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TECHNICAL EFFICIENCY OF DAIRY FARMS IN ETHIOPIA: THE CASE OF SEBETA TOWN AND SELECTED SUB- CITIES OF ADDIS ABABA

MULUGETA KEBEDE

JANUARY, 2018

ADDIS ABABA, ETHIOPIA

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A THESIS SUBMITTED TO SCHOOL OF GRADUATE STUDIES OF ST. MARY'S UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN AGRICULTURAL ECONOMICS

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ENDORSEMENT

This thesis has been submitted to St. Mary's University, School of Graduate Studies for examination with my approval as a university advisor.

Maru Shete (PhD and Assoc. Prof.)

Advisor's Signature _____

DEDICATION

This thesis document is dedicated to my venerated family and my wife Medhanit Anberber who have committed to unreserved moral support, patient, encouragement and responsibility for the betterment and success of my life.

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To God be the glory for its neither by my power nor my might but by His grace that is superfluous and more than sufficient. I thank Him for making this a reality. Several individuals and organizations deserve acknowledgement for their contributions to the study. My foremost appreciation and thanks goes to my major advisor, Maru Shete (PhD and Assoc. Prof.) for his close supervision and professional advice and encouragement during the research work.

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Finally, I would like to acknowledge all individuals who assisted me in the course of my study.

ACRONYMS

ADLI	Agricultural Development Led Industrialization
AEI	Allocative Efficiency Input
AEO	Allocative Efficiency Output
AMAE	Asella Model Agriculture Enterprise
ATEVTS	Agricultural Technical Education and Vocational Training School
BOA	Bureaus of Agriculture
BOAM	Business Organization and their Access to Markets
CSA	Central Statistical Agency
DAS	Development Agents
EDUCAHH	Education of Household
EIAR	Ethiopian Institute of Agriculture Research
EMDTI	Ethiopian Meat and Dairy Technical Institute
FARMEXP	Farmer Experience
FRECONEA	Frequency Of Contact With Extension Agent(s)
FAO	Food and Agricultural Organization
FTTCS	Farmers Training Centers
GDP	Gross Domestic Product
HARC	Holetta Agricultural Research Center
Km	Kilometer

Kg	Kilogram
LANDHOLD	Land Holding
ME	Marginal Effect
MOA	Ministry of Agriculture
MOARD	Ministry of Agriculture and Rural development
MOFED	Ministry of Finance and Economic Development
NAIC	National Artificial Insemination Center
NGO	Non-Governmental Organizations
SNNP	Southern Nations Nationalities and People
SPF	Stochastic Production Frontier
RE	Revenue Efficiency
RTS	Return To Scale
TE	Technical efficiency
TEI	Technical Efficiency Input
TEO	Technical Efficiency Output
TEVT	Technical Education and Vocational Training
VIF	Variance Inflation Factor

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ABSTRACT

The purpose of the study was to analysis the technical efficiency of dairy farm milk producers on sampled area which located in Sebeta town and the sub cities of Addis Ababa town two woreda administrative neighbors to Sebeta. A sample of 530 target population was selected using purposive and random sampling techniques and among these 100 were sampled households were selected randomly using probability proportionality size following a simplified formula provided by Yamane (Yamane, 1967). Data were analyzed using the Stochastic Frontier Production Function (SFPF) to estimate the level of technical, efficiency of the dairy milk producers. Both primary and secondary data were collected and the data was analyzed using descriptive statistic and econometric analyzing method. The results of the model showed that two of the input variables in the production function: i.e. herd size and labor man-day's had a positive significant effect on technical efficiency level of dairy milk productivity. The result of the efficiency scores indicates that the mean of technical efficiency was found to be close 83.60%. The estimation of the Tobit regression model showed that age, education level, of farm owner, training service and marketing facility, were found to be statistically significant in explaining the variation in the level of technical efficiency of the dairy farm milk producers in the study area.

Key words: Dairy, Cobb Douglass, efficiency, Stochastic Frontier and Tobit.

CHAPTER ONE

INTRODUCTION

1.1. Background of the Study

In Ethiopia, agriculture is a source of food to the population. It also provides employment opportunities, foreign exchange earnings as well industrial raw materials for the various industries. It accounts for 41% of GDP for the country, followed by 46.6% and 13.3% coming from service and the industrial sectors, respectively (MoFED, 2011). Within agriculture, 50% of the output of the agricultural GDP comes from crop production, whereas, 47% and 3% are from livestock and forestry, respectively (Fitawok and Roy, 2012). Most agricultural holders acquire the food they consume and the cash they need to cover other expenses only from farming activities. Since farming in Ethiopia is often precarious and usually at the mercy of nature, it is invariably an arduous struggle for the holders to make ends meet. This, it often transpires, is true to the frequent shortfalls in the volume of production that occur in the country (CSA, 2010; 2012).

Dairy plays an important role in the Ethiopian agricultural sector and the national economy (Tegegne et al. 2013). The sector is a source of livelihoods for a vast majority of the rural population in terms of consumption, income and employment. Recent estimates by the nation's Central Statistical Agency (CSA) indicate that there are about 55 million cattle, of which 44.6% are male and 55.4% are female (CSA 2014). The CSA survey further indicates that 2.8 billion liters of milk was produced in 2012/2013, out of which 42.3% was used for household consumption. This shows that dairy production is an important agricultural activity in the country and provides livelihood for significant proportion of smallholders.

Per capita consumption of milk in Ethiopia is as low as 17 kg per head per year while, the average figure for Africa is 26 kg per head per year (Mohamed et al., 2003). Milk and milk products are part of the diet for many Ethiopians. Getachew and Gashaw (2001) estimated that 68% of the total milk produced is used for human consumption in the form of fresh milk, butter, cheese and Yogurt while the rest is given to calves and/or sold. The amount of consumption of milk and milk products vary geographically between the highland, the lowlands and level of urbanization.

The demand for milk depends on many factors including consumer preference, consumer's income, population size, price of the product and price of milk substitutes. In general, population growth, rising real income and decreasing consumer price are expected to expand the demand for milk and milk products.

Population in Ethiopia is estimated to grow at a rate of 2.9% per year while the urban population increases at a rate of 4.4%.Therefore, an increasing population size and consumers' income in the future are expected to increase dairy milk consumption. Dairy production is an important issue in Ethiopia's-livestock-based society where livestock and their products are important source of food and income, and dairy farm has not been fully exploited and promoted (Tangka et al., 2003).

Since the early 1990s, Ethiopia has embarked on a policy reform that aims to bring about a market-oriented economic system. Subsequently, several macro and sectarian economic policy changes were implemented. The federal government launched a national development strategy namely; Agricultural Development Led Industrialization (ADLI).This strategy seeks to bring about an improvement in the livestock sector by enhancing the quality and quantity of feed, and improved extension services, increasing livestock health services and improved productivity of local cows by artificial insemination while preserving the indigenous breeds (Mohamed et al., 2003). Peri-urban and urban dairy production system is becoming an important supplier of milk products to urban centers, where the demand for dairy milk products is remarkably high. As a result of this, urban dairying is being intensified through the use of cross breed dairy cows, purchased and conserved feed and staff-feeding. These production systems are favored due to the proximity of the production sites to centers of high fresh milk demand, easy access to agro-industrial by- products, veterinary services and supplies (Azage et al., 2005). On the other hand, modern dairy farming practices cover a range of intensive management practices and zero grazing. This production system also involves the use of exotic crossbreed genotypes that give high yield as compared to the traditional dairy farms. Both practices are confronted with the problem of competing for scarce resources. Nonetheless, these resources have to be optimally and efficiently utilized on the bases of their marginal value productivity in order to get maximum income from dairy enterprises. Efficient milk production is a key to sustainable development of dairying.

1.2. Statement of the Problem

As pointed out earlier urban dairying needed to be promoted, as it is the main source of milk for urban dwellers. It also contributes considerably as income sources and as one-way of job creation for self-employment. Commercial milk producers in Sebeta administrative town and Addis Ababa same selected sub cities farmers are engaged in dairy milk production. There is a herd size variation ranging from smallholder, medium to largest size and also farm input usage variation. It is believed that, this variation in herd size in turn lead to differences in efficiency of resource use and profitability of farms. (Wuletaw 2007) in Ethiopia in general and urban dairy farm technical efficiency in particular has not been extensively studied in the central Ethiopia particularly in Sebeta town and Addis Ababa City even though, dairy farms are a source of income and job creation opportunities to the dwellers and dairy farms households. To assess the technical status of dairy farming, it is important to address the following issues; which herd size and input are more profitable and efficient and need to be promoted?, cross breed is efficient in input use? And, which input resources are critically limiting the technical efficiency cross breeds?

