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Cost and Benefit Analysis of Dairy Farms in the Central Highlands of Ethiopia

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ይህ ጥናት የወተት ላም የወጪ-ገቢ ትንተና ለማድረግ የታቀደ ነዉ:: ጥናቱ ከ35 ትናንሽ እና 25 ትላልቅ የወተት ፋርሞች ላይ የተደረገ ነዉ:: መረጃዉ ከአራት እስከ ስድስት ተከታታይ ወራት የተሰበሰበ ስሆን ይህን መረጃ ለማጠናከር የወተት ፋርሞች መልካም አጋጣሚዎችና ተግዳሮቶች ተሰብስቧል:: መረጃዉ የተሰበሰበዉ ፋርሙ ዉስጥ ካሉት ሁሉም የዲቃላ የወተት ላሞች ነዉ:: የዚህ ምርምር ግኝት እንደሚያመለክተዉ 80 ፐርሰንት የሚሆነዉ የወተተዉ ላሞች ወጪ ምግብ ነዉ:: ትናንሽ ፋርሞች ከትላልቅ ፋርሞች 35 ፐርሰንት የበለጠ ወጪ ያወጣሉ፤ ነገር ግን ትላልቅ ፋርሞች ከትናንሽ ፋርሞች በ55 ፐርሰንት የበለጠ ዓመታዉ ትቅም ያገኛሉ:: ትልቁ የወተት ላሞች ገቢ ከወተት ስሆን የጥጃ ገቢም በተከታይነት ትልቅ ቦታ የሚሰጠዉ ነዉ:: በዚህ ጥናት ግኝት መሰረት የትላልቅ ፋርሞች ያልተጣራ ማርጂን ከትናንሽ ፋርሞች በሦስት እጥፍ እንደሚበልጥ ተረጋግጧል:: የጥቅም-ወጪ ንፅፅር 1.43 እና 2.24 ለትናንሽና ለትላልቅ የወተት ፋርሞች በቅደመ ተከተል እንደሆነ ጥናቱ ያመለክታል:: ይህም ትላልቅ ፋርሞች ከትናንሽ ፋርሞች የበለጠ ትርፋማ እንደሆኑ ያሚያሳይ ነዉ:: የማስፋፍያ መሬት እጥረት፣ የብድር አገልግሎት አለመኖር፣ የምየዊ ድጋፍ አለመኖር፣ የመኖና የመድሃኒት ዋጋ ንረት፣ ከፍተኛ የወት ዋጋ መለያየት፣ የማዳቀል አገልግሎት ዉጤታማ ያለመሆን፣ የጽንስ መጨናገፍ በፋርሞቹ ባለቤቶች የተነሱ ተግዳሮቶች ናቸዉ:: በዚህ መሰረት ምርታማነታቸዉ ዝቅተኛ የሆኑትን ላሞች ማስወገድ፤ የላሞች ቁጥር ማብዛት፣ በስልጠና የፋርሞቹን ባለቤቶችና የማዳቀል አገልግሎት የሚሰጡትን አካላት ማብቃትና የገበያ ትስስር ማጠናከር፣ አርሶ-አደሩን በመደራጀት የመኖ ማቀነባበርያ መትከል አስፈላጊ እንደሆነ ይህ ጥናት ምክረሃሳብ ያቀርባል::

Abstract

This study was conducted to estimate costs and gross profits of dairy farms under small and large diary management in central highlands of Ethiopia. Thirty-five small and 25 large farms were randomly selected. Quantitative data was collected from sampled households/farms for six to seven consecutive months. Qualitative data was also collected to supplement the quantitative data. All crossbreed milking cows of the sample households were included for the study. The result of the study showed that small commercial farms disbursed 38% more cost than large commercial dairy farms. More than 80% of the variable costs went to feed in both small and large dairy farms. The result also revealed that large dairy farms earned 55% more annual revenue than small farms. The larger revenue share was from milk sale followed by calf sale for both large and small dairy farms. The gross margin of large dairy farms was higher than the small counterparts by more than three folds. The benefit-cost ratio was 1.43 and 2.24 for small and large dairy farms, respectively, implying that large dairy farms are more profitable than small dairy farms. The benefits from both small and large dairying indicated that dairying is a beneficial business. Shortage of land, lack of credit, lack of technical support, lack of adequate market outlet, inefficiency of AI services, abortion, high price of feed and medicine were identified as the main constraints of dairy farming. It is suggested that the need to establish feed processing machines, cull unproductive cows, empower dairy farmers and key service providers through training, promoting, complementary technology packages and market infrastructures.

Introduction

Various livestock related policies of the successive regimes in Ethiopia have been underlining to improve smallholder and commercial dairy production in selected areas of the country through introduction of exotic and crossbreed cattle, and feed and management technologies and development of a milk processing industry to supply the growing demand for dairy products. The policy instruments and operational procedures employed to achieve these goals varied over time, reflecting the politico-economic philosophy of the respective regimes. Moreover, the short-term dairy policies focus on increasing the supply of milk and milk by-products by improving productivity through selection and management. Concomitantly, the long term policy of dairy development focus on enhancement of productivity by improving the genetic merit of the animals, raising the quantity of the feed available to livestock and improving management at all levels from production to preservation, collection, processing and marketing of dairy products without losing any of its inherent quality and quantity. These policy interventions are expected to enable to supply adequate amount of milk, both in quantity and quality to satisfy the minimum per capita requirement of milk for the whole population (SNV, 2008).

