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Economics of Dairy Production: Evidence from Adea and Lume Districts of East Shoa Zone, Ethiopia

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Abstract: This study was conducted to analyze economics of dairy production in Adea and Lume districts, Oromia, Ethiopia. Research based information on economics of dairy production in smallholder dairy farm is scanty in Ethiopia in general and in the study areas in particular. There is a need to know the economics of smallholder dairy production. The objectives of the study were to analyze the cost and returns of smallholder dairy farmers milk production in the study areas and to identify constraints and challenges of improved dairy technologies adoption thereby suggest interventions for policy makers to understand the quick way out of poverty and the sustaining of food secure society at community level through wise utilization of local resources. Primary data were collected from 45 dairy farming households selected randomly through multi-stage sampling procedure. Descriptive statistics, gross margin analysis and cost-benefit analysis were used to analyze economics of dairy production. The gross margin was calculated to be Birr10, 454.35 of dairy cross breed milk sold per head per year. The mean milk yield of the cross breed dairy cows in the area was 9.70 liter per day/animal. The dairy cross breed milking cow benefit cost ratio was computed to be 1.74. This ratio depicted that dairy cross breed production was economically profitable at farm household level; and if the number of milking cows increased per household, the income generated would be double or triple and become more profitable to bring livelihood change in communities engaged in the business.

Key words: Cross Bred Cows · Dairy Production · Gross Margins · Variable Cost · Benefit-Cost Ratio · Ethiopia

INTRODUCTION

Agriculture is the main stay of Ethiopian economy contributing about 43% of the GDP, 80% of employment, provides livelihood for 65% of the population and 90% of the export [1]. The roles livestock play in Ethiopia, especially in augmenting rural livelihood improvement by providing draft power, food, transportation, alternative energy sources, social prestige and status in communities are well recognized [2]. Livestock production also creates income opportunities for landless poor who provide fodder and engage in value addition and marketing. It also creates employment opportunities and improving the nutritional standards of the people. Moreover, smallholder dairy production is becoming increasingly important and it contributes magnificently to the improvement of the livelihoods of smallholder farmers in the country.

Dairy development in Ethiopia has played a major role in increasing milk production, thereby improving income level of smallholder farmers. According to the Ministry of Agriculture about 300, 000 crossbred dairy cows are found in Ethiopia and milk production has improved over the past years [3]. For instances, from the years 2008/09 to 2010/11 2, 765, 2, 940 and 4, 058, million liters of cow milk respectively was produced [3]. Nevertheless, dairy production in Ethiopia is characterized by very low input that varies according to the levels of market orientation of a farmer. This means the choices have to be made about where, when, how much and how to deploy the dairy resources. Economic analysis provides a scientific and systematic method for making these choices as indicated by researchers in different countries [4, 5] in Zambia; and [6] in Ethiopia conducted economic analysis of dairy farm, using diverse approach.

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Poverty reduction and achievement of sustained economic and infrastructural development remain priority goals of the Government of Ethiopia. The government formulated the Ethiopian Growth and Transformation plan as the overarching strategy for transforming agriculture to attain livelihood improvement of the people. Encouraging market oriented smallholder dairying has been one approach to enable resource poor smallholder mixed crop-livestock farmers to raise household incomes. However, there is concern among development agencies and policymakers over the efficiency of smallholder milk producers amidst increasing competition from intensive dairy producers in both urban and peri-urban areas. Thus, Economic analysis of dairy farming in mixed farming system provides basis for delineating possibilities of controlling costs of milk production and increasing returns to make it a viable enterprise.

However, research based information on cost benefit analysis of small smallholder dairy farm is scanty in Ethiopia in general and in study areas in particular. To this effect, there is a need to know the cost benefit analysis of smallholder dairy production. Thus, the study was conducted to provide information for policy makers, development planners and farmers when making decisions related to the profitability of smallholder dairy enterprise. Therefore, the study was aimed at analyzing profitability of smallholder dairy production, production efficiency and identifying challenges to small holder dairy farm in Adea and Lume districts of Ethiopia. This study aimed to analyze the cost and returns of smallholder Dairy farmers milk production in the study areas to identify constraints and challenges of improved Dairy technologies adoption in the Study areas.

MATERIALS AND METHODS

Description of the Study Areas: The study was undertaken in Adea and Lume districts of Oromia Regional State in the central high land of Ethiopia.

