

Analyzing the Dairy Milk Supply Chain and Its Economic Impact on Household Livelihood in Paghman District

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Abstract

The dairy sector plays a significant role in rural economies by generating income, enhancing food security, and supporting household livelihoods. This study analyzes the dairy milk supply chain and examines its economic impact on household livelihoods in Paghman District, Afghanistan. The research focuses on key actors involved in the supply chain, including dairy farmers, collectors, transporters, processors, and retailers, and evaluates how value addition and market linkages influence household income and economic stability. Using a mixed-methods approach, primary data were collected through structured questionnaires and semi-structured interviews with dairy-producing households and supply chain stakeholders, complemented by secondary data from relevant reports and literature. Quantitative data were analyzed using descriptive and inferential statistical techniques, while qualitative data provided contextual insights into operational challenges and opportunities. The findings indicate that dairy milk production contributes significantly to household income, employment generation, and livelihood resilience; however, inefficiencies in transportation, limited access to cold storage, price fluctuations, and weak market coordination reduce potential economic benefits. The study concludes that strengthening supply chain integration, improving infrastructure, and enhancing institutional support can increase the economic returns of dairy farming and improve household livelihoods in the study area. The results offer practical implications for policymakers, development organizations, and agribusiness stakeholders aiming to promote sustainable dairy value chains in rural Afghanistan.

Keywords: Supply chain, Dairy, Paghman and Afghanistan

Introduction of the Problem of Practice

Dairy milk production is one of the most important livelihood activities for rural households in Afghanistan, particularly in districts such as Paghman where agriculture and livestock remain central to the local economy (Ahmadzai, 2022). Despite its potential, the dairy supply chain in Paghman District faces numerous challenges that limit production efficiency, reduce household income, and weaken the economic resilience of families who rely on livestock as a primary source of livelihood (Jawhar et al., 2024). Issues such as inadequate access to quality feed, limited veterinary services, lack of modern dairy equipment, poor market access, and unstable milk pricing create significant barriers for small-scale dairy producers. At the same time, consumer demand for fresh and reliable dairy products continues to grow in Kabul city and surrounding markets (Waldman, 2008). However, inefficiencies in the supply chain ranging from production and collection to processing and distribution prevent rural households from fully benefiting from this demand (Charkhi et al., 2024). As a result, many dairy producers remain trapped in subsistence-level operations, earning less than their potential and facing recurring financial instability (Ahmad et al., 2023). Understanding the structure, constraints, and opportunities

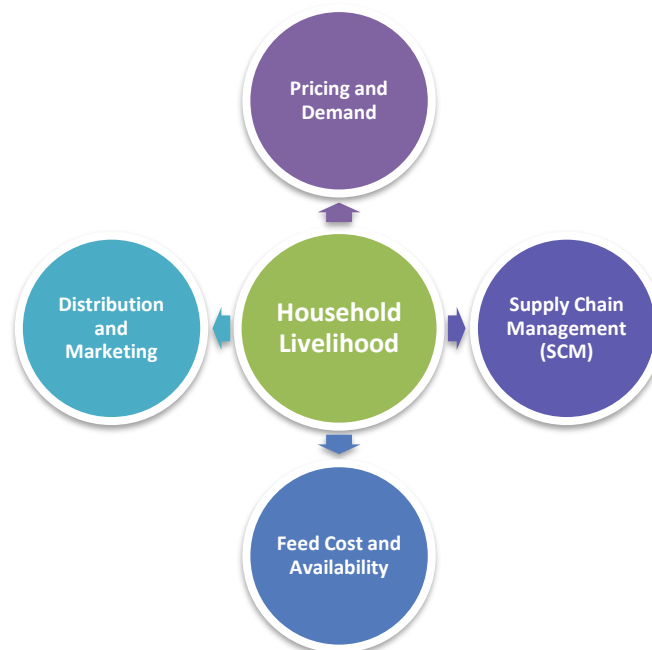
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within the dairy milk supply chain is crucial for improving productivity and strengthening household livelihood outcomes. By analyzing how milk is produced, transported, marketed, and sold, this research aims to identify practical gaps and propose solutions that can enhance income generation and economic sustainability for households in Paghman District.

