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DETERMINING COST OF MILK PRODUCTION IN BHUTAN

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ABSTRACT: It is important to determine the cost of production to ascertain the profitability of any farming enterprises. A simple cost-benefit analysis was carried out in the selected cattle rearing districts representing four Agro-Ecological Zones (AEZs) to establish cost of production for milk in Bhutan. A total of 320 dairy units, 80 each from four AEZs were randomly sampled. The primary data were collected from dairy farmers through face-to-face interview using a pretested semi-structured questionnaire. The details of cost were estimated using Microsoft Excel and the final data set was analyzed using ANOVA in SPSS version 20. The overall average annual capital investment per dairy unit under smallholder farming system in Bhutan was Nu. 27,258. The highest investment cost was accounted for cow purchase of 38%, followed by 33.63% on farm machinery and equipment. The overall, annual average variable cost recorded was Nu. 2, 14,052 per dairy unit, with labour constituting the highest cost of 65%, followed by feed cost of 31%. The study recorded significantly higher fixed and variable costs in cooler and dryer zones in comparison to the warm and wet zones ($p<0.05$). The overall average cost of production (CoP), farm gate (FG) price and profit margin recorded for litre of milk were Nu. 26.85, 38.7 and 11.9, respectively. Both CoP and profit margin differed significantly between the AEZs ($p<0.05$). The CoP was higher in cooler (Nu. 38.9/litre) and dryer zones (Nu 31/litre) as compared to that of warmer and wetter zones. Further, CoP also significantly differed between the herd sizes ($p<0.05$), where the CoP of smaller herd size (1-5 milking cows) was almost three times higher than the bigger herd size of 6-10 milking cows. The study concludes that in general, irrespective of AEZs increase in business volume and reduction in maintenance costs through strategic interventions such as in-house production of replacement stock, improvement in availability of feed and fodder resources, efficient utilization of farm labour and application of labour-saving devices can reduce the cost of production and maximize profit in dairy farming.

Keywords: Cost-benefit analysis; cost of production; dairy farming; profit margin.

1. INTRODUCTION

Dairy farming is very popular among livestock farmers in rural Bhutan. It is one of the major sources of income and employment opportunities for the rural farming communities. Dairy farming system in Bhutan is similar to other countries in South Asia, characterized by small-scale operations which are integrated with crops and other farm activities. However, over the years, dairy sector has witnessed a paradigm shift from a largely unorganized activity into a market-oriented enterprise. Milk production has increased from 47, 270.32MT in 2016 to 57, 546.77 MT in 2019 (Department of Livestock [DoL] 2019) with estimated annual growth rate of 7.25 percent. Further, the demand for milk is projected to reach 100,034 MT by 2040 (Ministry of Agriculture [MoAF] 2020) with increasing household per capita consumption with higher disposable income. The milk demand could further increase coupled with fast changing socio- economic dynamics and as such making a paradigm shift in the production system is inevitable. The milk producers are scaling up their milk production capacities to tap the market opportunities. As a result, many dairy farmers' groups/cooperatives are formed and more individual dairy enterprises are investing substantially to modernize dairy farming to increase milk production and income.

Determining the cost of production should be considered to know a reasonable selling price for the dairy farmers (Jayaweera et al. 2007; Mburu et al. 2007 determine profitability of dairy enterprise (Mburu et al. 2007; Ghule et al. 2012) and to establish minimum wholesale and retail milk prices International Farm Comparison Network (IFCN 2015; Quddus 2018). Earlier studies on economics of milk production indicated possibilities of maximizing profit either through maximization of returns or reduction in the cost. However, returns are largely dependent on external environment of the firm which has no control of the entrepreneur. Hence, minimization of the cost is an important tool to lower the maintenance cost of the animal and reduce cost of milk production (Ghule et al. 2012; NDDB 2018). The choice of production and marketing strategies by farmers therefore, seem to contribute in determining costs and level of production. Therefore, understanding costs-benefits of dairy farming by the farmers is reported as a pre-requisite for policy formulations aimed at improving productivity levels as highlighted in studies conducted (Mburu et al. 2007; Uddin et al. 2010 and Quddus 2018). Till date, information on cost-benefit analysis of a dairy unit and associated technical parameters is scarce in the country. Therefore, this study was conducted to assess the cost of milk production in the country by AEZs, herd sizes and location by assessing fixed and variable costs investments in dairy production. The outcome of this study was intended to provide recommendation for policy directives in dairy development and setting milk prices by the dairy entrepreneurs in the country.