Thus, the existing knowledge gap regarding return and usage of important inputs between Sebeta Administrative town and Addis Ababa City dairy farms as well as in different farm sizes need to be filled-in. To assess the technical status of dairy milk farming in the selected area it is important to address the following issues; technical efficient level of dairy farm and determinate factors that contributing for dairy farm inefficiency? And, which input resources are critically limiting the production. A number of studies have examined the potential of the Ethiopian dairy sector to meet the expected growth in demand as well as to improve the incomes of the farmers (Staal, 1995; Benin, Ehui and Pender, 2002; Felleke, 2003; Ahmed, Ehui and Assefa, 2004). Many of those studies, however, focus on technological constraints of the sector including poor genotype of local breed animals, animal diseases, availability of feed, input and output markets, and related policies. The studies ignore an important source of growth - improving the technical efficiency of farmers.

Therefore, in order to improve dairy milk production and productivity, it becomes vital to undertake technical efficiency analysis at farm level under the existing technology to

enhance the contribution of the dairy farm sector to national economy. Moreover, identifying the extent of efficiency and the factors that contribute to it is of a paramount importance on the level of resource use efficiency in dairy milk production. Such information is useful for formulating appropriate policies and for reducing the level of technical inefficiency.

1.3. Objectives of the Study:

1.3.1. General Objectives

The general objective of this study was to estimate the technical efficiency levels of dairy farms in the study area.

1.3.2. Specific Objectives

In addition to the above general objective this study assumed the following specific objectives. The specific objectives of the study are:

1. To measure the level of technical efficiency of dairy production in the study area
2. To identify the determinants of technical efficiencies of dairy in the study area.

1.4. Research Questions

This study made an attempt to address the following main research questions:

1. Do institutional factors affect the efficiency of dairy producers in the study area?
2. Do socioeconomic factors affect the efficiency of dairy producers in the study area?
3. Do demographic factors affect the efficiency of dairy producers in the study area?
4. What is the return to scale of smallholder dairy producers in the study area?
5. What is the level of technical efficiency of dairy farm milk producers in the study area?

1.5. Significance of the Study

This study attempted to evaluate the technical efficiency of milk producers in Sebeta Administrative town and the sub cities of Addis Ababa and also to identify constraints of inputs to produce more milk output. The results thus help to devise and guide producers as to which part of the business for best profitability given the resources available.

Knowing the technical efficiency is the effectiveness with which a given set of input is used to produce an output.Technical efficiency of dairy milk producers help to identify opportunities and constraints that can be used as input information to device improvement

strategies that intensify milk product in Sebeta Administrative town and the sub cities of Addis Ababa city. Moreover, the three areas are the faster growing agro-industrial cities of the country; it shares quite many similar features with other urban areas in the country. Therefore, the results of the present study can be extended to other parts of the country. Hence, these results can be used by policy makers, government and Non-government organizations to streamline intervention for milk production in the country in general and for the study area in particular. Moreover, considering the growing interest of intensifying milk production in urban area in the country, this study can be used as a springboard or baseline to conduct similar other studies.

1.6. Scope and Limitation of the Study

The study was restricted to the three places area in central Ethiopia. These are Sebeta town , Nifas Silek Lafto and Kolfe Keranio Sub Cities of Addis Ababa town which the sampled farm areas selected from two administrative woreads near to Sebeta town about 3 to 5 kms. distance where the milk product highly demanded due to highly dweller of population in the area. These Administrative town and sub cities economic activities randomly increasing from time to time from the rest of urban towns of the country.Beside this, shortage of finance, logistics and inaccessibility of some of milk producers' will expect imposed additional burden.

1.7. Organization of the Thesis

This thesis was divided into five chapters. Chapter one constitutes background, statement of the problem, objectives, general objectives, specific objective, research Question, significance of the study and scope and limitations of the study. The second chapter presents literature review that provides theoretical and empirical framework to the research. The third chapter of this study was deals research methodology including the descriptions of the study, types and sources of data, sampling design, data collection and methods of data analysis. The fourth chapter is the main body of the research that comprises data analysis, interpretation and findings. Finally, the fifth chapter presents Conclusions and Recommendation based on the results of the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Theoretical literature

2.1.1 Efficiency

Efficiency is considered as one of the most important issues in agricultural production economics. It is measured by comparing the actually attained value of the objective function against what is attainable at the production frontier. The analysis of production and resource use in the smallholder dairy sector has more significance in agricultural policy frameworks that seek to increase local milk production by encouraging optimal resource utilization. Improving technical efficiency is an important factor of productivity growth in a developing country like Swaziland. Hassanpour (2012) stated that the analysis of technical efficiency under the current technological change in agriculture helps policy makers to formulate adequate and appropriate, extension services, pricing, marketing, and credit, input distribution and land allocation policies.

2.1.1. 1. Technical Efficiency

In economic theory, a production function is described in terms of maximum output that can be produced from a specified set of inputs, given the existing technology available to the farm (Battese et al., 1995). When the farm produces at the optimal production frontier, it is considered efficient. The most common assumption is that the goal of the producer is profit maximization; however, it is believed that the objectives and goals of the producer are intertwined with farmers' psychological make-up. Technical Efficiency (TE) is achieved when a high level of output is realized given a minimum level of inputs. It is therefore concerned with the efficiency of the input to output transformation. The reason for TE research is to understand factors that shift production function upwards on the production frontier (Battese et al., 1995).

The milk production system in Ethiopia can be categorized based on market orientation, scale and production intensity. Accordingly, three major production systems have been identified as traditional smallholders, privatized state farms and urban and peri-urban systems. Among these the traditional smallholder system refers to the rural milk production system and produces 97% of the total national milk production and 75% of the commercial milk production. This sector is largely dependent on the indigenous breeds such as native

Zebu cattle, which are characterized by low productivity, yielding about 400-680 kg of milk /cow per lactation period (Alemu et al., 2000).

The state dairy farms now privatized or in the process of privatization, use grade animals (those with more than 87.5% exotic blood) and are concentrated within 100 kms radius around Addis Ababa. The urban and peri-urban milk production system, the third production system, includes small and larger private farms in urban and peri-urban areas, concentrated in the central highland plateaus (Getachew and Gashaw, 2001). This sector is commercial and mainly based on the use of grade and cross breed animals that have the potential to produce 1120-2500 liters over a 279 days lactation period (Holloway et al., 2000).

In Ethiopia, according to Central Statistics Authority (CSA, 2003), cattle are the main source of milk production, although small quantities of milk are also obtained from goat and camel in pastoral areas. The total cattle population is estimated at about 41.5 million out of which 189 thousand (0.47%) and 56 thousand (0.13%) are cross and pure breeds, respectively. The total urban cattle population is estimated at about 888 thousand of which 2,354 (0.26%) and 9,792 (1.1%) are cross breed and pure exotic breeds, respectively. The population of milking cows is estimated at about 9.3 million and 259 thousand exist in urban areas. The total milk production of the nation is estimated to be over 2.5 billion liters and this corresponds to an average milk production of 1.284 liters per cow per day. In the urban areas the total milk production is estimated to be 112 million liters and this gives an average daily production per cow of 2.1 liters (CSA, 2003).

In many studies of technical efficiency, the results are used to estimate the effects of various factors on inefficiency. These may be estimated using a two-step process in which the production frontier is first estimated and the technical efficiency of each farm is derived afterward. These are subsequently regressed against a set of variables which are hypothesized to influence the farm's efficiency. This approach has been adopted in a range of studies (FAO, 2000). The measurement of technical efficiency of a farm indicates that if a farm is successful in converting all the physical inputs into outputs and the efficiency of converting is equal to the frontier production function, then it is said to be an efficient farm

and if a farm falls short of this requirement, then the farm is termed as technically inefficient farm (Reddy *et al*. 2008).

2.1.2. Smallholder Dairy Producers in Ethiopia

Smallholder dairy producers dominate the dairy industry at the production and are the users of the extension services provided by various development partners. Different players are linked and interact with smallholder dairy producers at various levels based on the type of ongoing joint venture activities. The actors are: extension agents, various non-governmental and international development partners mainly Food and Agricultural Organization (FAO), Netherlands Development Organization (SNV), Land O'Lakes, Self Help, Hunde (in the central highlands), cooperatives and research and higher education institutions (Yilma *et al.*, 2011).