The existing literature highlights the important role of livestock and dairy production in supporting rural livelihoods, household income, and food security in Afghanistan and other developing countries. Jawhar (2024) notes that Afghanistan is largely an agrarian country where livestock plays an important role in the economy and in the daily lives of rural communities. Although the livestock sector faces several challenges, including inadequate pasture, poor nutrition, limited access to clean water, animal health problems, weak breeding systems, and poor market infrastructure, small-scale livestock farming remains an important source of income, employment, and food security. Similarly, FAO et al. (2018) found that dairy production can contribute significantly to poverty reduction and improve household and community welfare, particularly when farmers have sufficient land and labour and receive adequate training, inputs, disease-control services, and access to markets. Wane et al. (2017) also demonstrated that income from milk production can strengthen household food security, particularly when farmers are able to maintain stable dairy income, diversify their sources of income, and improve livestock feeding and management. Misganaw (2020) further emphasizes that the sustainability of the dairy value chain depends on balancing economic, social, and environmental considerations. The study found that dairy farmers often bear the greatest production costs and risks, while processors and retailers receive a larger share of the value, indicating weaknesses in the distribution of benefits along the value chain. In the Afghan context, Zahir et al. (2024) highlight the importance of livestock production for addressing food insecurity and improving nutritional security, particularly in the face of population growth, climate change, and declining agricultural productivity. The authors argue that improving the entire livestock and dairy value chain requires cooperation among farmers, markets, government institutions, and other stakeholders. Overall, these studies show that strengthening dairy and livestock value chains through better production practices, veterinary and extension services, improved access to inputs and markets, fairer value distribution, and supportive policies can increase household income, improve food security, and contribute to sustainable rural livelihoods. These findings provide a strong basis for examining the dairy milk supply chain and its economic impact on household livelihoods in Paghman District.

Research Variables



Objectives

1. To identify the effect of the dairy milk supply chain on the household livelihood.
2. To explore the relationship between dairy milk supply chain and the household livelihood.
3. To know the variation between demographic profile and household livelihood impact.

Hypothesis

H1: There is significant positive effect of the dairy milk supply chain on the household livelihood.

H01: There is no significant positive effect of the dairy milk supply chain on the household livelihood.

H2: There is a positive relationship between dairy milk supply chain and the household livelihood.

H02: There is a negative relationship between dairy milk supply chain and the household livelihood.

H3: There is a positive variation between demographic profile and household livelihood impact.

H03: There is a negative variation between demographic profile and household livelihood impact.

Significance of Study

This study holds significant academic, economic, and practical importance, particularly within the context of rural development and agribusiness management in Afghanistan (Muradi, 2014). From an academic perspective, the research contributes to the limited body of empirical literature on dairy supply chain analysis in post-conflict and developing economies (Charkhi, 1395). By examining the structure, efficiency, and economic outcomes of the dairy milk supply chain in Paghman District, the study provides localized evidence that can support future research in agricultural economics, supply chain management, and livelihood studies. From a managerial and business perspective, the findings offer valuable insights for dairy farmers, cooperatives, and agribusiness entrepreneurs by identifying key inefficiencies, cost drivers, and value-adding opportunities within the dairy milk supply chain (Naima, 2017). Understanding these factors can support better decision-making, improve operational efficiency, enhance market access, and increase household income sustainability. The study also informs small-scale producers on strategies to strengthen their participation in the supply chain and improve their bargaining power (Zia, 2011). From a policy and development standpoint, the research provides evidence-based recommendations for policymakers, non-governmental organizations, and development partners working in the agricultural and rural development sectors (Wane et al., 2017). By highlighting the economic impact of dairy milk production on household livelihoods, the study supports the formulation of targeted interventions, such as infrastructure development, market linkage enhancement, and capacity-building programs. Ultimately, the study aims to contribute to sustainable livelihood improvement, poverty reduction, and food security in Paghman District and similar rural contexts in Afghanistan.

Methodology

This section presents the methodology adopted to examine the dairy milk supply chain and its economic impact on household livelihoods in Paghman District, Kabul Province, Afghanistan. The study employed a case study design with a deductive approach and descriptive research methods. Primary data were collected through a structured and standardized questionnaire administered to randomly selected households, while secondary data were obtained from journals, articles, textbooks, newspapers, internet sources, and other relevant publications. From a population of 147 households across different villages of Paghman District, a sample of 121 households was selected using the Cochran sample size calculation method. Prior to the main survey, a pilot test involving 10 households was conducted to assess the reliability of the questionnaire, with Cronbach's alpha values ranging from 0.654 to 0.917 across the study dimensions, indicating acceptable to excellent internal consistency. Data were collected through questionnaires, observations, and review of existing records, and were subsequently edited, coded, tabulated, and analyzed using SPSS. Descriptive statistical techniques were applied to assess supply chain management, distribution and marketing, feed cost and availability, pricing and demand, and the overall impact of dairy milk production on household livelihoods.