Adea district is located at 45 km South East of Addis Ababa, at 8°44N and 39°2E and an altitude of 1880m above sea level. The district receive a mean annual rain fall of 865mm with mean minimum and maximum annual temperature of 15 and 28°C, respectively. The district covers an area of 1750 km^2. There are 27 kebele rural farmers' administrations and 9 urban kebeles in Adea district. According to 2007 national census the district has a total population of 99, 928, of whom 47, 860 were men and 52, 068 were women. The agro-ecology in the district is best suited for diverse agricultural production and the main stay of the people in the district. The proximity of the district to Addis Ababa city, Adama, Mojo and Bishoftu towns create a large market for most agricultural commodities. Crop and livestock production are the major source of income and livelihood for the peoples in the district. The district is nationally known as dairy belt.

Lume district is one of the districts in the Oromia region of East Shoa Zone. The altitude of the district ranges from 1500 to 2300 meters above sea level. Available reports showed that54.3% of the land in Gimbichu is arable or cultivable, 3% pasture, 2% forest and the remaining 20 % is considered degraded or otherwise unusable. The district is known for its crop and livestock production. According to 2007 national census the district has a total population of 117, 080, of whom 60, 125 were men and 56, 955 were women; 38, 771 or 33.06% of its population were urban dwellers. About 60% of the total population has access to drinking water.

Sampling Procedure and Sample Size: Sample size and the sample selection process should assure the representativeness of the population. Sample size determination has its own scientific approach. In this study, to determine sample size, different factors such as research cost, time, human resource, accessibility and availability of transport facilities were taken into consideration. The study used a multi stage procedure which included both purposive and random sampling was employed in this study. The first stage involved purposive selection of two major dairy producing districts in East Shoa Zone of Oromia regional state of Ethiopia. In the second stage, potential kebeles (the smallest administrative unit) were purposely selected due to the large number of improved dairy farmers who produce milk mainly for market In the third stage, from a list of dairy farmers who owned improved dairy cows. Simple random sampling method was used to select dairy farmers who had their cows in milk for the previous 12 months. The information gathered pertains to production season of 2014/2015. A Total of 45 smallholder farmers were involved in the study.

Data Collection: The survey collected cross sectional data and made use of both primary and secondary data. Primary data were collected through personal interview applying face-to-face interview method through structured questionnaire. The questionnaire was pre-tested to remove ambiguities. The structured

questionnaires were administered to 45 smallholder farmers producing dairy. The information collected included quantities of variable inputs used and cost per each variable inputs, dairy cattle production levels, herd size and socio-economic characteristics of respondent farmers. The collected information was first tabulated, coded and entered into computer for analysis.

Cost - Benefit Analysis (CBA): Cost-benefit analysis is a financial appraisal of an activity that compares all costs and benefits that go into the production process. Measuring the costs and benefits of production is important if a farmer wants to know whether he is making profit. While one can tell the price of agricultural product right away, According to Bailey (2001), it is often difficult to measure production costs and profits. Evaluation of economic returns plays crucial role in influencing farmers' choice to adopt improved agricultural technology and consequently influences farmers' resource allocation decisions. The understanding of costs and benefits is also an important pre-requisite for policy formulations aimed at improving productivity levels. Different scholars used cost benefit analysis to measure smallholder farm profitability for instance; Mburu, Gitu and Wakhungu [7] used cost-benefit analysis to compare the profitability of smallholder dairy production in different agro-ecological zones in Kenya highlands. The results showed that farmers in the upper midlands were making much more profit from milk than those in the lower highlands.

Gross Margin Analysis: Johnson [8] defines gross margin as the difference between the value of an enterprise's gross output and variable cost of production. Gross margins are used to evaluate economic viability of an enterprise. They are used in agriculture for farm planning and comparing different farms with similar characteristics or different enterprises on the same farm Chamdimba [9]. The gross margin analysis was used to assess the profitability and viability of smallholder dairy production in Gambia[10]. The results showed that smallholder dairy farming in Gambia was viable. In this study in order to determine the profitability of dairy enterprises, gross margin and cost benefit analysis were used to estimate the average variable annual costs and returns of the enterprise and cost benefit ratio. The variable costs are summed to derive the total variable cost of production on s per head of dairy cow milked. Variable costs refer to those costs which vary directly according to the level of production dairy cow. These costs include labor, feeds (concentrates), veterinary service and AI service which were calculated based on financial prices. Hence, gross margins were calculated for smallholder farmers produce improved dairy production. The following formula was used to calculate gross margin.