Smallholder producers, however, lack the required technological, organizational as well as institutional capacities. Lemma *et al*., (2008) reported them to be less organized and distant from market outlets, lack economies of scale and institutions for risk management and face higher transaction costs. Urban and peri-urban smallholder producers are the main suppliers of raw milk to milk processors of different scales. One of the major commercial processors (Sebeta Agro Industry) has its own dairy farm but depends on outside sources for 99 percent of its raw milk intake (Haile, 2009).

2.1.3. Local and International Development Partners

Different national and international development partners have been involved in the development of the country's dairy sector by providing material and technical support to smallholder producers, dairy cooperatives and unions and the private sector. The major development partners currently involved in dairy development at different levels and in different dairy potential areas of the country include: SNV, Land O'Lakes, FAO, Heifers International Organization and Non-Governmental Organizations (NGOs) such as Self Help and Hunde that operate in the central highlands. Land O'Lakes provides technical assistance to dairy farmers, producer groups and cooperatives, input suppliers and processors. The objective of this assistance is to have a competitive Ethiopian dairy industry built upon private investment that creates employment and generates income for smallholder families and provides quality products to local consumers. The key components of the technical assistance include: milk shed development, stimulation of

business development, strengthening of market linkages among stakeholders and advancement of dairy industry organization. SNV through its 'Support to Business Organizations and their Access to Markets (BOAM) program, supports the development of value chains by establishing market linkages, bringing value chain actors together, developing agro-processing activities and linking the private sector to public sector initiatives. It can also where possible work with the Dutch business community, from local producer organizations and processing companies to multinational partners. The overall aim is to increase the access of Ethiopian companies to markets. The three strategic intervention areas of the dairy industry include: milk collection centers and linkage to farmers milk packaging and quality management. Reports of research results on various aspects of the dairy sector (SNV, 2009). FAO is involved in dairy development activities with the major objective of raising the subsistent type of smallholder dairy production to commercial level through its 'Crop Diversification and Marketing Development' Project. The principal activities include: distribution of crossbreed heifers to increase milk production (thereby increasing the amount of milk delivered to milk collection, processing and marketing cooperative centres), establishment of new cooperatives and upgrading the existing ones, improvement of the marketing channel through improving quality of products, the marketing system and identifying linkages between producers and consumers. FAO is also engaged in need assessment studies for future improvement interventions in areas such as actor linkages in dairy innovation system, climate change and livestock production and trade.

The Private Sector

The private sector constitutes an important part of the dairy sector. It is engaged in providing farm inputs (feed and veterinary drugs), animal health care and milk processing and storage equipment and serves as an important market outlet for milk and milk products. Commercial processors are those adopting modern technology with the majority of their output being pasteurized milk in packs of 500 ml. currently, there are over 22 medium- and large-scale dairy processing companies in Ethiopia with nine of them operating in Addis Ababa and the rest in other major regional cities.

Research Institutions

Dairy development research endeavors have been oriented towards genetics, husbandry, feed-resource management, animal nutrition, physiology, animal health, dairy processing technology, social economics and technology transfer. Research work has been undertaken on-station and whenever necessary followed by on-farm verifications. The Holetta Agricultural Research Centre (HARC) of the Ethiopian Institute of Agricultural Research (EIAR) serves as a centre of excellence for dairy research. The centre coordinates all dairy improvement research activities in the federal system as well as in different regional states including joint venture research activities with agricultural universities and colleges. Both federal and regional research institutions adopt and generate appropriate technologies for dairy development and are also involved in capacity building by organizing and providing trainings. They verify and demonstrate promising technologies on farms with the participation of smallholder farmers.

Higher Learning Institutions

Higher learning institutions are involved in providing long term trainings on a regular basis to high level agricultural professionals and short term trainings on request. Universities that provide long term trainings on dairy related fields include: Haramaya University, Hawassa University, Bahir Dar University, Jimma University, the Veterinary Faculty of Addis Ababa University, and the Asella Model Agricultural Enterprise (AMAE) of Adama University. There are also 25 Agricultural Technical Educational and Vocational Training Schools (ATEVTS) operating in different parts of the country that accept students who have completed tenth grade and provide them a three-year diploma program in one of five disciplines: Animal Science, Animal Heath, Agricultural Cooperatives Development, Natural Resources, and Plant Science. All ATEVTS offer Animal Science, Natural Resources and Plant Science, while a few others offer Animal Health and Agricultural Cooperatives. The ATEVTS curriculum was first introduced in September 2000 by the Ministry of Agriculture and Rural Development, (MOARD) in 28 ATEVTS located across the country. In 2001, the number was reduced to 25. The 25 ATEVTS graduated the first Development Agents (DAs) in 2004. By 2008, the colleges had produced nearly 60 000 DAs (12% of them women). ATEVTS seek to produce mid-level skilled and competent agricultural DAs who will then teach farmers at Farmers Training Centres (FTCs).There

are two categories of ATEVTS colleges: federal and regional colleges. There are seven federal colleges (four in the large regions and three in the emerging regions) that report to and are managed by the MoA. The rest (regional colleges) are managed by the regional Bureaus of Agriculture (BoA) or the Ministry of Education through the Technical, Educational and Vocational Training (TEVTS) Commission or Agency (Davis *et al*., 2010).

Other Important Players

There are also a number of other important players that contribute to the development of the dairy sector. The National Artificial Insemination Centre (NAIC) imports semen of pure exotic breeds, produces semen from selected crossbreed bulls from its Holetta Bull Dam Farm and liquid nitrogen. NAIC distributes semen to nine sub centres (Liquid Nitrogen Plants) located in five regions, namely: Oromia (Nekemt and Asella), SNNP (Wolayta and Wolkite), Amhara (Bahir Dar and Dessie), Tigray (two sub centers in Mekelle) and Harar. NAIC also provides training on AI service provision to AI technicians as trainees and trainers. The major functions of the sub centres include: supplying AI inputs (semen, liquid nitrogen and AI equipments), providing and coordinating AI services in the respective regions. Established in 2008 at Debre Zeit, the 'Ethiopian Meat and Dairy Technology Institute' (EMDTI) provides tailor-made trainings on different aspects of dairy development. Banks and microfinance institutions are also playing an important role in the dairy development of the country. Colleges, universities, hospitals, cafes and restaurants of big enterprises can be categorized as institutional buyers of milk with most of them sourcing from collectors (Haile, 2009).

2.1.4. Theoretical Perspectives on Efficiency Analysis

Technical efficiency is just one component of overall economic efficiency. However, in order to be economically efficient, a firm must first be technically efficient. Profit maximization requires a firm to produce the maximum output given the level of inputs employed, use the right mix of inputs in light of the relative price of each input and produce the right mix of outputs given the set of prices (Kumbhaker and Lovell, 2000). These concepts can be illustrated graphically using a simple example of a two input (x1, x2)-two output (y1, y2) production process (Figures 1 and 2). Efficiency can be considered

in terms of the optimal combination of inputs to achieve a given level of output (an input-orientation).

2.1.4.1. Input oriented measures of efficiency

In Figure 2.1, the firm is producing a given level of output (y1*, y2*) using an input combination defined by point A. The same level of output could have been produced by radials contracting the use of both inputs back to point B, which lies on the iso-quant associated with the minimum level of inputs required to produce (y1*, y2*) (i.e. iso(y1*, y2*)). The input-oriented level of technical efficiency (TEI(y, x)) is defined by 0B/0A. However, the least-cost combination of inputs that produces (y1*, y2*) is given by point C (i.e. the point where the marginal rate of technical substitution is equal to the input price ratio w2/w1). To achieve the same level of cost (i.e. expenditure on inputs), the inputs would need to be further contracted to point D. The cost efficiency (CE(y,x,w)) is therefore defined by 0D/0A. The input allocative efficiency (AEI(y,w,w)) is subsequently given by CE(y,x,w)/TEI(y,x), or 0D/0B.