Data Analysis-Hypothesis testing

The dependency effects of understanding levels of Household livelihood on dimensions like Supply chain management, Distribution and Marketing, Feed cost and availability, Pricing and demand, among households of Paghman district is defined in hypothesis 1 and hypothesis 01, taken up and its results are shown in table-1, as an outcome of multiple regression model conceptualized. From the results, it can be inferred that the F value of 5.274 is found to be significant at 5 percent level and hence, the null hypothesis H01 is rejected and alternative hypothesis H1 is accepted. These results suggest that household livelihood depends on the group of 4 household livelihood dimensions in households of Paghman district. Further, the adjusted R square value of .125 from the table-1 indicate that 12 percent of understanding levels factor affecting household livelihood depend on this group of 4 dimensions households of Paghman district. Also the 't' values of -.561, .878, .390, 3 and 4.51 corresponding household livelihood dimensions such as The dependency effects of understanding levels of Household livelihood on dimensions like Supply chain management, Distribution and Marketing, Feed cost and availability, Pricing and demand and household livelihood are found to have significant effects on the model conceived.

More specifically, price and demand issues among households in Paghman is found to be having significant superior effect of household livelihood with highest value of 4.513. The findings clearly demonstrate that pricing and demand dynamics play a strongly positive and influential role in shaping household livelihoods in Paghman District, as reflected in the highest regression value of 4.513. Households generally perceive the market price of milk as fair, and stable demand throughout the year supports consistent income generation. However, seasonal fluctuations continue to create noticeable shifts in pricing, often affecting producers' earning capacity. Increased market demand is shown to significantly enhance household dairy income, yet the influence of middlemen and traders remains a determining factor in final market prices. Overall, the results confirm that households actively adjust their production and sales strategies in response to market demand, and these adaptive behaviors collectively contribute to improved economic stability and better livelihood outcomes for dairy-dependent families.

Similarly, distribution and marketing among Paghman household significantly good effect on household livelihood with the next higher t value of .878. The results clearly indicate that distribution and marketing mechanisms hold a meaningful and positive influence on the livelihood of dairy-producing households in Paghman District, as reflected in the next highest t-value of 0.878. The ease with which dairy products reach the market through existing distribution channels contributes to smoother income generation, while market demand and competition remain central factors in determining the price farmers receive for their milk. Access to dependable buyers and collection centers further strengthens marketing efficiency, although the limited availability of cold storage facilities continues to restrict producers' ability to maintain milk freshness and market value. Moreover, the presence of middlemen and local traders still plays a considerable role in shaping market prices, often reducing farmers' direct control over their earnings. Overall, the findings confirm that well-functioning distribution networks and marketing channels are essential components for enhancing economic stability and improving the livelihood conditions of dairy-dependent households in Paghman.

Table-1: Results of the regression for hypothesis-1

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate		
1	.592 ^a	.554	.525	1.86346		
a. Predictors: (Constant), Pricing and Demand, Feed Cost and Availability, Supply Chain Management, Distribution and Marketing						
ANOVA ^a						
Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	73.258	4	18.314	5.274	.001 ^b
	Residual	402.808	116	3.472		
	Total	476.066	120			
a. Dependent Variable: Household Livelihood						
b. Predictors: (Constant), Pricing and Demand, Feed Cost and Availability, Supply Chain Management, Distribution and Marketing						
Coefficients ^a						
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.

		B	Std. Error	Beta		
1	(Constant)	18.674	3.792		4.925	.000
	Supply Chain Management	-.032	.056	-.051	-.561	.000
	Distribution and Marketing	.045	.052	.081	.878	.382
	Feed Cost and Availability	.037	.094	.035	.390	.001
	Pricing and Demand	.349	.077	.390	4.513	.000
a. Dependent Variable: Household Livelihood						

The 't' value of .390 obtained for the feed cost and availability among households in the Paghman district causes considerable household livelihood. The findings indicate that feed cost and availability exert a notable influence on household livelihood in the Paghman district, as reflected by the obtained t-value of 0.390. Although quality animal feed is generally accessible in local markets, its affordability remains a challenge for many dairy-producing households. Seasonal variations continue to disrupt feed availability, often leading to shortages that directly affect production capacity. The increasing cost of feed further restricts households' ability to expand milk production, limiting their potential income growth. Market-related supply issues also contribute to periodic feed scarcity, making households more vulnerable during critical production periods. Despite these constraints, farmers do have access to various types of feed including green fodder, concentrates, and hay which supports the basic sustainability of dairy activities. Overall, the analysis confirms that fluctuations in feed availability and rising feed costs are important factors shaping household economic stability and the overall livelihood of dairy-dependent families in Paghman.