$$GM = GR - VC \quad (1)$$

where, GM is gross margin per cows and GR is gross revenue calculated as the product of price per unit and output. The amount of milk produced per year per cow in liter, VC is variable costs associated with milk production and marketing per cow per year in Birr Gross income of dairy included the value of milk sold, the value of milk consumed by the household and milk given to the calf. Dairy enterprise variable costs included feed (concentrates), veterinary and labor costs that were calculated based on market prices.

Break-Even Level of Milk Production: The break-even level of milk production is that level of milk output where the farm is neither at loss nor at profit. In the study, it was calculated in terms of milk production per animal per year. The procedure followed for obtaining the Break-even level of output: The break-even formulas mathematically shown as;

$$\text{Break Even Sale Price} = \frac{\text{Average Total Costs}}{\text{Average Total Production (Yield)}} \quad (2)$$

$$\text{Break Even Yield} = \frac{\text{Average Total Costs}}{\text{Break Even Sale Price}} \quad (3)$$

Finally a sensitivity analysis has been carried out to assess the stability of gross margins of cross dairy breed under varying condition to deem uncertainty into the economic evaluation. Milk price, milk yield and TVC per head were subjected to reduction at some percent and to increase by similar percent then new gross margins computed separately against each scenario to evaluate the resultant scenario.

Statistical Analysis: All the local measurements were converted into standard unit and final analysis was done using computer software packages: Statistical Package for Social Science (SPSS). Physical data related to dairy production practices, costs and yield, sale quantity of produce and selling prices has been collected in 2014-2015 production year. Secondary data were collected from previous documents, websites, previous research findings on dairy production in Ethiopia and elsewhere in the world.

The study used descriptive statistics such as frequencies and means to analyze the socio-economic characteristics of dairy producing farmer. Cost benefit and gross margins analysis were used to assess economic analysis of smallholder farmers in dairy production.

RESULTS AND DISCUSSION

Socioeconomic Characteristics of Household Heads: About 100% of the respondent farmers were practiced mixed farming system, integration of dairy and crop production. The total sample size was 45 smallholder dairy farmers. About 25.5% of the sampled farmers were drawn from urban areas and 74.5% of them were from peri-urban areas of the study districts implying the majority of dairy small holder farmers concentrate in peri-urban areas due to market availability and basic inputs such as land for dairy production. Out of the total sample respondents, 94.4% were male-headed households and 5.6% were female-headed households. It also indicated that majority of dairy producing farmers were male farmers revealing that female farmers have the limitation of capital and financial resources for dairy production that needs intervention to increase the involvement of female farmers in dairy production. Majority (97.7%) sampled farmers were married implying dairy production is labor intensive activity.

Age of Household Head: The overall mean age of the household head of the sample respondents was 44.3 years. The mean age of household heads was 44.6 and 43.8 years old in Adea and Lume district respectively. This implies that middle-aged farmers were involved in dairy production. This could be because of the fact that old age and its associated physical and economic constraints would limit the aged households to manage dairy cattle.

Household Size: The survey results revealed household sizes varied from an average of about 7 and 7.5 people for households living in Adea and Lume districts respectively. The minimum and maximum household size of household was 4 and 10 people in Adea district, respectively. While, the minimum and maximum household size of Lume district was 4 and 15 people respectively. From this it could observed that the household size is higher than the average national household size which is 5 people; Moreover, household size influences labor availability for dairy farming activities, because the activity require intensive labor and household members were the main source of labor for dairy activities.

Education of Household Head: The level of education was included to ascertain the respondent's ability to use and interpret agricultural information. Experience showed that people with high education level are likely to analyze and interpret information than those who have less education or no education at all. The results showed that 7.1% of the sampled farmers had no formal education and were illiterate while 11.6% of sampled had informal education and they are able to read and write. Moreover, 32.6%, 20.9% and 23.3% of the dairy farmers had educational status of 1-6, 7-8 and 9-12 grades range the remaining 4.6% being diploma holders. The results showed that majority of the respondents have acquired basic education, which could assist them to develop knowledge, skills and change attitude on how to solve problems associated dairy cattle managements. The high proportion of household heads with secondary school education among smallholder dairy cattle farming showed educated farmers were engaged in dairy cattle production activities.