(a)

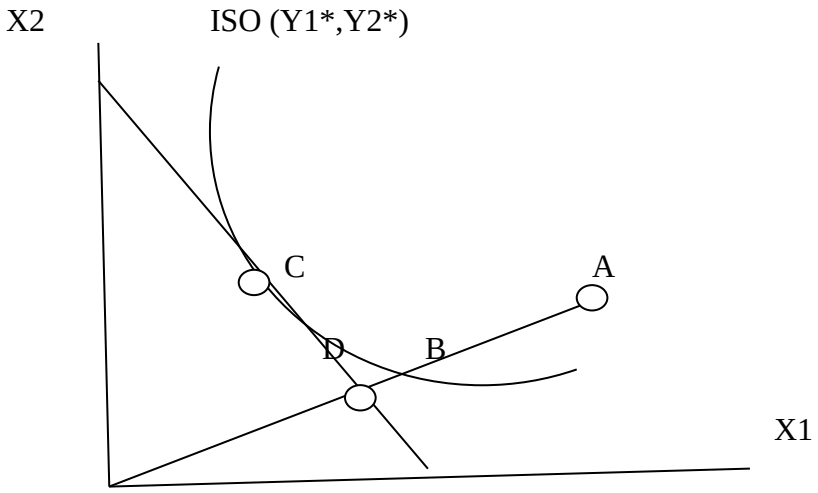


Figure 2. 1 Input oriented measures of Efficiency

Source: Kumbhaker and Lovell (2000)

2.2. Empirical literature

Zelalem et al. (2011) on their study titled A review of the Ethiopian Dairy Sector, majorly found Cow milk accounted for 95.1 percent of the total milk produced in 2009/10 from milking cows and camels in the country . The regional differences in the distribution of the population of milk animals are also reflected in milk production. Accordingly, Oromia, Amhara and SNNP Regions accounted for 88.8 percent of the total annual milk produced from cows at national level. Furthermore, the number of milk cows at national level varied during the 15 years reference period (1996 to 2010). Generally, this number tended to increase from about 8.8 million in 1996 to 11 million in 2001 and sharply decreased to roughly 7.9 million in 2003 then increased to 9.6 million in 2010. Milk production, however, increased steadily from about 927 million liters in 1996 to 2.9 billion liters in 2010 (31.5 percent increase) (Figure 2). According to FAO (2010), the world milk production increased by 150 million tons per year following the 2002 to 2007 analysis. China, India and Pakistan accounted for about two-third of all the volume growth, while most of the remaining growth was from Brazil, Egypt, New Zealand, Turkey and USA. These eight countries accounted for approximately 85 percent of all milk volume growth from 2002 to 2007.

Africa contributed to only 5 percent of the world's milk production and Ethiopia, in spite of its largest cattle population in the continent, is not among the four largest milk producing countries (Egypt, Kenya, South Africa and Sudan) (FAO, 2010). The total annual cow milk production reported for the year 2010 was approximately 2.9 billion litters which is less than each of the International Farm Comparison Network top-21 milk processors Wubneh (2006), on his study of Technical Efficiency of Smallholder Dairy Farmers in the Central Ethiopian Highlands, found that, new technologies are certainly essential to expand the production frontier, they also involve large initial investment costs. In a study of dairy farmers' market participation in the Ethiopian highlands, Holloway et al (2000) estimated that to enter a milk market, a representative non-market participant must increase daily milk surplus by 9.8 liters. This requires adding 2.5 cross-breed or 6.4 local breed cows, which is a substantial entry cost to poor smallholder farmers. They also show that entry could alternatively be affected by increasing extension visits by 10 per year or reducing transport time to the market by 2 hours. Weletaw (2007) on his thesis of 'economics of

urban dairy in Hawassa town, southern nations, nationalities and people's regional state' the average herd size (in livestock units) of local and cross breed farms was 4 and 4.51, respectively. The average herd size of small size farm was 2.36 while it was 6.94 for medium size farms. The average herds for small and medium size categories of cross breed farms were 2.76 and 6.49, respectively, whereas, for local breed farms, small and medium size farms on the average kept 2.03 and 7.54 herds, respectively. The medium size farms had 3 fold dairy herds than small size farms. Similarly, medium size categories of cross breed and local breed cow owner farms had almost 3 fold herd size than their counterparts in small size farms group. In general, the average herd size was larger for cross breed cow owner farms (4.51) than local breed cow owner farms (4), whilst, the medium size local breed cow owner farms had larger herd size (7.54) than medium size cross breed cow owner farms (6.49), Small size cross breed cow owner farms almost had larger herd size (2.76) than small size local breed cow owner farms (2.03).

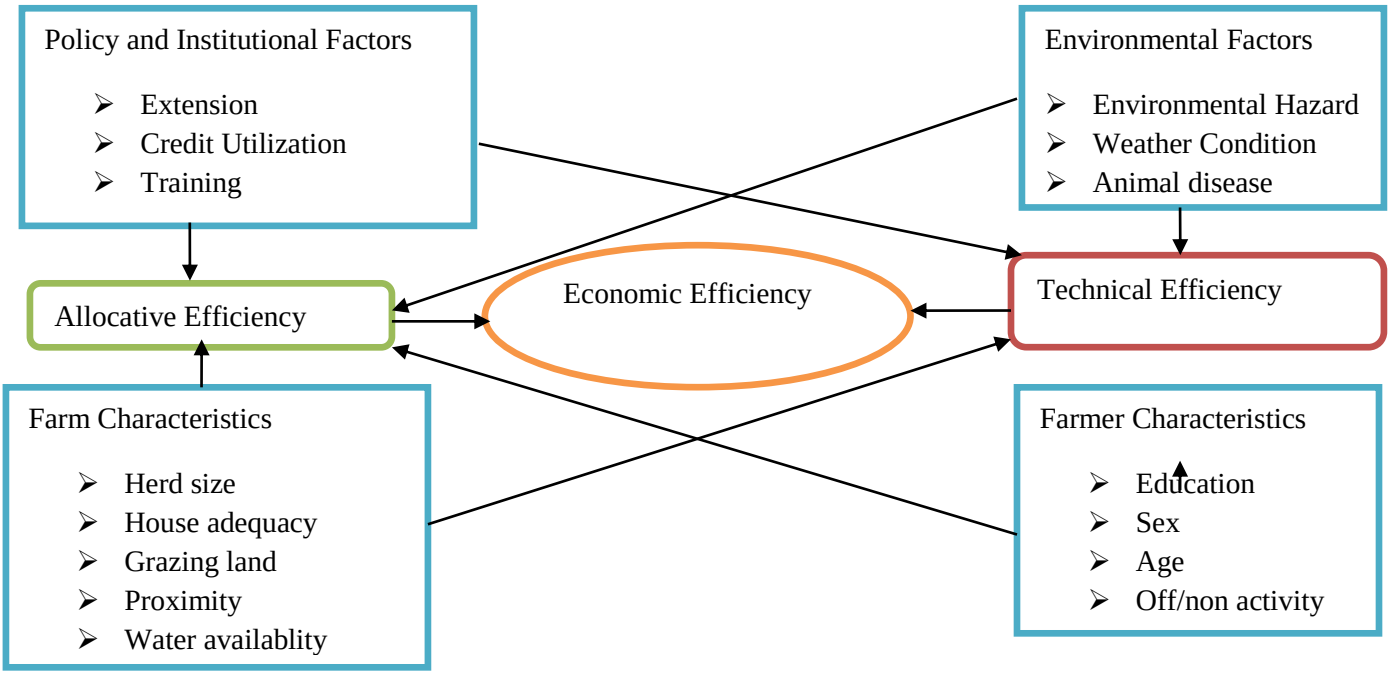
The overall average herd size of dairy farms in Hawassa town was 4.27.Sajjad and Khan (2010) used stochastic frontier production and cost function models to examine the economic efficiency of milk production in Peshawar district during 2009. Return to scale (RTS) for the production function revealed that the farmers operated in the irrational zone of the production surface having RTS of 1.074. The result of the analysis indicates that presence of technical inefficiency and allocative inefficiency had effects in milk production as depicted by the significant estimated gamma coefficient of each model. The estimated gamma parameter (γ) for production function was 0.851, indicating that about 85% of the variation in the output of milk among the farmers was due to differences in their technical efficiencies while the estimated gamma parameter (γ) of model for the cost function was 0.781 indicating that about 78% of the variation in the total cost of production among the farmers was due to the presence of allocative inefficiency. The result also showed that rising age would lead to a decline in the efficiency means, and recommended that Government policy should focus on ways to attract and encourage young people who are agile and aggressive in dairy business. Hassen *et al*. (2012) analyzed the efficiency of crop-livestock production and assessing their potential for improvement in North-East Ethiopian highlands. Cross-sectional data were used to analyze the economic efficiency of mixed crop and livestock production system and identify its determinant factors.

The parametric stochastic frontier approach was employed to measure economic efficiency. Their result indicated that most farmers in the study area were not efficient with the mean technical efficiency, allocative efficiency and economic efficiency of the households calculated from parametric approach of stochastic frontier analysis being 62%, 51% and 29%, respectively. Results also showed that improved agricultural technology adoption significantly improved production efficiency of households. They suggested that the technology adoption and production efficiency of the crop-livestock farmers should be improved by raising their education, farm household asset formation and by providing extension and credit services.