The 't' value of -.561 also causes significant household livelihood. This confirms the negative effects of supply chain management, the negative t-value of -0.561 suggests that weaknesses in supply chain management exert a significant adverse impact on household livelihood in Paghman District. Although some essential dairy inputs such as feed, medicines, and basic equipment are available in the local market, their accessibility is not always reliable or consistent. Transportation facilities for delivering milk to market remain limited, which increases the risk of delays and product spoilage. Households also face challenges in receiving timely supplies of necessary farm resources, including fodder and veterinary services, which hinders efficient dairy production. The existing supply chain system provides minimal support in reducing milk wastage during storage and transport, further affecting household income. Coordination among farmers, suppliers, and buyers is often weak, resulting in inefficiencies and miscommunication throughout the chain. Moreover, the cost of obtaining key dairy inputs is neither stable nor fully affordable for many households. Overall, the findings confirm that gaps and inefficiencies within the dairy supply chain negatively influence production performance and impose financial burdens that weaken household livelihood in Paghman.

Interrelationship among dairy milk supply chain and its economic impact on household livelihood factors.

The possibility of 5 factors such as Supply chain management, Distribution and Marketing, Feed cost and availability, Pricing and demand and Household livelihood relating with each other is defined in hypothesis- H2 & H02 taken up and its results are shown in table-2, as an outcome of Bivariate Correlation test. From the results it can be inferred that Pearson 'r' values between the range -.188 and 0.377 corresponding to 3 different correlations are found to be significant at 5 percent level. While these results form the basis to reject the hypothesis-H02 and accept H2. Thus, the details of all different correlations between 5 mentioned dimensions with varied levels of relationship are identified from the above results based on the standard approach (Nunnally, 1978) and provided in table-2.

Table 2. Correlations

		Supply Chain Management	Distribution and Marketing	Feed Cost and Availability	Pricing and Demand	Household Livelihood
Supply Chain Management	Pearson Correlation	1				
	Sig. (2-tailed)					
	N	121				
Distribution and Marketing	Pearson Correlation	-.277**	1			
	Sig. (2-tailed)	.002				
	N	121	121			
Feed Cost and Availability	Pearson Correlation	-.122	-.188*	1		
	Sig. (2-tailed)	.183	.039			
	N	121	121	121		
Pricing and Demand	Pearson Correlation	.028	-.157	.022	1	
	Sig. (2-tailed)	.757	.085	.814		
	N	121	121	121	121	
Household Livelihood	Pearson Correlation	-.066	.027	.034	.377**	1
	Sig. (2-tailed)	.470	.766	.712	.000	
	N	121	121	121	121	121
**. Correlation is significant at the 0.01 level (2-tailed).						
*. Correlation is significant at the 0.05 level (2-tailed).						

Supply Chain Management and Distribution and Marketing (-.277**)

There exists a weak to moderate negative relationship between Supply Chain Management and Distribution and Marketing in the dairy milk supply chain. This indicates that as inefficiencies or constraints in supply chain management increase, the effectiveness of distribution and marketing activities tends to decline. The relationship is statistically significant at the 5 percent level, suggesting that the observed association is not due to random chance. A negative correlation implies that weaknesses in supply chain coordination, transportation, or storage moderately hinder distribution and marketing performance within the dairy milk sector. Although the strength of the relationship is not strong, it is meaningful and consistent across observations. This finding suggests that improvements in supply chain management practices could contribute to better distribution and marketing outcomes for dairy milk producers in Paghman District. The statistical significance, as indicated by the low p-value, confirms that this inverse relationship is reliable and unlikely to be coincidental.

Feed Cost and Availability and Distribution and Marketing (-.188*)

There exists a weak negative relationship between Feed Cost and Availability and Distribution and Marketing within the dairy milk supply chain. This indicates that increases in feed costs or limitations in feed availability are associated with a slight decline in the effectiveness of distribution and marketing activities. The relationship is statistically significant at the 10 percent level, suggesting that the association is meaningful, though relatively weak. A weak negative correlation implies that challenges related to feed cost and availability mildly constrain distribution and marketing performance in the dairy milk sector. Although the magnitude of the relationship is

limited, it remains relevant across observations. This finding suggests that rising feed costs and inconsistent feed availability can negatively affect marketing and distribution outcomes for dairy producers in Paghman District. The statistical significance, as reflected by the low p-value, indicates that this relationship is unlikely to be purely coincidental.