2. MATERIALS AND METHODS

2.1 Study location

The study was conducted in all cattle rearing agro-ecological zones (AEZs) of the country. Cattle are found distributed across all the AEZs except in highlands of Alpine zones. The different AEZs of Bhutan are classified into Alpine, Cool Temperate, Warm Temperate, Dry Subtropical, Humid and Wet Subtropical regions. The study sites (Table 1*)* were selected according to the multistage random sampling method for each AEZs

2.2 Study design and data collection

A multistage random sampling method was applied to sample Dzongkhags and Gewogs. In each AEZ, two Dzongkhags (two Gewog from each Dzongkhag) that accounts to eight district and 16 sub-districts were selected for the study. A complete list of all dairy units (a household involved in dairy farming) operating in sampled

Table 1: Potential dairy farming areas selected for the study

AEZ/Region	West	West Central	East Central	East
	Dzongkhag (*Gewog*)			
Cool Temperate (2600-3600)	Paro *(Luni & Shari)*		Bumthang (*Chokor & Chumey)*	
Warm Temperate (1800-2600)		Tsirang *(Samjong & Tsirang Toed)*		Mongar *(Mongar & Ngatshang)*
Dry Subtropical (1200-1800)		Wangdue *(Gasetshogom & Thedtsho)*		S/Jongkhar *(Deowathang & Gomdar)*
Wet & Humid Subtropical (100-1200)	Samtse (*Yoseltshe & Tading)*		Sarpang *(Chudzon & Gelephu)*	

area was obtained. In total, 320 dairy units, 40 from each district (20/Gewog) were randomly selected considering the following selection criteria a) proportionate representation of production systems (Farmers' group member and non-member; b) herd size of milking cows (less or more than five cows) and c) location of cluster of dairy units (one cluster near the market and the other distant from market). The sampling method and selection criteria were applied to give a fair representation of the dairy farming system in a way to find out the cost of milk production in the country. The primary data were collected through face-to-face interview method using pretested structured questionnaire.

2.3 Data analysis

The details of cost were estimated using Microsoft Excel and the final data set was analyzed in SPSS version 20 (Landau and Everitt 2004). Analysis of Variance (ANOVA) was used to test the difference in various costs per litre of milk production and profit margin between different AEZs. Post Hoc LSD test was used to test significant difference variation between means. An independent sample t-test was used to test difference in CoP between herd sizes and location of dairy units. Difference between means was considered significant if *p* values were less than 0.05.

2.4 Parameters used for cost-benefit analysis

Capital investment, costs and returns concepts were adapted from Ghule et al. (2012) and National Dairy Development Board (NDDB 2018) considering the nature of Bhutanese mixed farming practices of livestock rearing simultaneously with crop cultivation. Cost and milk yields are computed for one year in each dairy unit. The cost of labour, machinery and other operating expenses were apportioned for dairy farming activities. As dairy farmers maintain animals of different categories and age groups, the relative share of the maintenance cost attributable to milking stock, the cattle maintained at each dairy unit was converted into Livestock Units (LU) as per the standards reported (Wangchuk et al. 2008). The total cost was apportioned on the basis of relative assigned weights converted to LU for the cow, heifer, bull and calf as 1, 0.70, 1 and 0.33 respectively.

A. Fixed cost

Fixed costs are the investment made in an enterprise. Level of investment reflects the extent of business activity and its income generating capacity in the long term. In this study, fixed costs comprised of depreciation on animal, shed, farm machinery and dairy equipment, land rentals and interest on fixed capital. Depreciation on fixed capital for cattle shed, machinery and equipment were worked out applying the Department of National Property (DNP 2016), considering present market value and useful economic life of the capital asset. Interest on fixed capital was worked out based on average loans rate of 11% levied by the Bhutan Development Bank Limited (BDBL 2019) to the rural communities.

i. Animal/herd

Stock inventory of the animal herd of each dairy unit was categorized into two groups, purchased or replaced from within the herd. For the purchased group, values used were actual purchased price and for those animals replaced from within the herd, imputed the values by asking the farmer potential current market price that particular animal could fetch. Investment on animal was derived by adding the government subsidy amount (for those who availed) and the price paid by the farmer. Depreciation on milking animals was worked out based on latest analysis of (Ghule et al. 2012) i.e., cross- bred cows - 8 percent (productive life 12.2 years) and local cows - 10 percent (productive life 10 years).