The Ethiopian dairy cattle population is distributed over all regions of the country. The four regions with the greatest number of milking cows are highlands of Tigray, Amhara, Oromia and Southern Nation, Nationality and People (SNNP). Out of the total milking cow population, only 10% is located in lowland areas. Smallholders in the highland areas mainly keep the 11.4 million milking cows that produce 3 billion liters of milk. About 3% of the milk produced in the highland areas comes from medium and large-scale commercial farmers. Indigenous stock produce 97% of the milk produced by cattle and the remaining 3% comes from improved exotic crosses and pure grade exotic cattle. The percentage of Friesian or Jersey-blood in these crossbreds usually ranges between 60% and 90%. This type of cattle can mainly be found within the urban and peri-urban farming systems and within the commercial farms in the milk sheds of Addis, Adama-Asella, Ambo-Woliso, Hawassa-Shashemene, and Mekelle areas. The mild temperatures, high rainfall, and fertile soil in the highlands create good conditions for higher producing exotic breeds (Zijlstra *et al.*, 2015).

Farmers engaged in agricultural activities are frequently exposed to changes that force them to adjust their operations to increase profitability and competitiveness. Due to limited resources, businesses including agribusiness firms need to make the best use of the economic resources available to them to maximize outputs, sales revenue, and profit. Therefore, managers of different business firms need to take prudent decisions regarding the production, processing, type of product mix, choice of inputs, and the prices they pay in purchasing inputs and product prices they receive and so on. The principles of economics, in this regard, should be applied to the decision-making process within the firm or organization (ICRA, 2015).

Dairying is considered as an important subsector for improving the rural livelihood. Because of the emphasis given to the sector and growing demand of dairy products due to

population growth and changes in lifestyles of urban dwellers, private sectors are interested to join the dairy industry. Improving dairy farming system through intensification (use of crossbred cows, improved feed, health, and management) is believed to enhance the process of economic development. However, improving this subsector requires the knowledge of production costs and receipts. Thus, there is a growing demand for more updated and day-to-day knowledge on economic indicators to make the sector more competitive and profitable in the era of highly volatile milk and feed prices. The main aim of this study is, therefore, to provide detail information on cost of production and gross profits of crossbreed dairy cows under small and large dairy farms. Analyzing the profitability of an enterprise reveals the gains or losses made by the enterprise after taking into account the full costs of the enterprise in achieving the activity. The information generated from this study is expected to support private investors to make informed decisions as well as facilitate evidence-based policy making in the dairy-sub-sector.

In most cases, farmers get relevant information about improved technologies from extension agents. However, the extension service in Ethiopia tend to focus more on crop production, with little emphasis on other important sub-sectors such as livestock and fishery production. That is why in most improved dairy cows adoption studies in Ethiopia (Solomon *et a*l., 2019), the role of extension services either become insignificant or appeared with a negative sign, explaining the skewed outreach services to staple and food crops. Part of the reason for this is that extension services providers do not have up-to-date information concerning the viability of the sector in relation to other competing enterprises. This warrants the generation of relevant information pertaining to the profitability of the dairy–sub-sector, especially in mixed farming system of Ethiopia. Hence, availing profitability information regarding the dairy farm would support extension works to disseminate relevant dairy information to farmers. This study, therefore, was designed to estimate the cost-benefit of dairy farms under the management of small and large dairy farms. The information from this study will serve the private investors, researchers, policy makers, extensions and other stakeholders.

Methodology

Study area

This study was conducted in three districts of Oromia Special Zone. Oromia special zone is found in the central part of the Oromia regional state, surrounding Addis Ababa. The special zone has an estimated total area of 4,800 km^2. It consists of six districts namely Akaki, Berek, Mulo, Sebeta Hawas, Sululta and Welmera, and eight major towns. The astronomical location of the zone lies between Latitude 8.5”9.5’N and Longitude 38.4”39.2’E. It shares borderlines from Eastern Shewa Zone in the east, North Shewa Zone in the North East and South-west Shewa Zone in the South West. The zone accounts for 1.5% of the total area of the regional state of Oromia. Dega (temperate), Woyina Dega (sub-tropical) and Kola (tropical) accounts 50%, 49% and 1%, respectively. The mean annual rainfall ranges from 800 to 1240 mm. The mean annual temperature is found between 20-25^{0}c in the low land and 10-15^{0}c in the highland areas. The area is known for a mixed crop-livestock farming systems. The major food crops produced in the zone are

cereals, pulses, oil seeds, and others. Among cereals, tef, barley and wheat are the predominant and among pulses faba beans and field peas are grown widely. Other crops include vegetables, fruits, root crops, and aromatic crops. Area under cereals covers the largest part of the total area of the Zone. Farmers in this zone have been using different crop-livestock technologies. Holetta agricultural research center has been providing improved crop and livestock technologies. Welmera, Sululta, and Sebeta Hawas Districts were selected for this study. These districts are well known both for its small and large intensive and extensive dairy farms. The majority of supply of milk for Addis Ababa town is sourced from these sample districts.

Livestock enterprise budget

The construction of livestock enterprise is much more complex than the crop enterprise because of internal transfers and replacements of animals and their different valuation (Turner & Taylor, 1998). Some managers develop livestock enterprise budgets on a per head basis, while others take some typical size operation as the basis for a budget. Presenting a typical size operation may not be precise enough for some operation and there is a need for their further adjustment. The revenue in livestock enterprises is usually presented on a per head basis. Most of the livestock enterprise budgets are calculated for one year. However, there can be different situation where the production period is shorter than a year (Kay *et al.,* 2008). Per head base analysis was also used for this study. The prevailing market prices were used to value economic costs and returns. Farmer supplied inputs was valued at the market opportunity cost including unpaid family labor. The principle of opportunity cost was also applied to other inputs produced and used (manure, dung and milk used, and feed produced). Quantities produced were valued at the farm-gate price at the time the production is sold. Inputs were also valued using the corresponding market price at the time the input is used.