Major Sources of Income: The results showed that the majority (74.4 %) of sampled farmers gave priority for crop farming and followed by dairy farming (25%) as the major sources of income. This means that dairying operated under a mixed crop- livestock system and services as secondary source of income and dairying makes enormous contribution as source of income since it creates regular flows of cash and milk for household consumption. Activities such as carts rent, cattle fattening activities were serviced as tertiary source of income for about 25.6% of the sampled farmers.

Land Rent for Dairy Production: The results showed that average cost incurred for land rent in Adea district was 10, 605.20 birr per ha and 8, 133.20 birr cost incurred for land rent in Lume district during 2014/2015.

Cross Breed Dairy Cows and Purpose of Production: The results revealed the mean number of cross breed milking cow owned by household was 1.88 cows and the mean number of cross heifer was 1.04 animals and that of bull cross and calve came to be 2.2 and 1 in respectively. The mean numbers of cross oxen owned were 2.2 and that of local dairy cow was 1.6 cows. Majority (94.4%) of dairy farmers participated in cross breed dairy cows and cross breed heifer for market. Moreover, 93% of them involved in cross bull production both for food and market purpose. About 32.6% sampled farmers are rearing local milking cow for home consumption and majority (67.5%) of reared local milking cows for market. Besides to this,

Table 1: Socio-economic characteristics of sampled households

Characteristic	Adea disrict	Lume district	All(n=45)
Mean age of household head (Years	44.6(8.9)	43.8(10.8)	44.3(9.75)
Mean household size	7(1.7)	7.5(2.9)	7.2(2.34)
Mean farm size* (No. of milk cows)	1.76(1.05)	2(1.16)	1.88(0.8348)

Source: survey data, 2014/2015

Note: Figures in parenthesis are standard errors

*Farm size was measured by head count of milk cows

65.1% of them produce oxen for food production. It was also observed that 53.5% of the farmers produce local bull for food production and 46.5% of them produce local bull for market

Sources of Dairy Cows: The results showed out of dairy cows produced in the study areas 74.4%, 23.3%, 2.3% were found to be cross breed milking cows, heifer and exotic dairy cows in respectively. Most of sampled farmers (41.9%) sourced dairy milking cows through own purchase and 11.6% of the farmers took research centers via extension service rendered by the center. About 25.6%, 7%, 11.6%, 2.3% of sampled farmers sourced milking cows from district office of Agriculture, NGos, neighboring farmers and cooperative unions respectively. Few numbers (7%) of sampled households were sourced dairy cows by credit implying that there is very limited credit access for dairy production.

Major Constraints and Challenges of Improved Dairy Technologies Adoption: About 44.3% of sampled farmers elucidated that unavailability of cross breeds, high price of cross breeds cows, high price of feed compared to low price of milk and lack of technical trainings were the major problems associated with adoption of cross breed dairy cows Furthermore, about 41.8% of sampled farmers revealed unavailability and non-effectiveness of AI service, high transport cost of feeds, limited veterinary services and high cost of labor were found to be the major problems associated with adoption dairy cross breeds. The remaining 13.9% farmers point out that limited market access for milk and milk product during fasting period, limited knowledge of record keeping and limited quality feed supply were the major problems associated with adoption of improved dairy technology.

Cost Benefit Analysis of Smallholder Dairy Production: This study analyzes variable costs incurred in dairy production of smallholder and the benefits derived from the enterprise.

Dairy Production Costs: Table (2) shows the estimated production costs based on the dairy enterprise. Fixed costs were ignored in the study because it is difficult to obtain the data as there was no record keeping in smallholder farmer's milk production and they do not affect optimal combination of variable inputs in smallholder dairy production [5, 7]. Results of the study showed that concentrates and roughage feeds were the major variable costs incurred in improved dairy production wherein concentrate feed accounts for Birr 6871.40 (46%) and roughage comprise of Birr, 2254.6 (15%) of the total variable costs incurred per year per animal indicating that feeds accounts for about 61% of the total variable cost of production. This underscores the economic significance of feeds in improved smallholder dairy farming. Similar findings by Ergano and Nurfeta [11] reported that 80% of the total variable cost was attributed from feed in smallholder dairy in Southern Ethiopia. Furthermore, the mean cost of labor for milking and feeding of cross breed dairy cows was found to be Birr 2529 (17%) of the total variable cost of dairy production. About Birr, 538.40 (8%) of total variable cost incurred for bull services and artificial insemination per dairy cow per year and 1128.45 cost incurred for veterinary service per animal per year. On top of this, about Birr 254.40 variable cost was incurred for purchase of medicine per year. The average transport cost of milk was 709.30 birr per year. The cost for drinking water was 349.9 birr per year per animal.