ii. Cattle shed

Cattle shed was categorized into three types; improved (proper housing with concrete feeding trough and floor) traditional (rammed mud and timber), and temporary shed (just roof with open sides. The cost of the cattle shed was obtained in two ways i) used actual expenses for those recently constructed shed and for those constructed earlier, cost was estimated by asking the farmer potential current expenses that could incur to construct that particular type of shed. Investment on cattle shed was derived by adding government subsidy amount (for those who availed) and actual expenses farmers spent. Depreciation of the shed was calculated at 5 percent (DNP 2016)

iii. Farm machinery and equipment

Detail list of farm machinery and equipment used for forage production and basic dairy processing were obtained along with price paid and depreciation was calculated at DNP (2016) rate. From the total investment in farm machinery, share for dairy farming was apportioned (30% for power tillers, tractors and utility vehicle; 20% for grass cutters; 100% for chaff cutter and butter churners).

iv. Land rentals

Land rental was derived by multiplying acreage of land rented for dairy purpose with prevailing rates per acre in the locality.

B. Variable costs

These costs comprise of expenses on feed, labour, hire of farm machinery and miscellaneous cost.

i. **Feed cost**

This comprises of only cost incurred on purchased feed such as concentrate, mustard oil cake, cereal grains, crop residue, brewer's grain etc. The cost was worked out by multiplying quantities purchased with the respective prevailing prices of the feed in the study area.

ii. Labour cost

Labour is classified into two types- hired and family which are further broken down into full time and part time. Full time hired labour is the permanent labour kept in dairy unit on salary basis, while part time is labour hired occasionally to do seasonal dairy works. In case of family labour, both full time and part time labour is converted into total labour by aggregating time devoted for dairy activities such as tending animals, fodder collection, milking, feeding animals, cleaning shed, processing of milk and so on apart from crop cultivation and other off-farm activities.

Cost calculations were: a) Full time hired labour (Number of labour X salary); b) Part time hired labour (Number of man days X prevailing daily wage rate of that locality); c) Family labour (Total labour X prevailing daily wage rate of that locality). Added all to form labour cost.

iii. Cost on hire of farm machinery

Cost of hiring farm machinery for the dairy related activities were obtained based on the prevailing rates of that locality.

iv. Miscellaneous cost

The cost of electricity, water, agricultural implements etc. were apportioned for the dairy farming.

v. Veterinary cost

This cost was not included in the calculation as it is provided free of costs by the government unlike in other countries.

C. Maintenance cost

It was obtained by adding up all cost components of the fixed and variable costs apportioned on LU basis.

2.5 Cost of milk production

In order to estimate the cost of milk per litre, following equation from Ghule et al. (2012) was adopted:

$$\text{Cost Per Litre (Nu.)} = \frac{\text{Net maintenance cost per animal per year}}{\text{Total milk produced per animal per year}}$$

2.6 Farm gate price

It is the price of milk per litre received at the farm or from farmers' institution exclusive of transport or delivery charges.

2.7 Profit margin

It is the difference between cost of milk per litre production and its farm gate price received by the milk producers.

3. RESULTS AND DISCUSSIONS

3.1 Profile of dairy enterprise

Characteristics of dairy units provided a profound outlook on how dairy enterprises are operated, the size and scale, which influences the decision-making process and profitability of dairy enterprise. The findings (Table 1) revealed that dairy farming is relatively gender-neutral activity where both male (46.6%) and female (53.8%) members are equally involved and were in the productive age group (45.91 years).