Sampling

A three stage sampling procedure was employed to select the sample small and large dairy farms. In the first stage, districts and peasant associations *(*kebeles*)* were randomly selected based on dairy cattle population and milk supply. Secondly, small and large farms were randomly selected after stratifying the farms based on the size of dairy cattle they own. This study considered small dairy farms as those who own less than five crossbreed cows and large dairy farms as those who own more than five crossbreed cows. This classification is consistent with Yifat *et al.,* (2009) and Tafari (2016). Thirty-five small and 25 large commercial dairy farms were investigated for this study.

Data collection

Quantitative data was collected from sampled households and farms. The detail of costs and benefits from household who managed milking cows was collected and compiled for analysis. The data collection lasts for six to seven consecutive months using cost and benefit recording checklist prepared specifically for this study. All crossbreed milking cows of the sample households was examined. A total of 146 and 513 dairy cows of small and large dairy farms were investigated, respectively. Qualitative data was also collected,

especially on the opportunities and constraints of dairying, to supplement the primary data.

Data analysis

The analysis was made based on a single cow. Data entry and analysis were carried out with Microsoft Excel and SPSS version 20. Descriptive, gross margin, benefit-cost ratio, sensitivity, and break even analyses were done to summarize the collected data.

Gross Margin (GM)

Gross margin is the difference between the Gross Return (GR) and the Total Variable Cost (TVC).

$$\mathrm{GM} = \mathrm{GR} - \mathrm{TVC}$$

The gross margin is not profit because it does not include fixed or common costs like depreciation and interest expenses that have to be met regardless of production volume. Main use of the gross margins is recognition of the individual enterprise performance in the multi-enterprise businesses. It is possible with numbers from the profit and loss account and with some additional information to construct enterprise gross margin figures, which can be used for management purposes where fixed capital is negligible portion of the farming enterprise (Olukosi and Erhabor, 1988; Turner and Taylor, 1998). Here, fixed costs are not included in the gross margin analysis since they are unrelated to higher levels of milk production and they do not affect optimal combination of variable inputs. This estimation is consistent with Mburu *et al*., (2007) and Mumba *et al*., (2011). The authors estimated the gross margin by excluding the fixed costs of dairy farms.

Benefit-Cost Ratio (BCR)

Benefit-Cost Ratio is given by the ratio of gross return to total variable costs.

$$BCR = \frac{GR}{TVC}$$

If the ratio is less than one, then the costs exceed the benefit. However, if the ratio is more than one then the benefits exceed the costs (Gittenger, 1982; Jehanzeb, 1999).

Break-even Analysis

In economics, break-even analysis can be performed at various levels. It is the point where gross margin and total variable cost (TVC) are the same when the sales of a farm are enough to cover the expenses (variable costs) of the farm. The goal of calculating a break-even price is to find out at what price a product would have to be sold for in the market place in order to pay for its production costs. Break-even yield also shows at what production potential (yield per unit area) a product is economically feasible given the variable cost and price. Accordingly, it is given as

$$Break-even\ Yield\ (BEY) = \frac{TVC}{Per\ unit\ sale\ price}$$

$$Break-even\ Price\ (BEP) = \frac{TVC}{Total\ Production}$$

Sensitivity Analysis

The sensitivity analysis is a technique used to determine the effect of different values of input and output prices on a certain dependent variable (gross margin) in predetermined conditions. It is used to identify key sources of variability and uncertainty for the variation of an expected result in order to take the best decisions. Gross margin is influenced decisively by the sales price of the product, yield, variable costs and subsidies. Sensitivity is calculated to estimate the impact of assumptions regarding the changes of risky factors on the gross margin by using the principle 'what if' (Anca and Ana, 2016).

Results and Discussions

Characteristics of dairy farmers

Of the total sample farmers involved, 54% and 76% are male headed small and large dairy farmers while the rest (46% & 24%) are female headed respectively, indicating female headed households also intensively participate in crossbreed dairy farming. The result also revealed that small dairy farmers had significantly more number of oxen and equines than the large dairy farmers. This might be obvious as small dairy farmers have crop-livestock farming and they use oxen for traction and equines for transportation of inputs and outputs. Whereas large dairy farmers had significantly more number of cows, heifers and chickens than their small counterparts. Large dairy farms had on average more than 80 chickens. This implies that large dairy farms have a tendency to practice more side by side business farm enterprise than small dairy farmers [Table 1].

Table 1: Livestock holdings

Variable	Small farms (n = 35)		Large farms (n = 25)		P value
	Mean	S.D	Mean	S.D	
Oxen	2.54	1.38	0.72	0.62	0.000***
Bull	1.23	1.18	0.88	0.23	0.170
Cow	3.40	1.49	18.12	9.83	0.000***
Heifers	1.37	1.31	3.44	3.01	0.016**
Calves	2.26	1.48	2.40	2.21	0.791
Sheep and goat	2.97	2.49	1.71	1.20	0.247
Chicken	4.06	4.05	80.17	78.71	0.000***
Equines	1.22	1.18	0.11	0.08	0.000***

****, ** indicate significance level at 1% and 5%, respectively*
Source: survey result, 2016-2017

The result also showed that large dairy farms obviously had significantly large number of crossbreed cows, calves, and heifers than small dairy farms [Table 2].