2.3. Conceptual Framework

Figure 2.2.shows the interaction between various factors that were considered to have a various degree and direction of effect on the level of TE of dairy milk production. Efficiency of production was determined by the multitude of socio-economic and institutional factors (Jema, 2008). These factors directly/indirectly affect the quality of management of the farm's operator and, therefore, are believed to have effect on the level of TE, AE and EE of farms. According to Bakhsh (2007), a range of factors like distinctiveness of farms, management, physical, institutional and environmental aspects could be the cause of inefficiencies in the production process of the farmers.

Environmental factors such as perception on weather condition and disease can affect resource use efficiency in dairy milk production. Hasan (2006) indicated that there may be a negative interaction between some agricultural practices and the environment. Levels of producer's education influence the producer's management capacity. Ajibefun (2002) indicated that education level of farmers and farming experience are important determinants of efficiency which can be incorporated into the agricultural policy. The farmers with more education, more and farming experience are more likely to adopt new technologies.



Source: Adapted from author Tarekegn Newut (2016)

Figure 2. 2 Conceptual framework of TE in dairy milk production

Policy and institutional factors such as perception on agricultural policy, extension, training, credit utilization and input accesses can have significant effect on the resource use efficiency of dairy production. Extension and access to credits are important policy and institutional variables that positively influence efficiency (Tchale, 2009). Level of producer's education and age influences the producer's management capacity. The farmers with more education and more farming experience are more likely to adopt new technologies. Ajibefun (2002) indicated that education level of farmers and farming experience are important determinants of efficiency which can be incorporated into the agricultural policy. Efficiency variations between farms can also be explained by herd size, feeds, veterinary and medicine cost barn size and fixed input and depreciation cost.

CHAPTER THREE

3. RESEARCH METHODOLOGY

In this chapter the choice of the towns, and sample dairy milk producers traders for sample study were discussed. Sources of data, methods of data collection and analysis was depicted. In the study the Stochastic Production Frontier (SPF) framework and tobit Model were used to analysis the dairy farm technical efficiency and determinants factors affecting technical efficiency were identified. And also Variables employed for empirical investigation were defined.

3.1. Descriptive of the study area

The study areas of this thesis paper were focused on three urban dweller i.e. Sebeta administrative town of Oromia region state of Finnie special zone about 25 kms. south-west of Addis Ababa city, it is geographical location is 8’55’’ N to 38’37’’ E latitude and 38’57’’ E longitude on an elevation of 2,356 meters above sea level, Nifas silk-lafto sub city of Addis Ababa located in the southern suburb of the city it is physical location is 8’95’’ N to ’73’’ E latitude and 38’72’52’ E longitude on an elevation 0f 2,206 meters above sea level and Kolefe Keranio sub city it is located in the western town of Addis Ababa city. It is geographical location is 8’98’’ N to 30’67’’ w latitude and 38’712537’’ N longitude on an elevation of area is 2,297.4 meters above sea level. The two sub city was found in region 14 of Addis Ababa neighborhood to Sebeta administrative town of Oromia region.

Figure 3. 3 Map of the study area

3.2. Research Design

It adopted both descriptive and casual designs to find out the technical efficiency of the farmers in the areas. In the study a cross sectional data were employed. To examine the subsequent challenges and risks the farmers faced as per the self- reports made by the respondents a descriptive research design is adopted. In addition, a casual research design was adopted to identify the determinants of efficiency of dairy farm in the study area.

3.3. Sampling Procedure and Sampling size determination

The target population was Sebeta Administrative, Nifas Silek Lafto and Kolfe Keranio Sub-cities of Addis Ababa town. From Kolfe Keranio Sub-cities woreda three administrative and from Nifas Silk Sub-cites Woreda one administrative dairy milk

producer farms total population was: N= 530 farmers. The sample size was determined at a confidence level of 0.95%, this level was an appropriated level. The error term was 0.5

The purposive and random sampling techniques were used to select sample survey of 100 commercial dairy milk producers' farmers. The selection criterion of the sample was based on the relative importance of the number of milk cows in each area. Then, used the following formula to determine the sample size of individual members.

This study applied a simplified formula provided by Yamane (Yamane, 1967 cited in: Yilma Muluken, 2005) to determine the required sample size at 95% confidence level, degree of variability=0.5 and level of precision= 9% (0.09). Accordingly, the distribution of sample size with the size of the areas was presented in Table 3.1.

$$\mathbf{n} = \frac{N}{1+N\mathbf{e}^2} \qquad (3.1)$$

Where,

n = sample size

N = population size

e^2 = precision

Table 3. 1. Dairy farm Sampled by area:

Sr. No	**Administrative area**	**Total targeted dairy farms**	**Total Sampled dairy Farms**
1	Sebeta administrative	348	66
2	Nifas Silek Lafto sub city woreda one administrative	106	20
3	Kolfe Keranio sub city woreda three administrative	76	14
	Total	530	100

Source: Computed from survey data 2017

3.4. Data sources and data collection method

Both primary and secondary data were used for the study. Accordingly, the information was collected from farm owners of milk producers, like total milking herd size, breed, dry feed (kg), average amount of concentrate (kg), average amount of mineral supplements (kg), number of labour, farmer age, milk output per cow, education level, experience, and other socio-economic characteristics of the producers .Other data, like water availability, and extension service from sample informants through personal interviews using structured questionnaire. From 530 households who dairy milk producers, about 100 sample households were selected randomly using probability and proportionality size following a simplified formula provided by Yamane (Yamane, 1967).Secondary data sources include the Department of Statistics, and from each selected urban town and city Agricultural Desks and other related sources.

3.5. Methods of Data Analysis

3.5.1. Specification and Data

The functional form we employed to specify the stochastic production is the Cobb Douglas function. The Cob-Douglas functional form is chosen because the small number of observations makes it impossible to estimate a model with fully flexible functional forms. It is also broadly applied in farm efficiency analysis for both developing and developed countries (Bravo-ureta and pinheireo, 1993: Ahmed.et al.2002:Ajibefun. 2002).

Transforming given input in to outputs is the main concern of the concept of efficiency.

The primary and secondary data collected were summarized to describe households and farms characteristics. In addition, data on quantities of inputs, in milk production and amount of milk produced and return obtained from milk and milk by-products were summarized to compute values of input parameters needed for production function model.

3.5.2 Technical efficiency

Technical efficiency was analyzed through estimation of the Stochastic Frontier Production function using the Cobb Douglas functional form. The technical efficiency of an individual farm was defined in terms of the ratio of the observed output to the corresponding frontier output given the available technology. A version of the traditional

Stochastic Production Frontier (SPF) framework was implemented in this study to achieve its goals. The implemented stochastic production function.

$YI=f(Xij)\beta)\exp(Vi-Ui), =1, 2\ldots. ...n,$ (3.2)

Where:

Yi is output of the i^{th} farm,

Xi is the vector of input quantities used by the i^{th} farm,

β is vector of unknown parameters to be estimated;

f represents an appropriate function (e.g. Cobb Douglas, trans log, etc).

Vi is a symmetric error which accounts for random variation in output due to factors beyond the control of the farmer e.g. weather, disease outbreaks, measurements errors, etc,

Uj is a non-negative random variable representing inefficiency in production relative to the stochastic frontier.

Technical efficiency ***(TE) =Yi/Yi**** ***(3.3)***

$$= f(Xi, \beta) \exp (Vi-Ui)/ f(Xi, \beta) \exp (Vi)$$
$$= (\exp) (-Ui)$$

(3.4)

Where:

Yi = observed Output.

Yi* = Frontier Output.

Technical inefficiency relative to the stochastic production frontier is captured by the one-sided error component exp (-U), $U \geq 0$. The condition $U \geq 0$ ensures that all observations lie below the stochastic production frontier (Anwarul & Arshad, 2010).

Frontier Analyst statistical package was used to obtain the TE scores. Frontier software was developed by Coelli (1996). Further information on the model can be found in Coelli et al. (2005).

The Econometric Model of Stochastic Frontier

The SPF analysis approach requires that a functional form was specified for the frontier production function. The production technology of dairy farms in this study was assumed and specified by the Cobb Douglas frontier production function defined as follows:

$$\ln Yi = \beta_0 + \beta_1 \ln X1 + \beta_2 \ln X2 + \beta_3 \ln X3 + \beta_4 \ln X4 + \beta_5 \ln X5 + \beta_6 \ln X6 + Vi - Ui \quad (3.5)$$

Where:

Yi = Value of milk produced.

X1 = Herd size (number of milk producing cows).

X2 = Feed quantities.

X3 = Labor input (man-day's).

X4 = Value of Veterinary Services, Drugs and Medicine.

X5 = Fixed inputs and depreciation costs.