Table 1: General characteristics, herd composition and dairy holding of sampled dairy units

Variables	Cool Temperate	Warm Temperate	Dry Subtropical	Wet Subtropical	Overall
No of respondents (n)	80	80	80	80	320
Average age (years)	46	49.36	44.06	44.20	45.91
Male respondent (%)	32.5	40	57.5	55	46.6
Female respondent (%)	67.5	60	42.5	45	53.8
Located near market (%)	77.5	100	50	27.5	63.8
Located far from market (%)	22.5	0.00	50	72.5	36.3
Average herd strength (No)	7.13	4.5	6.13	6.16	5.97
Average LU	5.90	3.43	5.01	4.51	4.72
Milking cow (%)	34.74	33.71	30.82	35.29	33.68
Dry cow (%)	21.23	8.99	17.96	9.74	15.14
Heifers (%)	15.09	18.82	17.14	8.72	14.67
Breeding bull (%)	1.58	1.97	1.22	0.00	1.15
Other bull (%)	8.42	2.53	12.04	0.41	6.18
Bullock (%)	0.18	8.99	2.04	9.53	4.71
Young stock (%)	18.77	25	18.78	37	24.67
Female animal (%)	82.64	76.76	76.92	78.37	78.67
Male animal (%)	26.20	35.08	34.19	34.36	32.54
Herd size: 1-5 cows (%)	75	98.8	96.3	97.5	91.9
Herd size: 6-10 cows (%)	25	1.3	3.8	2.5	8.1
Average own land (Acres)	3.69	2.94	4.33	3.67	3.65
Average land for dairy (Acres)	1.54	1.33	1.57	1.24	1.42

From the study, it is evident that higher percent of dairy units were located near the market (63.8%). Dairy units have an average herd strength of 5.97 animals that accounts to 4.72 LU. The majority of dairy owners maintained crossbred cows with small herd size of 1-5 cows (91.9%). Herd composed of all categories of animal. However, farmers gave more emphasis in maintaining higher proportion of female stock (78.67%). The study indicated that majority of the dairy units owned land and half of it was used for growing fodder and setting up dairy infrastructure. This finding is in agreement with studies of (Mburu et al. 2007; Uddin et al. 2010) wherein they reported that many Asian farmers were generally smallholders that rear few heads of cattle owing to mixed farming system where a farmer grow crops and tend animals at the same time.

3.2 Fixed costs

The total investments on fixed variables are presented in Table 2. In overall, average capital investment estimated was Nu. 27,258.66 per dairy unit over the period. There was a significant difference in total investment on fixed variables between different AEZs ($p<0.05$). The investment in Cool Temperate (Nu. 39,404.73) was almost double than that of Warm Temperate (Nu.18, 366.62) Zone. Analysis showed that overall investment in fixed capital decreased with altitude, indicating higher feasibility of investment in dairy farming under warm and wet zones areas as compared to cool and dry zones.

3.2.1 Herd investment

Herd investment constituted the highest (38.08%) portion of total investment cost of the dairy unit. Average investment on herd per dairy unit was Nu 10,379.74, of which Nu 8,130.94 was for dairy cows and Nu 2,248.80 for other categories of animals such as bulls and young stock (Table 2). Dairy cows constituted major (29.83%) portion of the herd investment. Overall average dairy cow holding per dairy unit was between three and four (M=3.85, SD=2.36). Average cost per dairy cow in this study was Nu 38,663.84 (range 5,000 to 120,000). It was found that most of the replacement stocks were purchased; escalating the cost due to additional logistics/transport expenses on the top of cow's cost. Significant difference was observed in investment on dairy cows as well as total herd investment across AEZ ($p<0.05$), with highest in cool temperate zone and lowest in warm temperate zone for both the cases.

The finding suggests that major cost incurred for establishment and operation of dairy unit is attributed to the purchase of quality crossbred dairy cow across AEZs. Thus, this warrants more emphasis for in-house production of replacement stock (heifer) to make the farming enterprise more attractive and feasible.

3.2.2 Machinery and dairy equipment investment

Overall average investment on farm machinery and dairy equipment apportioned for dairy on an average per dairy unit was Nu 9166.13 which formed 33.63 % of the total investment cost (Table 2).

The investment on farm machinery and dairy equipment showed a significant difference between AEZ (p<0.05). The investment in farm machinery and equipment were highest in Dry Subtropical zone (Nu 14394.54) and lowest in Wet Subtropical zone (Nu 1,744.66). Results indicated that use of farm machinery and equipment was higher in colder and dryer zones than in warmer and wetter zones. It may be attributed particularly to forage production system in different AEZ. Field observation revealed that in colder and dryer zones, cultivation of annual fodder oat and fodder crop with use of farm machinery was a common feature particularly in Paro, Bumthang and Wangdue districts. While in lower lands, forage was generally produced manually either by harvesting from fodder trees and patches of pastures grown within farmland and or collected from the nearby forest through cut and carry system.