Table 2: Sample households' crossbreed cattle ownership

Variable	Small farms (n = 35)		Large farms (n = 25)		P value
	Mean	S.D	Mean	S.D	
Crossbreed cows	2.23	1.09	18.12	9.83	0.000***
Crossbreed calves	1.34	0.99	2.40	2.11	0.054*
Crossbreed heifers	0.80	0.16	3.44	3.01	0.000***

****, * indicate significance level at 1% and 10%, respectively*
Source: survey result, 2016-2017

Cost of dairy farms

The study has classified costs of dairy farming in to four. These include feed cost, **labor cost, medical and breeding cost, and miscellaneous cost.**

Feed cost

Cost of feed had the highest share in dairy farming. Farmers feed different feed types for their dairy cows. Hay, concentrates, grasses and others are common feed types the farmers used to feed their cows. High share of feed cost goes to concentrates followed by green grass and hay for small dairy farms. Concomitantly, the cost went to concentrate followed by hay and green grass for large dairy farms. Moreover, small dairy farmers disburse 3% more mean feed cost per cow per year than their large counterparts [Annex 1]. This might be due to the economies of scale. The concentrate feed type includes oil seed cake, molasses, wheat bran, by products of local beer and others.

Labor cost

Dairy farming is a labor-intensive agricultural activity. Based on the result of his study, the highest share of labor cost went to shepherd and management both for small and large dairy farms followed by milking. However, the mean labor cost of small farms was significantly higher than large dairy farms. The result of the study is consistent with theory of economies of scale. Economies of scale refer to the phenomena of decreased per unit cost as the number of units of production increase. It tend to occur in industries with high capital costs in which those costs can be distributed across a large number of units of production both in absolute terms and relative to the size of the market. The result showed that large farms costs 53% less for labor than small farms [Annex 2]. The result of this study corroborate with Saadullah (2001) who found that large farms employ 60% fewer labor hours than small farms. Uddin *et al.*, (2010) also pointed out that traditional small farms use approximately 75% more labor input than large extensive farmers.

The results imply that small farms are not efficient in terms of labor productivity and underutilize their family labor. The hired labor in large farms can carry out task faster than small farms due to better skills and time management. Moreover, hired workers in large farms need to work more efficiently to maintain their jobs whereas the family members work in a more relax atmosphere.

Medical and breeding cost

Medical and breeding costs are also considered for this study. The result of the study showed that the largest share went to medicine purchase followed by treatment, breeding, and vaccination and follow up cost for small farms. Whereas large costs of medical and breeding were incurred for medicine purchase followed by treatment, vaccination, follow up and breeding expenses for large farms [Annex 3]. Consequently, there was significant difference between small and large dairy farms in breeding and medical costs. Large dairy farms disburse 63% more medical and breeding cost than small dairy farms. The reason could be small farms use cultural medicine to treat their cattle.

Miscellaneous costs

Miscellaneous costs include costs of market, electricity and others. The result of the study showed that small farms spent significantly higher miscellaneous cost than their large dairy farm counterparts. This might be due to the fact that less bargaining power of small dairy farmers, this is due to unorganized or scattered markets they faced [Annex 4].

Variable costs

The summarized result of costs showed that large total variable cost was incurred by small dairy farms [Table 3]. Small dairy farmers disburse 38% more cost than large dairy farms. This result is in line with the prominent economic theory; economies of scale. The cost summary also showed that high share (more than 80%) of cost went to feed cost under both small and large dairy farms [Figure 1].

Table 3: Summary of costs in Birr

Particular	Small farms (n = 146)	Large farms (n = 513)	T	P value
Feed cost/cow/year in Birr [A]	23373.84	22785.50	1.33	0.523
Labor cost/cow/year in Birr [B]	4588.28	3004.20	2.32	0.034**
Medical and breeding cost/cow/year in Birr [C]	453.64	738.70	-1.87	0.054*
Miscellaneous costs/cow/year in Birr [D]	734.11	543.49	1.83	0.072*
Total variable cost in Birr [A+B+C+D] = [E]	29149.87	27071.89	1.80	0.078*
Total variable Cost in US$	1049.31	758.53	1.80	0.078*

Remark: 1US$=27.78 ETB
Source: survey result, 2016-2017

Dayanandan (2011) also found that high share of costs of dairy farming goes to feed accounting 59% followed by fixed cost (depreciation and interests) accounting 19% and labor cost (11%). Medicine and veterinary services accounting for 1% and miscellaneous cost accounting for 10%. Ergano and Nurfeta (2006) also reported that feed expenses accounted for 80% of the total expenses in smallholder dairying in Southern Ethiopia. According to Uddin *et al.* (2010), large-scale dairy farming systems both extensive and traditional have higher total farm costs than large-scale dairy intensive farming systems. Within large farms, traditional large-scale farming incurred a higher (17%) than intensive large-scale farming.

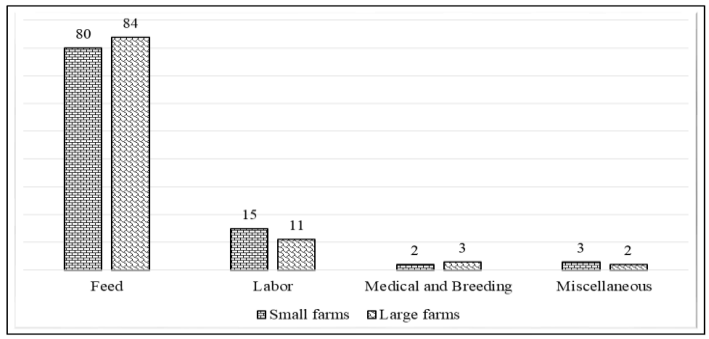

Figure 1: Share of costs in %

Gross returns of dairy farms

The major gross return from dairy cows is classified in to four primary products. Milk, calf, dung, and manure are the source of income of dairy farms. In this study, the income from butter and cheese was excluded to make the estimation free from double counting. Dayanandan (2011) also estimated revenue from dairy farms by considering milk sold and consumed, sale of cattle, appreciation of calves, cow dung and manure.