X6= Barn size (m^2)

Vi = Random error.

Ui = Technical inefficiency.

Bo, ***B1***, ***B2***… ***B6*** are regression parameters to be estimated.

As in most frontier production analysis Ui is assumed to follow a half normal distribution

3.2. Variables Definition:

3.2.1 Definition of Output and Input Variables in the production Models:

Milk output(y): It is a continuous variable measured the whole milk produced (in liters) from the sampled selected dairy milk producer farm areas considered as dependent variable.

B/ Input/Independent Variables:

Herd size (number): It is a continuous variable indicate the number of cattle animals in the sampled selected farm area. Herd size may increases technical efficiency by providing advantages of economies of scale. Producers with large herd sizes are more likely to be committed to their farms, than those with small herd sizes who are more likely to diversify into nonfarm employment.

Milking Cows (MC): It is a continuous variable that refers to dairy cows (lactating cows) that are primarily kept for milk production in the study area. Cows are the main sources of milk production in the study area. These production variables were measured by number of milking cows (cross bred) per farm.

Dry Feed: It is a categorical variable grouped animal feeds into dry fodder in the form of straw of barley, wheat and maize stalk. Most farmers use a combination of the above fodder types at harvest time and store to be utilized for the coming dry period. One fodder type can be a substitute for the other and dry fodder supplied to the lactating cows was measured per dairy milk production per year in litters.

Labor (man-day's): It is a continuous variable and measured as man-days was included to determine if farms that used hired labor had a significant advantage over farms which relied only on family labor.

Veterinary service availability: It is a dummy variable which indicate availability of regular veterinary services, drugs and medicine have direct effect to determine the efficiency of dairy milk production and economic profitability. It treated as if medicine and services are available =yeas and if not available = no.

Barn size: It is a continuous variable and measured the barn size for dairy farm feed store and shelter in meter squares. Farms have a big barn size better to shed large size animal and store too much animal feed to overcome feed shortage and cost escalation in the future.

Fixed input and Depreciation Cost: It is a continuous variable and measured fixed input annual depreciation cost due to service.

Supplement feed = It is a continuous variable and measured the total of industrial by products (concentrate feed) intake in kg. Per cow. In most dairy farms areas concentrate is used as supplement feed and formulated mainly from barn mixed with bone meal and salt.

Grazing pasture size: It is a continuous variable and measured the size of grazing land used by the farm in the production year (hectares).

3.2.2. Determinates Factors of milk Production inefficiency and the Working Hypotheses:

Dependent Variables: The dependent variable for this study was technical efficiency scores of milk production obtain from SFPF. Independent variables are identified based on theory and previous studies on production and factors affecting efficiency of dairy milk production, the following variables were expected to determine efficiency differences among dairy milk producers:

Age of the household head (AGE): It is a continuous variable which refers to the age of the dairy farm head measured in years. It is believed that age can serve as a proxy indicator for experience. In this case farmers with more years of experience are expected to be more efficient. Therefore, in this study age of the household head was hypothesized to have positive effect on efficiency. However, labor productivity is also expected to decreases as the farmer gets older; younger farmers tend to be relatively more productive, because of the tough nature of farm operations (Ike and Inoni, 2006). In this study, the variable is captured by age squared (AGE_SQU), and it is expected to affect efficiency negatively.

Sex of the household head (SEX): This is a dummy variable that is measured as 1 if the household head is male and 0, otherwise. Since female household heads are less exposed to farming operations, they are expected to have less practical experiences in farming operation and would probably use inputs less optimally than male household heads. Female-headed household are responsible for domestic activities. Thus, they may not accomplish the farming activities on time and efficiently (Aynalem, 2006). Therefore, it is hypothesized that female-headed households are expected to be less efficient than their male counterparts.

Educational level of the household head (EDUCLH): This variable is measured in years of formal education and was used as a proxy variable for managerial ability. Farmers with more years of formal education complete tend to be more efficient. This is because education enhances ability to acquire technical knowledge, which makes them closer to the

frontier. Educated farmers can thus understand, analyze, and interpret the advantage of different technologies more easily than uneducated farmers (Gbigbi, 2011). Therefore, farmers who have more years of schooling are expected to be more efficient.

Farmer Experience (FARMEXP): is measured in the number of years since a respondent started farming on his own. Experience of the farmer is likely to have a range of influences on input utilization. Experience will improve farmers' interest of adopting new technology for dairy farm production. A more experienced grower may have a lower level of uncertainty about the technology's performance (Abadi *et al*, 1999; Chilot *et al*, 1996). Farmers with higher experience appear to have often full information and better knowledge and will be able to evaluate the advantage of the technology. Hence, it is hypothesized to affect adoption and intensity positively.

Distance from veterinary Site: It is a continuous variable measured in km. to now the distance from agricultural agent office, market centre, veterinary service site and institutional office.

Water availability: This is a dummy variable measured in a litter per amount of the milking cow drinking per day to produce milk output. The availability water in dairy farm is mandatory.

Training (TRAING): This is a dummy variable that represents the access to training for farm related activities. If the household has got training, the variable takes a value of 1 and 0, otherwise. So, households who received training service were hypothesized to be more efficient than those who did not receive training

Marketing facility: This is a dummy variable that represents the access of market and marketing facility for sells of the dairy milk production in close proximity.

CHAPTER FOUR

RESULT AND DISCUSSION

The results of this study are divided in two sub-sections. The first section presents the descriptive results and the second deals with econometric results from the stochastic frontier function and Tobit models.

4.1. Descriptive Statistics Result

Descriptive analysis of this study is used to elaborate and helps to understand, socio-economic, farm owner and institutional characteristics of the sampled farm area.

4.1.1. Socio-economic Characteristics of farm owners:

Educational level: Farm owner educational status 77%, 10%, 4%, 8%, and 1% were illiterate, certificate, diploma, degree and PhD respectively. This showed more than 77% were unable to read and write so it has a negative effect on output and profit of the farm.

Experience of farm owner: Farm Owner experience less than or equal to 6 years of farming experience exhibit 51% and greater than 6 years farming experience exhibit 49%. It indicates that half of the farm owners are less experienced and the other half of the owners are more experienced (Table4.1).

Gender & Marital Status: With regards to the sex of respondents, about 14% of the sample households were female headed and the remaining 86% were male headed. It was understood that female headed households in rural and urban areas in Ethiopia face more challenges in agricultural production and marketing compared with their male headed counterparts. This is partly due to cultural barriers and partly due to their busy schedules as they are engaged in domestic, reproductive and community roles (SMU, 2012). The survey result showed that the total number of married, unmarried and widowed households during the survey period was 97%, 2% and 1%, respectively (Table 4.1).

Training service: Farm owner's who received training service were hypothesized to be more efficient than those who did not receive training. The survey indicate that farm owner that taken training service is 55 individual and who don't taken training service is 45 farm owner in the study area(Table 4.1).

Table 4.2.Socio-economic Characteristics of farm owners

Description	Category	Number	Percent
	$Illitrate$	77	77
	Certificate	10	10
Education	Diploma	4	4
	Degree	8	8
	$>$ Degree	1	1
Experience	$\leq$ 6 years	51	51
	$>$7 years	49	49
Gender	Male	86	86
	Female	14	14
	Married	97	97
Marital Status	Un married	2	2
	Widowed	1	1
Training service	TR. Taken	55	55
	NO Taken	45	45

Source: Computed from survey data (2017)

4.1.2 Farming characteristics of sampled dairy farms

The average herd size holding in a single farm owner is 14 and the highest herd size is 101 where as the lowest is 4. The maximum milk output of the farm owner is 6000 liters and the minimum of the same is 1080 liters, so the average milk output of the farm owner is 3036.9. The maximum supplementary feed cost of the farm owner exhibits 172300 and the minimum supplementary feed cost of them is 1900 the average of supplementary feed cost is 11600. The maximum number of labour on the farm is 18 and the minimum number of labor on the farm owner is 1 the average of labor on the farm owner is approximately 2(Table 4.2).