Household Livelihood and Pricing and Demand (.377**)

There exists a moderate positive relationship between Household Livelihood and Pricing and Demand in the dairy milk supply chain. This indicates that improvements in pricing mechanisms and increased market demand are associated with better household livelihood outcomes. Household livelihood improves moderately as pricing becomes more favorable and demand for dairy milk increases. The relationship is statistically significant at the 5 percent level, suggesting that the observed association is reliable and not due to random variation. A moderate positive correlation implies that effective pricing strategies and strong demand moderately enhance income stability and living standards of dairy-producing households. This finding suggests that pricing and demand conditions play an important role in improving household livelihoods in the Paghman District. The low p-value further confirms that this relationship is statistically significant and unlikely to be coincidental.

Supply Chain Management and Feed Cost and Availability (-.122)

The Pearson correlation analysis reveals a weak negative relationship between dairy milk supply chain management and feed cost availability, with a Pearson correlation coefficient ($r = -0.122$). This value indicates that improvements in supply chain management are slightly associated with a reduction in feed cost constraints, although the relationship is minimal in magnitude.

The negative direction of the correlation suggests that as supply chain mechanisms such as input procurement efficiency, transportation, storage, and coordination among suppliers improve, households may experience marginal relief in feed cost availability challenges. However, the low absolute value of the coefficient signifies that supply chain management alone does not substantially influence feed cost availability in the Paghman District.

This weak association implies that other factors, such as market price volatility, seasonal feed shortages, limited local feed production, and dependence on imported feed inputs, may play a more dominant role in determining feed costs at the household level. Consequently, while supply chain improvements are necessary, they are insufficient on their own to significantly reduce feed-related economic pressures on dairy-farming households. Overall, the findings highlight the need for integrated policy interventions, combining supply chain development with targeted strategies such as local feed production support, price stabilization mechanisms, and farmer cooperatives to enhance household livelihood outcomes in the dairy sector.

Supply Chain Management and Pricing and Demand (.028)

The Pearson correlation analysis indicates a very weak positive relationship between supply chain management and pricing and demand, with a Pearson correlation coefficient ($r = 0.028$). This value suggests that improvements in supply chain management are almost unrelated to changes in pricing and demand conditions within the dairy milk sector of the Paghman District.

The positive direction of the relationship implies that better coordination, distribution efficiency, and market linkages may be associated with marginal improvements in pricing stability and demand; however, the extremely low magnitude of the coefficient indicates that this relationship is statistically and practically negligible.

This finding suggests that pricing and demand for dairy milk are largely influenced by external market forces, such as consumer purchasing power, competition from imported dairy products, seasonal consumption patterns, and informal market pricing practices, rather than by internal supply chain management efficiencies at the household level. In conclusion, while effective supply chain management is important for operational sustainability, it appears to have limited direct influence on pricing and demand dynamics, underscoring the need for broader market-oriented interventions, including price regulation mechanisms, market information systems, and demand stimulation strategies to improve household livelihoods in the dairy sector.

Pricing and Demand and Distribution and Marketing (-.157)

The Pearson correlation analysis shows a weak negative relationship between pricing and demand and distribution and marketing, with a Pearson correlation coefficient ($r = -0.157$). This result indicates that improvements in distribution and marketing activities are slightly associated with unfavorable movements in pricing and demand, although the strength of the relationship remains limited. The negative direction of the correlation suggests that inefficiencies in distribution channels, high transportation costs, limited market access, and weak marketing linkages may contribute to price distortions and reduced consumer demand in the dairy

milk market of the Paghman District. Conversely, it may also reflect that increased marketing and distribution efforts raise operational costs, which are passed on to consumers through higher prices, thereby negatively affecting demand. However, the low magnitude of the coefficient indicates that the relationship is weak, implying that distribution and marketing alone do not strongly determine pricing and demand conditions. Other external factors such as household income levels, competition from imported dairy products, seasonal milk supply variations, and informal pricing mechanisms likely exert a more substantial influence.

Overall, the findings suggest that while distribution and marketing are important components of the dairy milk supply chain, their impact on pricing and demand is limited and indirect, emphasizing the need for coordinated interventions that improve cost efficiency, market transparency, and consumer access to locally produced dairy products to enhance household livelihoods.

Pricing and Demand and Feed Cost and Availability (-.022)

The Pearson correlation analysis indicates a very weak negative relationship between pricing and demand and feed cost and availability, with a Pearson correlation coefficient ($r = -0.022$). This result suggests that changes in feed cost and availability have an almost negligible association with pricing and demand dynamics in the dairy milk sector of the Paghman District. The negative direction of the correlation implies that increases in feed costs or limitations in feed availability may be marginally associated with unfavorable pricing and demand outcomes; however, the extremely low magnitude of the coefficient indicates that this relationship lacks practical significance. This finding suggests that dairy milk pricing and demand are largely driven by market-side factors, such as consumer purchasing power, competition from imported dairy products, seasonal consumption patterns, and informal pricing practices, rather than by production input costs at the household level. It also reflects the limited capacity of small-scale dairy farmers to transfer increased feed costs to market prices without negatively affecting demand.