Income from milk

Milk is the major source of income from dairy cows as the ultimate goal of dairy farming is milk. The result revealed that the mean per day milk yield of small farms was lower than their large counterparts. The price of a liter of milk for small dairy farmers was lower than the large farms. This might be due to the reason that transaction costs for collecting milk from small farms is high which in turn inflates milk price. The mean lactation period for the small farms is found higher than the large farms though not statistically significant. Moreover, large farms earned 46% more milk income than small farms per cow per year [Annex 5].

Gross revenue from calf

Calf is the second important goal of dairy farms after milk. The market price of calf vary with the age, breed and sex of calf. The mean price of calf was considered for this study. The mean market price of a one year calf was ETB 8666.67. An estimate of a one year calf was considered since the gross margin estimate was done for one year [Annex 6].

Mean gross revenue from dung

Dung is also another important product of dairy cows. The opportunity cost of selling a kilogram of dung was taken in to consideration for home consumption. Both mean production and revenue from dung per cow per year for small farms was higher than the large dairy farms, which is significant at 10% and 1% significance level, respectively [Annex 7]. The reason could be large farms dispose the manure as a waste and small dairy farms use the dung as a fuel for cooking and for sale. The result corroborate with Dayanandan (2011) who concluded that majorities of small farm households are poor and resides at the periphery of the town, and used cow dung as sources of fuel and manure as compared to medium farms.

Mean gross revenue from manure

Manure is another important product of dairy cows. Animal manure is used as an organic fertilizer, which reduces the use of expensive inorganic fertilizers. Most of the farmers do not sale manure. They use at home as fertilizer for their cropland. The study revealed that small farms used significantly large volume of manure relative to their large counterparts [Annex 8]. Large farms usually focus on the milk and they have no much space to store the manure. For that, they dispose or sale to flower industry and forest nurseries found near to their farm at a lower price.

Gross return of dairy farms

The summary of the revenue of small and large dairy farms revealed that large dairy farms earn 55% more annual revenue from a cow than small farms. Large share of revenue for both small and large farm dairy cows was milk followed by calf [Table 4].

Table 4: Summary of gross revenue

Revenue	Small farms (n = 146)	Large farms (n = 513)	t	P value
Milk revenue (Birr/cow/year)	29300.90	53893.91	-3.61	0.000***
Calf revenue (Birr/cow/year)	8666.67	8666.67	-	-
Dung revenue (Birr/cow/year)	1819.4	780.15	2.89	0.000***
Manure revenue(Birr/cow/year)	1131.50	237.90	3.04	0.000***
Total revenue/cow/year (Birr)	40,918.47	63,578.63	-3.10	0.000***
Total revenue/cow/year in US$	1,472.95	2,288.65	-3.10	0.000***

Remark: 1US$=27.78Birr
Source: survey result, 2016-2017

The share of milk is more than 70% for both small and large dairy farms followed by revenue from sale of calf [Figure 2]. The findings are similar to other previous studies. Dayanandan (2011) found that highest share of total returns for the categories of cross breed farms was from milk and milk by-product (85%) followed by appreciation of calves and heifers (13%), sales of cattle (2%) and cow dung (1%). Sadiq *et al.*, (2006) also reported that milk constituted the highest share of revenue (71%) followed by appreciation of calves and heifers (21%). Cow dung generates income for the majority of smallholder dairy farms, since it is used as a source of fuel and manure.

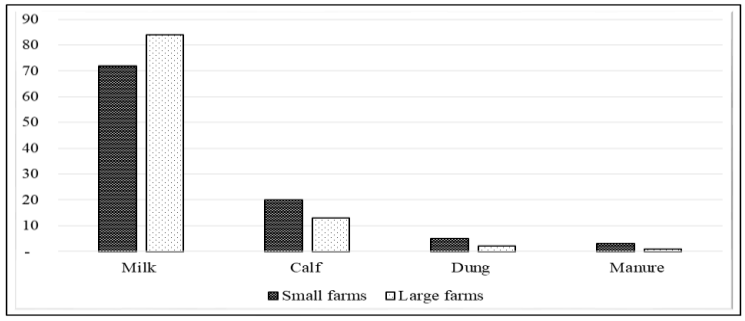

Figure 2: Share of returns in %

Gross margin analysis

The result showed that the gross margin of large dairy farms was higher by three folds of their small counterparts. The benefit cost ratio was 1.43 and 2.24 for small and large dairy farms, respectively. The break-even price of milk was Birr 14.03, which is lower than the actual price (Birr 14.10) which implies that sale price of milk among small dairy farms, could cover the variable costs. Whereas the break-even price among large dairy farms was 8.10 and the actual price of milk was Birr 16.10. The break-even yield of milk per day among small dairy farms was 8.30 liters and the actual was 8.34 liters, and the break-even yield per day among large dairy farms was also 6.82 liters and the actual was 13.57 liters. The result implies that large dairy farms are more profitable than small dairy farms [Table 5].