Table 4. 3. Average statists of the main characteristics of sampled dairy farms

Variables	0bs	Mean	Std.Dev.	Min	Max
Heredsize	100	14.13	11.99803	4	101
Output	100	3036.9	816.2871	1080	6000
Agefarmer	100	43.34	7.177715	26	62
Longowner	100	6.86	3.302952	1	20
Edufarmer	100	3.32	5.967725	0	17
Supplfeedcost	100	11600.63	17282.31	1900	172300
Dryfeed	100	.29	.456048	0	1
Labour	100	1.86	1.938551	1	18

Source: Computed from survey data

4.1.3. Institutional aspects in the selected dairy farm area.

In order to give effective extension service to the dairy farm owners, the urban agricultural office of Sebeta administrative , Nifas Silek Lafto and Kolfe Keranio Sub Cities of Addis Ababa town are assisting the farms with professional agricultural development agents who graduates from different agricultural technical vocational education, training colleges and universities specializing in animal science and natural resource management. About 55% of the respondents reported that they have been receiving extension services/advice about dairy farm production. The extension workers visit households at different intervals. On average, farm owner were being visited by extension workers 10 times per year. The

extension services mainly focused on national livestock vaccination service and improvements of commercial dairy milk production.

4.2. Econometric Results

The stochastic production frontier was estimated following the maximum likelihood estimation procedure. In this study the dependent variable of the model was milk output (Litter/Cow) produced during 2017 production year and the input variables used in the analysis were: herd size (milking cow), labor (man-days), feed quantity, veterinary and medicine cost, barn size and depreciation cost. Before running the econometric model, it was tested against econometric problems. In this study, the value of VIF for all the variables entered into the model was below 10, which indicate the absence of severe multicollinearity problem among the explanatory variables. Moreover, Breusch-Pagan test was also used to detect the presence of hetroskedasticity. The ML (Maximum Likelihood) estimators of Tobit regression model are inconsistent if there is heteroskedasticity problem (Greene, 2003). Therefore, the test result indicated that there was no problem of hetroskedasticity in the model.

4.2.1. Estimation result of the Production Function

The maximum likelihood estimation results of the parameters using the SFPF equation specified and presented in (table 4.3) were obtained using STATA 12.0 computer program. The value of σ^2 for the frontier of milk output was 2.71 which were significantly different from zero and significant at 1% level of significance. The significant value of the sigma square indicates the goodness of fit and correctness of the specified assumption of the composite error terms distribution. The Gamma (γ) statistic, which is a measure of the overall is highly significant indicating the presence of a high systematic inefficiency which explains about 99% of the variation in milk output. The results of the model showed that two of the input variables in the production function: i.e. herd size and labor man-days had a positive significant effect on the level of dairy milk productivity (Table 4.3). Hence, the increase in these inputs would increase productivity of milk significantly as expected. The coefficients of the production function are interpreted as elasticity. The highest coefficient of output to herd size (0.16) indicated that herd size is the main determinant of milk production in the study area. Dairy milk production is also relatively sensitive to the application of different units of labor. If there is a one percent increase in the amount of

herd size, and number of labor would increase milk production by16 percent and 11 percent, respectively. In other words the increase of these inputs will increase output of milk production at 5% significant level (Table 4.3).The coefficient for feed quantity, veterinary cost, barn size and depreciation costs are with negative sign indicating indirect relationship or these variables with milk production. This implies a 1% increase in each variable will lead to 0.028%, 0.008%, 0.040% and 0.011% respectively decrease in milk production (Table 4.3).

Table 4. 4. Estimation of the Cobb-Douglas Frontier of Production Function

Variable	Parameter	Coefficients	Std.Error	t-Value
Constant	β 0	8.104	0.439	18.469
Herd size	β 1	0.162	0.048	3.362**
Feed quantity	β 2	-0.028	0.037	-0.718
Labor (man-days)	β 3	0.109	0.047	2.316**
Veterinary cost	β 4	-0.008	0.031	-0.250
Depreciation cost	β 5	0.011	0.039	0.277
Barn size	β 6	-0.040	0.036	-0.110
Sigma (δ2)		2.713	6.401	-0.415
Gamma(γ)		0.990	0.026	37.423
Log likelihood Function			0.516	

Source: Compute from data (2017)

*significant at p< 0.01; **Significant at p<0.05 and *** Significant at p<0.01. ME = Marginal Effect.

The returns to scale analysis can serve as a measure of total factor productivity (Gbigbi, 2011) and the coefficients were calculated to be 0.246 indicating increasing returns to scale (Table 4.4).In other words, a one percent increase in all inputs proportionally would increase the total production by 0.246.

Table 4. 5. Elasticity and Returns to Scale of the Parameters of Production Function

Variables	Elasticity of Production
Herd size	0.162
Feed quantity	-0.028
Labor (man-days)	0.109
Veterinary cost	-0.008
Fixed input and depreciation cost	0.011
Return to scale	0. 246

Source: Computed from data (2017)

4.2.2. Hypotheses testing

Before discussing about parameter estimates of production frontier function and the inefficiency effects, it is advisable to run the several hypotheses tests in order to choose an appropriate model for further analysis and interpretation. One attractive feature of SFPF method is that it makes it possible to test various hypotheses using maximum likelihood ratio, which were not possible in non-parametric models. Accordingly, two hypotheses tests were conducted; one for the existence of inefficiency and other for variables that explain the difference in efficiency. The first test examines where the average production function best fits the data so as to verify whether there exists considerable inefficiency among dairy farm owner in the production of milk in the study area. The second hypotheses tests whether all coefficients of the inefficiency effect model are simultaneously equal to zero (i.e. H_o: $\delta_0 = \delta_1 = \delta_2 = ... = \delta_{15} = 0$). In other words, it was to check whether the explanatory variables in the inefficiency effect model contribute significantly to the technical inefficiency variations among milk producing farm owners. Generally, tests of hypotheses for the parameters of the frontier model were conducted using the generalized likelihood ratio statistics, λ, which can be defined as: $\lambda = -[\log L(H_o) - (\log L(H_A))]$ (4.2)

Where, $L(H_o)$ and $L(H_A)$ are the values of the log-likelihood function under the null and alternative hypotheses, H_o and H_A, respectively.

Table 4. 6. Generalized Likelihood Ratio tests of Hypotheses for the Parameters of the SFPF

Null hypothesis	Λ	Critical value (x^2, 0.95)	Decision
$H_o=\gamma=0$	3.76	1.71	Reject H_o
$H_o=\delta_1=\delta_2=\ldots.=\delta_{15}$	32.62	5.98	Reject H_o

Source: Compute from data (2017)

The likelihood test static obtained from the log likelihood functions of both the average response function (OLS specification) and stochastic production function were found to be greater than critical value (χ^2). This implies that traditional average production function does not adequately represent the data. Therefore, the null hypotheses that the average response function is an adequate representation of the data was rejected and the alternative hypotheses that stated there exist considerable inefficiency among milk producing farm owners were accepted. Similarly, H_a was also tested in the same way by calculating the likelihood ratio value using the value of the log likelihood function under the stochastic frontier model (H_0) and the full frontier model with variables that are supposed to determine inefficiency level of each farm owner (H_a). The value obtained was again higher than critical χ^2 value at the degree of freedom equal to the number of restrictions. The result suggested that the null hypothesis is rejected and the alternative hypotheses that the explanatory variables associated with inefficiency effect model are simultaneously different from zero. It implies, these variables simultaneously explain the differences in efficiency among milk producing farm owners.

4.2.3. Efficiency Scores

The result of the efficiency scores indicates that the mean, technical efficiency was found to be close to 83.60% in average, if farm owner in the study area operated at full efficiency level, they would have increased their output by 16.40% using the existing resources and level of technology. In other words, it implies that, on average, sampled farm owner can decrease their inputs (herd size (milking cow), labor (man-days), feed quantity, veterinary and medicine cost, fixed input and depreciation cost and barn size) by 16% to get the output they are currently getting (Table 4.6). The results indicated that farm owner can increase milk production by 16.40% without increasing inputs if they were technically

efficient. The farm owners had ranges of 40% to 95% with standard deviation of 10.73. in the sampled farm areas (Table 4.6).

Table 4. 7. Summary Statistics of Technical Efficiency Measures

Min	Max	Mean	Std. Deviation
40.29	95.12	83.60	10.729

Source: Computed From data (2017).

Distribution of the farm level measures of technical efficiency showed that the majority of the sample farm owners have technical efficiency score of 81% to 99%. But about 26 % of the farm owners have TE levels limited to the range of 40% to 80%. The farm owners in this group have a room to enhance their milk production at least by 20%. Out of the total farm owners, 26% of them have TE of greater than 90%. This implies that around 74 % of them can increase their production by at least 10 %(Table 4.7).

Table 4. 8. Distribution of the farm level measures of technical efficiency (TE).

