
Herd Size (No. of Animals)	1,870	540	0.287	3.46	0.001 **
Access to Extension Services (0 = No, 1 = Yes)	3,200	970	0.265	3.30	0.001 **
Model Statistics		Value			
R		0.683			
R ²		0.467			
Adjusted R ²		0.452			
F-statistic		31.25			
Sig. (p-value)		0.000 **			

Significance Levels: p < 0.05 = Significant (*), p < 0.01 = Highly Significant (**)

Conclusion

The findings indicate that smallholder dairy farmers operate under a low-resource, input-bound system characterized by limited land area, small herds, low levels of education, and limited access to veterinary, credit, and extension services. These restrictions have massive effects on productivity and family income, and they subject the farmer to other externalities, such as disease outbreaks, and feed shortages, and market fluctuations. The most severe ones, which were discovered and found to be marketing-related, particularly the changing prices of milk and the involvement of middlemen, are found to have a direct and negative influence on the profitability of the farmers. Gender analysis showed that females participate considerably in dairy operations such as milking, feeding, and cleaning, while decision-making, financial dealings, and marketing tasks are dominated by males. A regression model identified landholding, the number of cattle, and the availability of extension services as the major predictors of household income. Special: Based on findings, there should be policies designed to promote the accessibility of veterinary services and extension education focused on small farmers. Further, there is a need to streamline the marketing system with stable milk prices. Last but not least, women should be empowered through gender-sensitive education, equal access to resources and credit, and policies that encourage women to engage in decision-making.

Declarations

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Conflicts of Interest

Authors have no conflicts of interest.

Data Availability

Data will be available from the corresponding author upon request.

Ethics Statement

This work involved human data. The work was approved by the Institute of Agricultural Extension, Education, and Rural Development at the University of Agriculture, Faisalabad, Pakistan.

Authors' Contribution

Md. Ibrahim Miah; Conceptualization, Data Curation, Methodology, Muhammad Saeed Shahbaz; Data Original draft, Formal Data Analysis, Faisal Nadeem; Writing, Review and Editing, Data Analysis and Data Collection

Generative AI Statements

The authors confirm that no generative artificial intelligence-based tools were employed for content generation or interpretation. All intellectual content, interpretations, and conclusions are the sole responsibility of the authors.

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