Table 5: Cost-benefit analysis of dairy farms

Particular	Small farms (n = 146)	Large farms (n = 513)
Milk/cow/day in liters	8.34	13.57
Milking lactation days/year	249.17	246.68
Milk price/lit (Birr)	14.10	16.1
Total variable cost/year (Birr)	29,149.87	27,071.89
Total revenue/year (Birr)	40,918.47	63,578.63
Benefit-cost ratio)	1.43	2.24
Gross margin of a cow/year (Birr)	11,768.60	36,506.74
Gross margin of a cow/year (US$)	423.64	1,314.14
Break-even price (Birr)	14.03	8.09
Break-even (liters)	8.30	6.82

Source: survey result, 2016-2017

Dayanandan (2011) also found that the average cost-benefit ratio (CB) was 1.45 and 1.74 for small and medium crossbred farms, respectively. This implies that crossbred medium size farms are making more profit than small farms. These results are in line with study carried out by Sayeed *et al.,* (2004). The study by Mohamed *et al*., (2004) also showed that the benefit cost ratio of crossbreed dairy farming was 1.4 for local and 2.7 for crossbreed dairy cows. Chisoni (2012) pointed out that the average price received by the farmer from sale of a liter of milk was higher than the average cost of production by 58% that resulted a benefit cost ratio of 2.4. Cost of milk production was found to be 4 USD per 100 kg milk in extensive farming systems in Cameroon and 128 USD for an average sized farm in Japan, the average cost of over all countries was 46 USD/100 kg milk (IFCN, 2013). Uddin *et al.,* (2010) also found that the cost of milk production varies between 23 US-$/100 kg and 31 US-$/100 kg. The lowest milk price is seen for intensive large-scale dairy farming system compared to traditional dairying.

The result also showed that large dairy farms incurred less costs than the small dairy farms, which is consistent with James *et al.,* (2007). On average, farms with at least 1,000 cows realize cost advantages per hundredweight of milk produced 15 percent lower than farms in the next largest class (500–999 head) and 35 percent lower than farms with 100–199 head. Other evidence suggests that costs may continue to decline as herds increase to and above 3,000 head (refer), implying that large dairy farms have cost advantages over

small dairy farms due to economies of scale. The intensive farms receive much higher income per 100 kg than all other farms in extensive and traditional farming systems. The highest return on investment is observed for intensive farming system that corresponds to 40%. The possible reasons for this is higher economy of scale due to lower cost per unit of input and overall good management practices applied to the intensive farms (Uddin *et al.,* 2010).

Sensitivity analysis

For this study, 10 % decrease in milk prices and 15% increase in operating variable costs were observed based on the current trend of milk and feed price fluctuations. Sensitivity analysis of gross margin showed that raise in total variable cost by 15% is more sensitive than 10% fall in milk price under small farms. However, under large farms a 10% fall of milk price affects the gross margin than 15% increase in variable costs. Regarding benefit-cost ratio, 15% inflation of variable cost is sensitive than 10% reduction of milk price under both small and large dairy farms [Tables 6 and 7].

Table 6: Sensitivity analysis of small dairy farms

Particular	Original value	10% decrement of milk price	15% increment of total variable cost
Milk yield/day (liters)	8.34	8.34	8.34
Milking lactation days/year	249.17	249.17	249.17
Milk price/lit (Birr)	14.10	12.69	14.10
Annual milk revenue (Birr)	29300.90	26370.81	29300.90
Annual revenue from calf (Birr)	1819.40	1819.40	1819.40
Annual revenue from dung (Birr)	1131.50	1131.50	1131.50
Annual revenue from manure (Birr)	8666.67	8666.67	8666.67
Total variable cost/year (Birr)	29149.87	29149.87	33522.35
Total revenue/year (Birr)	40918.47	37988.38	40918.47
Benefit-Cost ratio (Birr))	1.40	1.30	1.22
Gross margin of cow/year (Birr)	11768.60	8838.51	7396.12
Break-even price)	14.03	14.03	16.13
Break-even yield	8.30	9.22	9.54
Gross margin difference	11768.60	2930.09	4372.48
% change (GM)		25	37

Source: survey result, 2016-2017

Considering the above risky conditions, the gross margin fall by 25-37% and 11-15% under small and large dairy farms, respectively. This implies that gross margin of large dairy farms is less sensitive to agricultural risks (raise of costs and fall in price) than that of the small dairy farms.

Opportunities of dairy farming

The study identified the opportunities of large and small dairy farming. Increasing demand for milk and milk by-products is the first and the most. Farmers perceived that an increase in the demand for milk is due to an increase in the population and increased awareness on milk consumption. The milk consumption culture in the country is changing especially in urban areas. The second opportunity reported by the farmers is feed supply, and the availability of feeds in the market encourages staying dairy farming. They

engaged in feed supply in the market for commercial farms and this becomes a source of income and employment for the family. Farmers reported that they supplied feeds including hay and straws of crops as a by-product and accessed hay, concentrates and factory by-products available in the market.