Milk Yield and Lactation Length of Cross Dairy Bred: The results indicated that the average lactation length of cross bred milking cows was on average 8.74 months. The mean milk yield of crossbred dairy cow was 9.70 liter per day/animal. The mean selling price of milk was found to be 9.8 Birr per liter. About 81.3% of them effectively use cow dung as bio fertilizer for improving the soil fertility at village level and the remaining 18.7% of them use cow dung for sell. Thus, market of this fermented dung has developed in the study areas. About 18.2quintals of cow

Table 2: Smallholder cross breed dairy production cost estimation per animal per year

Cost items	Mean costs of items (Eth Birr)	Standard deviation
Labor per year per animal	2529	15.33
Cost for AI and bull services per year per animal	538.40	3.05
Cost concentrate feed per year per animal	6871.4	109.6
Roughage feed	2254.6	80.9
Cost for medicament per year per animal	254.40	15.76
veterinary service per year per animal	1128.45	211.3
Transport (for feed and marketing costs) per animal	709.30	7.8
Drinking water per year per animal	349.9	2.6
Miscellaneous costs(cost of salt, death loss of animal and ropes, etc) per animal	194.40	17.08
Total variable costs per animal	14, 829.85	

Source: Survey data, 2014/2015

Table 3: Income generated from milk and dung per dairy cow per year

Parameters	Mean	Std. deviation
Milk yield per head per year (lit)	2, 543.30	73.45
Cow Dung per head per year in (quintal)	18.2	3.77
Milk price per liter in (Birr)	9.8	1.51
Cow dung price per quintal in (Birr)	45.6	1.99
Gross income from Milk per head per year (Birr)	24, 924	224.52
Gross income from dung per head per year (Birr)	829.90	56.71
Total Gross income (Birr)	25, 754	

Source: Survey data, 2014/2015

Table 4: Analysis of gross margin and cost-benefit per cross per head

Gross income	Total variable cost	Gross margin Birr/animal head	Benefit- cost ratios on variable cost
25, 754	14, 829.85	10, 924.15	1.74

Source: Survey data, 2014/2015

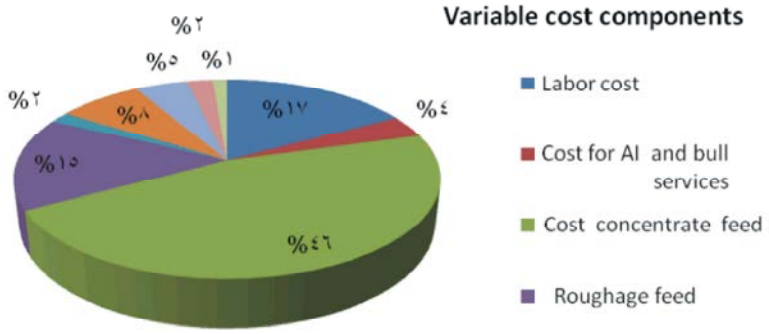

Fig. 1: Percent share of different variable cost components

dung was produced per year per animal and its selling price was 45.6 birr per quintal. Accordingly, they earn 1472 Birr from each dairy cattle per year.

The above result (Table 4) discusses the profitability analysis of dairy farm at smallholder farm level. The profitability was assessed using gross margin and benefit-cost ratio analysis. Accordingly, Birr 25, 754 gross income, Birr10, 924.15 gross margin and value for benefit-cost ratio of cross dairy cow was computed to be 1.74 Birr per dairy per cow on basis of variable costs. This ratio implies that for every Birr invested in dairy, there is 1.74Birr extra income generated given other factors constant. The cost per liter of milk production came to be Birr 4.9which was quantified by dividing the total milk yield by total cost of production.