3.2.3 Investment on shed construction

Almost 74 % of dairy owners housed the animals in an improved shed while 21% in traditional and slightly over 4 % in a temporary shed. Of the total investment, expenses for cattle shed construction constituted around 18 % of the cost. The findings indicated that on an average, Nu 4,935.10 was found to be invested in shed construction and annual maintenance (Table 2).

Table 2: Item wise investment (Nu/unit/year) of dairy units across different agro-ecological zones

Item wise cost	Cool Temperate	Warm Temperate	Dry Subtropical	Wet Subtropical	Overall
A. Animals					
i) Dairy cow	11470.75(29.11)	5366.50(29.22)	7921.50(24.02)	7765.00(42.07)	8130.94(29.83)
ii) Other stock	2438.66(6.19)	1983.55(10.80)	2341.44(7.10)	2259.78(12.24)	2248.80(8.25)
Total (i+ii)	13909.75(35.30)	7350.50(40.02)	10263.50(31.12)	10025.00(54.31)	10379.74(38.08)
B. Equipment, Machinery	14986.73(38.03)	3789.84(20.63)	14394.54(43.65)	1744.66(9.45)	9166.13(33.63)
C. Shed	6143.65(15.59)	4041.13(22.00)	4422.33(13.41)	5133.31(27.81)	4935.10(18.10)
D. Interest on fixed capital	2947.36(7.48)	1290.16(7.02)	2090.16(6.34)	1488.38(8.06)	1947.90(7.15)
E. Land rental	1417.24(3.60)	1895.00(10.32)	1807.71(5.48)	66.11(0.36)	829.79(3.04)
Total investment (A+B+C+D+E) (100)	39404.73	18366.62	32978.24	18457.46	27258.66
Traditional shed (%)	51.25	7.50	18.75	7.50	21.25
Improved shed (%)	43.75	92.50	68.75	92.50	74.38
Temporary shed (%)	5.00	0.00	12.50	0.0	4.38
Acreage of rented land	1.9	1.00	1.56	2.43	1.84
Land rental charge (Nu/acre)	4738.95	2333.33	22923.08	6000.00	11140.00

Figures in parentheses are the percentage to total investment

However, no significant difference was observed in the investment for shed cost across AEZs (p=0.067).

3.2.4 Interest on fixed capital and land rentals

Significant difference was observed (p<0.05) on interest with regard to fixed capital which constituted 7.15 % of total investment or an average value of Nu 1,947.90 per dairy unit. Around 18 % of dairy units rented land and out of which only 11 % had to pay rental charge. Average acreage of land rented was 1.84 acres with an average land rental expense of Nu 829.79 which constituted only 3 % of the total investment (Table 2). It was mainly because not all rented land has to make rental payment especially in lower altitude zones because fallow land in neighborhood were allowed to use free of charge. Moreover, in some instances, cost of land rental was covered by other crops cultivated on the same piece of rented land.

3.3 Variable cost

The total variable costs under various heads (A-D) are described in Table 3. Overall average variable cost per dairy unit in a year was Nu 2,14,052.00 (Table 3). Across different AEZ significant difference in variable costs was observed (p<0.05). There was huge variable cost difference between cool (Nu 337,320.00) and warm temperate (Nu 136,345.00) zones and dry sub-tropical (Nu 239,488.00) and wet subtropical (Nu138,359.00) zones. High cost of labour and feed has contributed to significant difference in variable costs indicating that dairy farmers of cooler and dryer zones have to spend more in comparison to those in warmer and wetter zones. This finding is in agreement with the studies of (Mburu et al. 2007) and (Ghule et al. 2012) wherein they indicated that expenses on labour and feed were found to be the major cost components of variable costs.

3.3.1 Labour cost

Each dairy unit had an overall average engagement of family labour ranging one to two full time (M=1.86; SD=0.99) and part time (M=1.57; SD=0.69). Little less than half day (41 %) of family labour time had been spent for dairy activities beside crop cultivation, off-farm activities and other daily household chores. Not many (n=4) full times labour was hired in the

Table 3: Variable costs of dairy units across different agro ecological zones (Nu/unit/year)