Table 7: Sensitivity analysis of large dairy farms

Particular	Original value	10% decrement of milk price	15% increment of total variable cost
Milk yield/day (liters)	13.57	13.57	13.57
Milking lactation days/year	246.68	246.68	246.68
Milk price/lit (Birr)	16.10	14.49	16.10
Annual milk revenue (Birr)	53893.91	48504.52	53893.91
Annual revenue from calf (Birr)	780.15	780.15	780.15
Annual revenue from dung (Birr)	237.90	237.90	237.90
Annual revenue from manure (Birr)	8666.67	8666.67	8666.67
Total variable cost/year (Birr)	27071.89	27071.89	31132.67
Total revenue/years (Birr)	63578.63	58189.24	63578.63
Benefit-cost ratio	2.35	2.15	2.04
Gross margin of cow/year (Birr)	36506.74	31117.35	32445.95
Break-even price	8.09	8.09	9.30
Break-even yield	6.82	7.57	7.84
Gross margin difference	36506.74	5389.39	4060.78
% change (GM)		15	11

Source: survey result, 2016-2017

Challenges of dairy farming

Farmers reported that they have faced different challenges that discouraged them to advance and specialize the sector.

Lack of technical support

Milk suppliers need to have technical support on the process of production including feeding and nutrition, breeding, sanitation and milk hygiene, human and animal health, marketing, handling and transportation of milk towards collection centers. Most of farmers interviewed did not get any training from government and non-government institutions. The farmers perceived that they received poor extension services regarding dairy management and development. SNV (2008) also reported that livestock extension services are inefficient in coordination of the dairy development activities, in controlling livestock diseases, improving forage production and improving the productivity of the sector. The result also corroborate with Tadesse and Mengistie (2016) and Tadesse *et al.* (2017).

Animal health issues

Dairy farming needs quality and easily accessible veterinary services. However, farmers pointed out the problem of accessibility of veterinary services. Disease prevalence especially mastitis was the main problem farmers cited. Farmers reported that government veterinary technicians are not willing to respond quickly when service is demanded, and private veterinary service including drugs (medicines) is expensive. This was also reviewed by Tadesse and Mengistie (2016).

Breeding issues

Shortage and inefficiency of AI services, AI technicians' bureaucracy (capability and willingness to serve) and lack of breeding bulls were reported to be the most important constraints facing the sector. Consequently, frequent abortion of dairy cows was common to both large and small dairy farms. This finding is in line with a study carried out by Tadesse and Mengistie (2016), reported abortion is the main challenge to the dairy sector. These issues causes poor reproductive performance and leads to economic inefficiency of dairy cows.

Role of cooperatives

Cooperatives are business organizations that make profit for the members. There are dairy product based cooperatives on the study areas but found to be too weak. For that, all farmers sale their milk products to milk collectors (traders) rather than cooperatives for main reason that dairy cooperatives do not pay for the collected milk immediately. On other hands, farmers complain cooperatives as they fix sale price for retailers and/or traders. The price cooperatives fix is the maximum price of milk for traders.

Inadequate market outlet

Low price of milk, which sometimes does not cover the cost of production especially among small farms, was reported as a constraint to dairying. Most of dairy farmers sale their products to farm gate collectors. The traders buy the milk at low price and sale at high price in Addis Ababa town without adding any value. This was due to lack of well-organized farmers' cooperatives and milk markets.

Price of feed

Although the supply of feed is progressing, the cost of feed is increasing from time to time. Specially, the price of some concentrates such as oil seed cake is highly inflating. The reason for this could the existence of only few companies that produce limited feed concentrates who fix the price by themselves.

Lack of credit

Dairy industry is capital intensive. Thus, capital for dairy farming is crucial to purchase feed and heifers. Farmers reported that heifers are very expensive due to brokers' intervention in crossbreed cattle market. Due to limited financial supports, smallholder farmers were not in a position to transform into commercial dairy farming. None of farmers interviewed had access to credit even though they need credit. SNV (2008) and Tadesse and Mengistie (2016) reported there is lack of credit for dairy industry.

Shortage of land

The dairy farmers, especially large farms reported that they faced shortage of land for pasture establishment. This inclined them to reduce their herd size. This result is consistent with SNV (2008), Tadesse and Mengistie (2016) and Solomon *et al.* (2014). They reported lack of land as a constraint to further advancement of the sector.

Other issues

Dairy farming is labor intensive. It was reported that the availability and high cost of labor is a major constraint faced dairying. Moreover, availability and accessibility of water for livestock is also reported as challenges faced the farmers. Solomon *et al.*, (2014) also found water as the major constraint for dairying.

Conclusion and Recommendations

The results indicated that small dairy farms disbursed more cost than large farms. High share of cost went to feed purchase under both small and large dairy farms. The study also revealed that large dairy farms earned more annual revenue per year per cow than small dairy farms. Large gross revenue for both large and small dairy farms was collected from milk sale followed by calf sale. The study also indicated that the gross margin of large dairy farms was higher than their small counterparts by more than three folds. This implies that large farms are more profitable than the small farms. Sensitivity result showed that the gross margin of large dairy farms is less sensitive to agricultural risks (raise of costs and fall of price) than that of the small farms. The study also identified shortage of land, lack of credit, lack of technical support, shortage of adequate market outlet, inefficiency of AI services (experts), abortion, high price of feed and medicine are the main constraints of dairy farming. Based on these findings, the following recommendations have been proposed.

Feed processing machines

Feed is the highest cost of dairy farming. Reducing feed cost raises the profit margin of dairy farming. Therefore, capacitating dairy farms and cooperatives to establish their own feed processing machine is crucial.

Timely culling and replacing of less productive cows

The result of the study showed that high share of revenue is collected from milk sale. This indicates that milk yield highly and directly affects the annual returns from the farms and/or cows. Thus, farms should use high yielding cows. If the productivity of the cows is getting low, culling and replacing is the only and best option to sustain the dairy business. In this regard research, extension, NGOs and other concerning bodies should participate from awareness creation to multiplication and supply of high yielding crossbreed cows and complementary technologies and recommendations.