In conclusion, the results demonstrate that feed cost and availability alone do not play a significant role in shaping pricing and demand, highlighting the importance of broader market and policy interventions to stabilize dairy prices and improve household livelihood outcomes.

Household Livelihood and Supply Chain Management (-.066)

The Pearson correlation analysis reveals a very weak negative relationship between household livelihood and supply chain management, with a correlation coefficient ($r = -0.066$). This indicates that variations in supply chain management practices are minimally and inversely associated with household livelihood outcomes in the dairy sector of the Paghman District. The negative direction of the relationship suggests that inefficiencies within the dairy milk supply chain such as limited access to reliable input suppliers, inadequate transportation infrastructure, weak coordination among actors, and post-harvest losses may slightly constrain household livelihood improvements. However, the low magnitude of the coefficient signifies that supply chain management alone does not exert a substantial direct influence on household income, food security, or economic resilience. This weak association implies that household livelihood outcomes are predominantly influenced by broader socio-economic factors, including herd size, productivity levels, access to veterinary services, household labor availability, and market price volatility, rather than by supply chain management practices in isolation.

In conclusion, while effective supply chain management is an important structural component of the dairy sector, its direct impact on household livelihoods appears to be limited, highlighting the need for integrated livelihood-enhancement strategies that combine supply chain improvements with productivity support, financial access, and institutional development.

Household Livelihood and Distribution and Marketing (.027)

The Pearson correlation analysis indicates a very weak positive relationship between household livelihood and distribution and marketing, with a Pearson correlation coefficient ($r = 0.027$). This result suggests that improvements in distribution and marketing activities are marginally associated with better household livelihood outcomes in the dairy milk sector of the Paghman District. The positive direction of the relationship implies that enhanced market access, improved distribution channels, and better marketing practices may contribute slightly to household income generation and livelihood stability. However, the extremely low magnitude of the coefficient demonstrates that this relationship is practically negligible, indicating that distribution and marketing alone do not significantly influence household livelihood conditions.

This finding suggests that household livelihood outcomes are largely shaped by internal farm-level and socio-economic factors, such as milk productivity, feed availability, herd management practices, household labor, and access to financial services, rather than by downstream supply chain activities in isolation.

In conclusion, while distribution and marketing are essential components of a functional dairy milk supply chain, their direct contribution to improving household livelihoods appears to be limited, underscoring the need for integrated interventions that link market access with productivity enhancement and livelihood diversification strategies.

Household Livelihood and Feed Cost and Availability (.034)

The Pearson correlation analysis shows a very weak positive relationship between household livelihood and feed cost and availability, with a Pearson correlation coefficient ($r = 0.034$). This indicates that improvements in feed availability or affordability are only marginally associated with better household livelihood outcomes in the dairy milk sector of the Paghman District. The positive direction of the relationship suggests that access to reasonably priced and reliable feed may slightly support household income stability and livestock productivity. However, the extremely low magnitude of the coefficient demonstrates that this relationship is negligible in practical terms, implying that feed cost and availability alone do not significantly determine household livelihood conditions. This finding suggests that household livelihoods are influenced by a broader combination of factors, including milk yield per cow, herd size, veterinary services, labor availability, market prices, and access to credit, rather than by feed-related factors in isolation.

In conclusion, while feed cost and availability are important inputs for dairy production, their direct impact on household livelihood appears to be limited, highlighting the need for comprehensive livelihood improvement strategies that integrate productivity enhancement, market access, and institutional support within the dairy milk supply chain.

Variations in Household Livelihood with demographic profile

The variations in the Household Livelihood with various levels of demographic profiles among the household in Paghman district were measured with one-way ANOVA and independent sample t test. The corresponding results of these measurements were provided in the following sections. The details of demographic profiles considered for measuring these variations are gender, age, educational level, household size, household income, and year of experience.

Variations on Household Livelihood with gender category

The variations in Household Livelihood between male and female households in Paghman district, taken up and its results are shown in the table-3, as an outcome of independent sample t-test. From the results of this independent sample t-test, it can be inferred that the t value of -3.148 corresponding to Household Livelihood is found to be significant at 5 percent level.