Items	Cool Temperate	Warm Temperate	Dry Subtropical	Wet Subtropical	Overall
A. Labour	249037.5	84712.3	167556	57588.8	139288
	(73.83)	(62.13)	(69.96)	(41.62)	(65.07)
B. Feed	79561.38	45943.7	62937.4	78424.7	66876.4
	(23.59)	(33.70)	(26.28)	(56.68)	(31.24)
C. Hire of farm machineries	5146.25	3139.13	5964.29	0.00	4577.21
	(1.53)	(2.30)	(2.49)	(0.00)	(2.14)
D. Miscellaneous	3575.02	2549.55	3030.46	2345.73	2875.19
	(1.06)	(1.87)	(1.27)	(1.70)	(1.34)
Total costs (A+B+C+D)	337320.1	136345	239488	138359	214052
	(100)	(100)	(100)	(100)	(100)
Full time family labour	2.39	1.39	2.66	1.01	1.86
Part time family labour	1.57	1.67	1.78	1.00	1.57
Full time hired labour	2.00	0.00	1.50	0.00	1.75
Part time hired labour (mandays)	16	17	15	2	16
Daily wage (Nu)	513.75	416.25	384.38	371.25	436.41
Proportion of labour share (%)	45.19	35.93	43.13	39.69	40.98

study area and 16 man-days on an average were hired occasionally. Overall average daily wage per person was found to be Nu 436.41 which was twice more than national work force wage. Of the total variable cost, labour cost constituted highest portion of about 65 % or the monetary value of Nu 139,724.00. Labour cost differed significantly between AEZ (p<0.05) with highest cost observed in cool temperate (Nu 249,037.5) and lowest in wet subtropical (Nu 57,588.80) zone (Table 3). This may be attributed to climatic condition and farming practices in different AEZ. Dairy farmers in colder and dryer areas need to put comparatively extra efforts to keep animal warm by collecting and carrying bedding materials from the forest. Moreover, field observation found irrigation for fodder cultivation was more frequent in colder and dry areas than in other two zones. The findings indicated that dairy farming was family oriented and labour was expensive irrespective of AEZ.

3.3.2 Feed expenses

Feed expenses included only purchased feed such as concentrate, mustard oil cake, cereal grains, crop residues and brewer's grain. Home grown feed and fodder were clubbed under labour cost as dairy owners could not provide reliable data for drawing the inferences. Feed cost is the second highest variable cost at 31% or in monetary value of Nu 66,876.40 (Table 3). Feed expenses differed significantly between AEZ (p<0.05). Feed expenses were highest in cool temperate (Nu 79561.38) and lowest in warm temperate (Nu 45943.65). This could be attributable to abundance of green fodder in warm zone thus purchasing less quantity of concentrate feed which formed major portion (66.62%) of the total feed types purchased by the farmers. Moreover, cost for transport of concentrate is cheaper in this zone owing to nearness of the location of feed plants.

3.3.3 Farm machinery and miscellaneous cost

Hiring of farm machineries mainly *gewog* power tiller for pasture development and seasonal fodder cultivation made up 2.14 % of the variable cost or monetary value of Nu 4577.21. Miscellaneous expenses included purchase of agricultural tools/implements and payment of electricity bill and water bill in some cases, apportioned for dairy work. This constituted 1.34 % of the total variable cost or Nu 2875.91 in monetary value (Table 3).

3.4 Cost of milk production

Overall average CoP was 26.85 per litre (Table 4). Milk production cost differed significantly between AEZs (p<0.05). CoP was higher in cooler (Nu. 38.92) and dryer (Nu. 31.01) zones than in warmer (Nu. 19.83) and wetter (Nu. 17.94) zones. Analysis revealed that dairy farmers in the study area were getting a net profit margin of Nu 11.87 per litre of milk against average FG milk price of Nu 38.71. Profit margin based on FG price in respective zone (Table 4) was highest in wet subtropical zone, followed by warm temperate, dry subtropical and cool temperate was lowest with just Nu 2.9 per litre.