Increase herd size

The result of the study also exhibited that as herd size increases, mean return from a cow increases and the mean cost per cow decreases. Thus, farmers should own and manage medium to large herds to reduce per cow cost and increase per cow returns. Therefore, there is a need to encourage farmers to specialize in dairy farming through the provision of improved dairy heifers and complementary technologies.

Empower key actors

Empower dairy farmers through the provision of training about feeding (rationing) to optimize the use of inputs, about health care and management aspects. It is also important to empower experts (AI, health, feed and nutrition), extension agents through capacity building. Dairy cooperatives are also important to bargain and have position in delivering inputs and supply outputs to the markets with better price.

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Annex

Annex 1: Feed cost of dairy farms (Birr)

Particular (per cow/year)	Small farms (n = 146)			Large farms (n = 513)			t	P-value
	Mean	% share	S.D	Mean	% share	S.D		
Hay	3289.87	14.06	3186.02	3394.84	14.90	2844.86	-0.10	0.221
Concentrates	12700.7	54.35	11577.4	14290.5	62.71	12306.6	-0.88	0.631
Crop residue	1074.38	4.60	908.14	1038.02	4.56	1011.56	0.76	0.814
Green grass	3869.54	16.56	1787.14	2057.61	9.03	1913.70	2.34	0.035**
Improved forages	1957.03	8.37	1077.51	1074.85	4.72	1047.69	2.41	0.021**
Water	309.12	1.32	177.08	761.29	3.34	723.19	-2.99	0.000***
Salt	173.20	0.74	170.28	168.39	0.74	162.11	0.98	0.876
Total feed cost	23373.84			22785.50			1.33	0.523

****, ** indicate significance level at 1% and 5%, respectively*
Source: survey result, 2016-2017

Annex 2: Labor costs of dairy farms (Birr)

Particular (per cow/year)	Small farms (n = 146)			Large farms (n = 513)			t	P value
	Mean	% share	S.D	Mean	% share	S.D		
Shepherd and management	2030.43	44.26	1672.26	1309.18	43.58	1301.85	2.19	0.016**
Milking	1247.25	27.18	1102.32	1181.38	39.32	1147.92	0.61	0.912
Feeding	724.01	15.78	528.89	220.59	7.34	169.03	2.87	0.000***
Barn cleaning	586.59	12.78	578.31	293.05	9.76	271.33	2.29	0.036**
Total labor cost	4588.28			3004.20			2.32	0.034**

****, ** indicate significance level at 1% and 5%, respectively*
Source: survey result, 2016-2017

Annex 3: Medical and breeding costs of dairy farms (Birr)

Particular (per cow/year)	Small farms (n = 146)			Large farms (n = 513)			t	P value
	Mean	% share	S.D	Mean	% share	S.D		
Medicine purchase	159.67	35.20	126.66	330.41	44.73	555.71	-1.69	0.087*
Treatment	125.00	27.55	162.64	173.13	23.44	152.24	-2.45	0.042**
Vaccination and follow up	46.57	10.27	29.11	143.19	19.38	89.53	-3.13	0.000***
AI and bull rental	122.40	26.98	51.81	91.97	12.45	79.51	1.74	0.065*
Total medical and treatment cost	453.64			738.70			-1.87	0.054*

****, **,* indicate significance level at 1%, 5% and 10%, respectively*
Source: survey result, 2016-2017

Annex 4: Miscellaneous costs of dairy farms (Birr)

Particular	Small farms (n = 146)		Large farms (n = 513)		t	P value
	Mean	S.D	Mean	S.D		
Miscellaneous costs	734.11	881.22	543.49	723.19	1.83	0.072*

** indicate significance level at 10%*
Source: survey result, 2016-2017

Annex 5: Mean gross return from milk

Particular	Small farms (n = 146)		Large farms (n = 513)		t	P value
	Mean	S.D	Mean	S.D		
Milk production (lit/day)	8.34	1.18	13.57	3.32	-2.77	0.000***
Income/lit/Birr	14.10	1.15	16.10	2.10	-2.68	0.000***
lactation days/year	249.17	67.97	246.68	30.65	1.33	0.688
Mean revenue per lactation/year/Birr	29300.90	11106.01	53893.91	13037.31	-3.61	0.000***

*** *indicate significance level at 1%*
Source: survey result, 2016-2017

Annex 6: Mean gross revenue from milk

Particular	Small farms (n = 146)			Large farms (n = 513)	
	Mean	S.D		Mean	S.D
Annual revenue from (Birr)	8666.67	4509.25	8666.67	4509.25	

Source: survey result, 2016-2017

Annex 7: Mean gross revenue from dung

Particular	Small farms (n = 146)		Large farms (n = 513)		t	P value
	Mean	S.D	Mean	S.D		
Mean annual dung production/cow (kg)	909.70	290.51	780.15	214.76	1.73	0.071*
Mean annual revenue from dung/cow (Birr)	1819.4	581.12	780.15	214.76	2.89	0.000***

***, * *indicate significance level at 1% and 10%, respectively*
Source: survey result, 2016-2017

Annex 8: Mean gross revenue from manure

Particular	Small farms (n = 146)		Large farms (n = 513)		t	P value
	Mean	S.D	Mean	S.D		
Mean annual manure production/cow (kg)	565.75	279.44	237.90	255.12	1.77	0.053*
Mean annual revenue from manure (Birr)	1131.50	562.18	237.90	255.12	3.04	0.000***

***, * *indicate significance level at 1% and 10%, respectively*
Source: survey result, 2016-2017