Table-3: Result of T test-Gender of Household Head							
Dependent variable	Source of grouping Gender	N	Mean	Std. Deviation	Std. Error Mean	t-value	Sig.
Household Livelihood	Male	88	25.9773	2.07324	0.22101	-3.148	0.002
	Female	33	27.2121	1.43086	0.24908		
Independent Variable: Gender; *Significant at 5 percent level Source: Computed from primary data							

the results of an independent sample t-test conducted to examine variations in household livelihood between male-headed and female-headed households in the Paghman District. Gender of the household head is treated as the independent variable, while household livelihood is the dependent variable. The results show that male-headed households ($N = 88$) have a mean household livelihood score of 25.98, with a standard deviation of 2.07, whereas female-headed households ($N = 33$) report a higher mean score of 27.21, with a lower standard deviation of 1.43. This indicates that, on average, female-headed households demonstrate better household livelihood outcomes compared to male-headed households.

The computed t-value of -3.148 is statistically significant at the 5 percent level ($p = 0.002$), confirming a significant difference in household livelihood between the two gender groups. The negative t-value reflects that the mean livelihood score for female-headed households exceeds that of male-headed households.

Overall, the findings suggest that gender of the household head plays a significant role in influencing household livelihood outcomes in the study area. This difference may be attributed to variations in livelihood strategies, resource management practices, or participation in dairy-related activities among male- and female-headed households in the Paghman District.

Variations in Household Livelihood with Age

An Analysis of Variance (ANOVA) was conducted to examine whether household livelihood differs significantly across different age groups of household heads in the Paghman District. The results of the ANOVA are presented in the table-4. The findings indicate that the between-group sum of squares is 32.661 with 3 degrees of freedom, while the within-group sum of squares is 443.405 with 117 degrees of freedom. The calculated F-value is 2.873, which is statistically significant at the 5 percent level ($p = 0.039$). This result demonstrates that there is a statistically significant variation in household livelihood across different age categories. The significance of the F-test suggests that age plays an important role in influencing household livelihood outcomes, as differences in experience, labor capacity, decision-making ability, and resource management may vary across age groups.

In conclusion, the ANOVA results confirm that household livelihood is not uniform across age groups, highlighting the relevance of age as a socio-demographic factor in determining livelihood conditions within the dairy-farming households of the Paghman District. Further post-hoc analysis could identify which specific age groups differ significantly from one another.

Table 4- ANOVA BY Age

Household Livelihood	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	32.661	3	10.887	2.873	.039
Within Groups	443.405	117	3.790		
Total	476.066	120			

Variations in Household Livelihood with Educational Level

An Analysis of Variance (ANOVA) was conducted to examine whether household livelihood differs significantly across different educational levels of household heads in the Paghman District. The results of the ANOVA are presented in the table-5. The findings indicate that the between-group sum of squares is 32.661 with 3 degrees of freedom, while the within-group sum of squares is 443.405 with 117 degrees of freedom. The calculated F-value is 2.873, which is statistically significant at the 5 percent level ($p = 0.039$). This result demonstrates that there is a statistically significant variation in household livelihood across different levels of education. The significance of the F-test suggests that education plays an important role in influencing household livelihood outcomes, as higher educational attainment is often associated with improved skills, better employment opportunities, enhanced income-generating capacity, and more effective resource management.

In conclusion, the ANOVA results confirm that household livelihood is not uniform across educational levels, highlighting the relevance of education as an important socio-economic factor in determining livelihood conditions within the dairy-farming households of the Paghman District. Further post-hoc analysis could identify which specific educational groups differ significantly from one another.

Table 5 - ANOVA BY Education Level

Household Livelihood	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	32.661	3	10.887	2.873	.039
Within Groups	443.405	117	3.790		
Total	476.066	120			

Variations in Household Livelihood with Household size

An Analysis of Variance (ANOVA) was conducted to examine whether household livelihood differs significantly across different household size categories in the Paghman District. The results of the ANOVA are presented in the table-6. The findings indicate that the between-group sum of squares is 151.114 with 3 degrees of freedom, while the within-group sum of squares is 324.952 with 117 degrees of freedom. The calculated F-value is 18.136, which is statistically significant at the 1 percent level ($p = 0.000$). This result demonstrates that there is a highly statistically significant variation in household livelihood across different household sizes. The strong significance of the F-test suggests that household size plays a critical role in influencing livelihood outcomes, as larger households may experience increased dependency ratios and resource pressures, while smaller households may benefit from more efficient allocation of income, labor, and productive assets.