Break-Even Level of Milk Production: The break-even level of milk production is that level of milk output where the farm is neither at loss nor at profit. It was calculated in terms of milk production per animal per year. The break-even milk production per animal was the minimum milk productivity that must be achieved if a farm is to avoid losses or to gain profit. It demonstrates the break-even sale price and the break-even milk yield of milk produced.

Table 5: Break-even analysis of cross bred dairy milk production

Type of Animal	Average milk yield per head per year	Av.TVC	Av price per Liter in(Birr)	Break-even price	Break-even milk yield
Crossbred dairy	2, 543.30	14, 829.85	9.8	5.83	1513.25

Source: Survey data, 2014/2015

Table 6: Sensitivity analysis of milk production

		Price		Milk yield		Input costs of dairy	
Items description	Original	10% decrease	10% Increase	10 % increase	10% Decrease	10% increase	10% decrease
Milk yield in (liter)	2, 543.3	2, 543.3	2, 543.30	2797.63	2288.97	2, 543.30	2, 543.3
Unit price per liter	9.8	8.82	10.78	9.8	9.8	9.8	9.8
Total revenue	24924.34	22, 431.9	27416.8	27, 416.8	22431.9	24924.3	24, 924.3
TVC (Birr)	14, 829.9	14, 829.9	14, 829.9	14, 829.9	14, 829.9	16312.89	13346.9
Total gross margin	10094.4	7602	12, 586.8	12, 586.8	7602	8611.4	11577.4

Source: Survey data, 2014/2015

The results revealed that smallholder farmers need to produce at least 1513.25 liters of milk per head per year and has to be sold at 5.83 Birr, per litter to cover operating costs of dairy cow (Table5). So the farmer has to produce more than the break-even milk yield and sell the milk more than the break-even price to be profitable from the dairy enterprise.

Sensitivity Analysis of Milk Production: The sensitivity analysis of milk production indicated that a reduction in price of milk by 10% reduced the profitability by about 24.6%, whilst a similar increase in yield also increased profitability by 24.6 %. Furthermore, an increase price by 10% would increase profitability by 24.6% at the same time a reduction in milk yield by 10% reduced the profitability 24.6% indicating the enterprise was likely to be equally sensitive to both price and yield fluctuations. Thus the milk marketing price and the milk yield must go parallel to sustain profitability. Similarly, 10% increase in operational costs would reduced profitability by 14.6 % and 10% reduction in operational cost would results in 14.6% increase in profitability of the dairy enterprise

CONCLUSIONS

The dairy cost benefit analysis was worked out by the accounting model to estimate the average variable annual cost of returns of the farm enterprise. These costs are summed up to derive at the total variable costs of production total variable costs per head of dairy cow milked. Then gross margins which are a measure of economic efficiency per cross bred cow was calculated by subtracting total revenue from total variable cost. Consequently a gross margin of cross dairy cow was Birr 10, 454.35 per year per animal. Likewise literally the economic efficiency of the enterprise could also be explained in terms of Benefit Cost Ratios (BCR). Hence the BCR of cross bred dairy production was 1.74. From this finding it could be concluded that considerable amount of income was generated from one dairy cow milk and dairy dung sold per year. If the number of milking cows increased per household, the income generated would be estimated to be double or triple and would enhance the quick way out of poverty and sustaining of food secure society at community level with the capacity to tolerate the risk of calamities that are likely to come. The feed costs accounted for nearly 61 per cent of the total variable costs of dairy production indicating that feed cost was the major component in the study areas. Labor cost was the second highest among the variable costs, constituting about 17 per cent of total costs of small holder dairy farmers, implicating labor to be high next to feed cost.

RECOMMENDATIONS

- It was found that feed was the main cost component of dairy farms; thus dairy farm owners should have their own farm land to produce improved feed. At the same time, the need of training to develop skills of the dairy farmers on how to develop and conserve reserved feed for future feed shortfall is prerequisite for the extension system. To make this development successful, improved forage seed with full technical package should be delivered to farmers in a way that inspire farmers to commercialize the dairy feed and the dairy enterprise with the aim to uplift the income from dairy production.
- Production of crossbred dairy cows was economically viable and gave high yield, improving the delivery system of crossbred cows can increase the income of a dairy entrepreneur. Therefore, delivery of crossbred cows to farmers should be popularized in the study areas.

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