The production cost per litre of milk in

Table 4: Average milk production costs (Nu/litre) and profitability of dairy units in different AEZs

Items	Cool temperate	Warm temperate	Dry Subtropical	Wet Subtropical	Total
Cost of Production	38.9	19.8	31	17.9	26.85
Farm gate price	41.8	35.5	38.6	38.9	38.71
Profit margin	2.9	15.6	7.6	21.0	11.87

Table 5: Comparison of average milk production costs by herd size and location of dairy units

Variable	Category	N	Mean ± SE	Sig. (2-tailed)
Herd size	1-5 cows	290	28.28±2.51	0.04
	6-10 cows	26	10.92±1.86	
Location of dairy unit	Near the market	202	25.83±3.04	0.56
	Distant from the market	114	28.65±3.54	

Bhutan was almost similar to that of India. Ghule et al. (2012) reported CoP of Rs 26.78≃Nu. 26.78 with net profit margin of Rs 2.16 per litre. Similar CoP of Nu 27.53 per litre was reported for the Punakha district (Ugyen 2020). CoP was recorded slightly higher in Nepal of Rs. 48.55 Nepalese Rupee ≃ Nu 30.56) as reported by NDDB (2018). Whereas, the CoP recorded for milk per litre in Sri Lanka was much lower of Rs 25.5≃Nu. 9.96, Rs 14.27≃ Nu. 5.57 and Rs 12.77≃ 4.98 (Jayaweera et al. 2007; Kumawat et al. 2014; Singh et al. 2017). Difference in milk production cost was noted in smallholder highland AEZ attributing to variations in maintenance costs (Mburu et al. 2007). The findings indicated that the cost of milk production conversely affected the profit margin and the production cost increased with altitude. Low cost of labour and abundance of fodder resources in warmer and wetter areas reduced the costs whereas use of farm machinery and equipment in cooler and dryer zones increased cost of labour and feed adding up to total costs. Thus, it can be inferred that dairy farming is more profitable in warmer and wetter zones when compared to cooler and dryer zones.

3.5 CoP of milk by herd size and location

Average CoP differed significantly between herd size (p<0.05). The CoP per litre of milk for smaller (Nu 28.28/l) type of herd almost tripled than that of bigger (Nu 10.92/l) herd size (Table 5). This finding demonstrates the theory of economies of scale wherein the larger the volume of business, lesser the production cost and vice versa. In other word, bigger herd size incurs substantially less cost compared to smaller herd. Datta et al. (2019) reported that farm size has positive influence on profitability of dairy farm, increase in farm size increase farm profit due to less cost and more gross return (Kaur et al. 2012). In terms of location of the farm, nearness to or farther away from market had no significant difference on CoP (p>0.05).

In this study, CoP was not affected by location as the dairy units in all sampled areas had access to farm road to purchase raw material or market dairy products. The finding is in line with Aujla & Hussain (2015) who reported that accessibility to market or establishment of institutional arrangement for continuous flow of input and output plays an important role in any business.

4. CONCLUSION

Dairy farming will contribute to the livelihood security of rural Bhutanese farmers through provision of regular animal-based food and sustained income. Crossbred cattle, predominantly Jersey crossbred cows were reared and farm productivity and income of farmers have increased. Most dairy farmers were smallholders with average herd size of six animals operated as a family business. It engages family labour and create self-employment opportunities. Study revealed that purchase of dairy cow, procurement of machinery and equipment and shed construction have largely contributed to investment under fixed costs. On the other hand, labour and feed costs formed the major portion of variable costs. While, hire of farm machinery and land rental costs constituted a smaller portion and had lesser bearing on CoP of milk. Thus, minimizing these costs effectively can have significant gains in dairy farm operation. Cost cutting measures such as in-house production of replacement stock, improvement in feed and fodder availability and maximizing labour outputs through application of labour-saving devices are some options to reduce CoP of milk. The overall average cost of milk production recorded was Nu 26.85/litre, and sells it at FG price of Nu 38.71/litre making profit margin of Nu 11.87/litre. This indicate that the dairy farming business is a profitable venture in Bhutan. Nonetheless, milk production costs differed considerably across AEZ so did the profit margin. The study indicated that higher cost of production and lower profit margin for farmers was evident in cooler and dryer zones and vice versa in other two zones. Dairy farming can earn better income in warmer and wetter zones than in cooler and dryer zones with merely a profit of Nu 2.9/litre of milk. Thus, to harness a better return from investment, dairy farmers in cooler and dry zones besides cost cutting measures, may need to upscale the business volume to have economies of scale in order to reduce the cost and maximize the profit. Further, considering the CoP as baseline parameter, increasing the FG price of milk in the cool temperate and dry subtropical zones may be recommended to increase income while status quo may be maintained on milk price for the other two zones. The outcome of this study was intended to provide recommendation for policy directives in dairy development and serve as basis for setting milk prices by the dairy entrepreneurs in the country.

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