In conclusion, the ANOVA results confirm that household livelihood is not uniform across household size categories, highlighting household size as an important demographic determinant of livelihood conditions among dairy-farming households in the Paghman District. Further post-hoc analysis would help identify which specific household size groups differ significantly from one another.

Table 6 - ANOVA BY HH size
Household Livelihood

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	151.114	3	50.371	18.136	.000
Within Groups	324.952	117	2.777		
Total	476.066	120			

Variations in Household Livelihood with Primary source of Income

An Analysis of Variance (ANOVA) was conducted to examine whether household livelihood differs significantly across different primary sources of income among households in the Paghman District. The results of the ANOVA are presented in the table-7. The findings indicate that the between-group sum of squares is 82.924 with 4 degrees of freedom, while the within-group sum of squares is 393.142 with 116 degrees of freedom. The calculated F-value is 6.117, which is statistically significant at the 1 percent level ($p = 0.000$). This result demonstrates that there is a statistically significant variation in household livelihood across households with different primary income sources. The significance of the F-test suggests that the type of income source plays an important role in shaping livelihood outcomes, as households relying on more stable or diversified income-generating activities tend to have better livelihood conditions compared to those dependent on irregular, seasonal, or low-return income sources.

In conclusion, the ANOVA results confirm that household livelihood is not uniform across different primary sources of income, highlighting income structure as a key economic determinant of livelihood conditions among dairy-farming households in the Paghman District. Further post-hoc analysis would be useful to identify which specific income source categories differ significantly from one another.

Table 7- ANOVA BY HH Income

Household Livelihood	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	82.924	4	20.731	6.117	.000
Within Groups	393.142	116	3.389		
Total	476.066	120			

Variations in Household Livelihood with Year of Experience in dairy

An Analysis of Variance (ANOVA) was conducted to examine whether household livelihood differs significantly across different categories of years of experience in dairy farming in the Paghman District. The results of the ANOVA are presented in the table-8. The findings indicate that the between-group sum of squares is 159.980 with 1 degree of freedom, while the within-group sum of squares is 316.086 with 119 degrees of freedom. The calculated F-value is 60.229, which is statistically significant at the 1 percent level ($p = 0.000$). This result demonstrates that there is a highly statistically significant variation in household livelihood across households with different levels of experience in dairy farming. The strong significance of the F-test suggests that years of experience play a crucial role in influencing livelihood outcomes, as more experienced dairy farmers tend to exhibit superior herd management skills, higher productivity, better cost control, and stronger market participation compared to less experienced farmers.

In conclusion, the ANOVA results confirm that household livelihood is not uniform across different experience categories, highlighting years of experience in dairy farming as a key human-capital determinant of livelihood conditions among dairy-farming households in the Paghman District. The magnitude of the F-value further indicates that experience is one of the most influential socio-economic factors affecting household livelihood in the study area.

Table- 8 ANOVA BY Year of Experience
Household Livelihood

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	159.980	1	159.980	60.229	.000
Within Groups	316.086	119	2.656		
Total	476.066	120			

The variations in the overall household livelihood between different demographic characteristics such as gender, age of household head, educational level, family size, primary source of household income and years of experience in dairy farming among the farmers of paghman are defined in hypothesis H_{03} and H_3 , as an outcome of different independent sample t-tests and one-way ANOVA models. From the results of different independent sample t-tests and one-way ANOVA models shown in above tables, it can be inferred that most the t and F values corresponding to overall household livelihood on each different considered demographic characteristics are found to be significant at 5 percent level. Hence, hypothesis- H_{03} is rejected and at meantime H_3 is accepted at 5 percent level of significance. The result clearly shows that there exist significant variations in the overall household livelihood among different demographic group.

Summary of Hypothesis Testing

Hypothesis	Statement	Result
H1	There is significant positive effect of the dairy milk supply chain on household livelihood.	Accepted (Significant)
H01	There is no significant positive effect of the dairy milk supply chain on the household livelihood.	Rejected
H2	There is a positive relationship between dairy milk supply chain and the household livelihood.	Accepted (Significant)
H02	There is a negative relationship between dairy milk supply chain and the household livelihood.	Rejected
H3	There is a positive variation between demographic profile and household livelihood impact.	Accepted (Significant)
H03	There is a negative variation between demographic profile and household livelihood impact.	Rejected

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Conflict of Interest

The authors affirm that no conflicts of interest are linked with this publication. The research was conducted autonomously without financial or non-financial assistance from external entities.

Author Contribution Statement

Both authors meticulously crafted the study, devised the methodology, executed the investigation and data analysis, composed the original manuscript, and undertook the review and editing of the document. AR supervised and modify the manuscript.

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