TE%	No. of Farms	% Total farms
40-49	3	3
50-59	1	1
60-69	5	5
70-79	17	17
80- 89	42	42
90-99	32	32
Total	**100**	**100%(Average of TE= 83.60%)**

Source: Computed from survey data (2017)

4.2.4. Determinants of efficiency in dairy milk production among sample farm area

The major interest behind measuring technical efficiency is to know what factors determine the efficiency level of individual farm owner and to come up with development and policy recommendations that improve their efficiency. The technical efficiency scores derived from the model were regressed on socioeconomic, farm owner, and institutional variables that explain variations in efficiency across farm households using the Tobit regression model. The estimation of the Tobit regression model showed that age, education level, of farm owner, training service and marketing facility, were found to be statistically

significant in explaining the variation in the level of technical efficiency. Detail discussions of the results from the Tobit model are presented in table below:

Table 4. 9. Determinants of Technical efficiency in dairy milk production among sample farm area

Variables	Std. Error	ME(dy/dx)
Constant	0.078213	0.7361
Age	0.001414	0.0014*
Sex	0.030053	-0.0481
Education	0.001797	0.0030***
Experience	0.003562	0.0757***
Distance	0.009323	0.0157*
Water	0.035278	-0.0256
Training	0.023276	0.0101*
Marketing	0.029786	0.0315**
	Log. L	87.905147

Source: Computed from data (2017)

* Significant at p<0.01;** Significant at p<0.05; *** Significant at p<0.1 ME=Marginal Effect

Age of farm owner: The estimated coefficient of age for technical efficiency was positive and significant at 10% level of significance. This implies that age contributed positively to technical efficiency for sampled dairy farm area. As age increases by one year, milk production increases by 0.14 percent and producers become skilful and farmers may develop the interest of using new methods of production. The estimated coefficient of age indicate efficiency of the sampled farm owner was increases the capacity of farm owners for produced optimal output and optimal allocation of resources and technology. This result was consistent with Nega (2006).

Sex of household head: Sex of household head was found to have negative and insignificant influence on milk production and technical efficiency, which was not in line with the hypotheses made. This indicates no relationship between the sex of the farm

owner and milk production of milk output. This result was consistent with Nega and Simeon (2006).

Education: Education had significant effect on technical efficiency with expected sign. It is positive and significant at 1% level of significance. As education increases by one year, milk production increases by 0.3 percent. The significant effect of education on technical efficiencies confirms the importance of education in increasing the efficiency of milk production. This result was consistent with Ali (2013). The result was positive and insignificant in Rahama, 2004 and Binam et al, 2004.

Experience of owner: The result of estimation on experience of the farm owner for technical efficiency indicated positive significant at 1 % level of significance. As experience increases by one year, milk production would increase by 7.6 percent. This implies technical efficiency of the farms reflecting that higher experience will end in higher TE due to more efficient use of input. This result was consistent with Ali (2013).

Distance veterinary: This variable was indicates a positive relationship with milk production and it was a significant at 10% level of significance. As distance for veterinary services decreases by one kilometre, milk production increases by 1.6 percent. But there was consistent regarding the relationship between distances for veterinary services and milk production because the sign was expected. This implies it affects the level of milk production positively. This result was consistent with Mosisa (2014).

Water availability: The estimated coefficient of water availability for technical efficiency is indicating negative and insignificant. This indicates that the indirect relationship between water availability and milk production. Availability of water is defined as the total area of private and public water in litters. The relationship between milk production and availability of water is insignificant.

Training service: Training on dairy farming refers to the training given to farmers on some improved dairy husbandry practices or protecting animals from disease etc. Farm owners who received regular training by extension workers, government and non government organizations appear to be more technical efficient. The coefficient for the access to training had statistically significant and positive relationship with TE at10% level of significance. As training services increases by one in unit, milk production would

increase by 1.01percent. This result was consistent with Mosisa (2014) and Lemma et al (2013).

Market facility: This variable was significant at 5% level and it was positively affects the level of technical efficiency. As market facility increases by one in unit, milk production would increase by 2.98 percent. These positive relationships indicate that the coefficient in favor of the prospect of being productivity increases with an increase in output. The nearer to a market is center, the higher the benefit a household gets. So, it was got distance to market center and technical efficiency of milk production was positively related. This result was consistent with Mosisa (2014) and Teshager et al. (2013).

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATION

5.1. CONCLUSIONS

This thesis paper study were conducted on dairy farm milk production to estimate technical efficiency and identify factors affecting efficiency among dairy milk producer on Sebeta administrative town, Nifas Silek Lafto and Kolfe Keranio Sub Cities of Addis Ababa city two administrative woreads near to sebeta town about 3 to 5 kms. distance which is the milk product highly demanded due to highly dweller of population in the area. In the study it adopted both descriptive and casual designs based on the collected a cross sectional data to find out the technical efficiency of the sampled farm areas. Both primary and secondary data were used for the study. The purposive and random sampling techniques were used to select sample survey of 100 commercial dairy milk producers' farms randomly using probability proportionality size following a simplified formula provided by Yamane (Yamane, 1967).Socio-economic, farm and institutional characteristics of the sampled farm area were analysis through descriptive statistic analysis method. The technical efficiency of the selected sample dairy milk producer farms were analysis in econometric analysis system using the Cobb-Douglas Frontier and binary tobit models. The result of the stochastic production frontier model indicated that herd size (milking cow) and human labor (mam-days) were significant determinants of technical efficiency level of the sampled dairy farm. The coefficient of feed quantity, veterinary cost, barn size and depreciation costs are with negative sign significant for technical efficiency The SFPF indicated that the average level of technical efficiency of milk producing sampled farms was 83.60 %. The Tobit regression model revealed that age of farm owner, education level, of farm owner, training service and marketing facility, were found to be statistically significant in explaining the variation in the level of technical efficiency of dairy milk producers in the study area.

5.2. Recommendation

Therefore, based on the findings of this study, policy implications are made to enhance resource use efficiency and increase dairy farm efficiency in the study area.

- Feed quantity affected technical efficiency of dairy farm milk producers. Hence, government should design the supply of inputs more efficiently under the existing technology.
- Veterinary costs affected technical efficiency of dairy farm milk producers. Thus government should devise delivery of medicine availability and veterinary service in close proximity.

- Barn size affected the technical efficiency of dairy farm milk producers. Therefore Concerning government body should take appropriative solution for limitation of Working place

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APPENDIX

Appendix 1 Technical efficiency score of the sample farmers (SPF)

F.C	EE	F.C	EE	F.C	EE	F.C	EE
1	0.82374488	26	0.87208803	51	0.93426300	76	0.61735132
2	0.90061001	27	0.93467807	52	0.91492339	77	0.78353193
3	0.89139538	28	0.92832238	53	0.91473076	78	0.92534328
4	0.85290770	29	0.90551479	54	0.81260051	79	0.91708358
5	0.87926197	30	0.84954602	55	0.93316221	80	0.93612819
6	0.93783456	31	0.82784975	56	0.88803973	81	0.89314332
7	0.89251319	32	0.60043802	57	0.95212372	82	0.90472874
8	0.91291924	33	0.71274680	58	0.92003522	83	0.74311664
9	0.80495458	34	0.67081054	59	0.76526631	84	0.93443564
10	0.87491499	35	0.81065437	60	0.57889911	85	0.40751694
11	0.94047055	36	0.89831592	61	0.77926174	86	0.86999519
12	0.90627828	37	0.93405960	62	0.92323734	87	0.91001970
13	0.89262486	38	0.90458050	63	0.86417557	88	0.84804157
14	0.75971393	39	0.81920184	64	0.65687585	89	0.76164650
15	0.87002674	40	0.81767309	65	0.85262890	90	0.40299826
16	0.84598299	41	0.90492630	66	0.77576922	91	0.80834328
17	0.91551536	42	0.88385409	67	0.75357536	92	0.78880136
18	0.93761492	43	0.87368048	68	0.80814698	93	0.78769289
19	0.88521023	44	0.82374488	69	0.80442402	94	0.78637213
20	0.76171230	45	0.89413156	70	0.68113149	95	0.74422932
21	0.93783456	46	0.85749245	71	0.49143283	96	0.77004553
22	0.89251319	47	0.86762465	72	0.76097723	97	0.89590830
23	0.91291924	48	0.83486274	73	0.87486452	98	0.89244040
24	0.80495458	49	0.94315582	74	0.90773695	99	0.88424588
25	0.87491499	50	0.87534723	75	0.79479879	100	0.89352988

Source: computed from survey data (2017)

QUESTIONNAIRE

I AM A MASTERS STUDENT IN AGRICULTURAL ECONOMICS AT THE SAINT MARY'S UNIVERSITY; AND CURRENTLY WRITING A THESIS TO FULFILL THE REQUIREMENTS FOR OBTAINING THE DEGREE. MY THESIS IS ABOUT THE FACTORS AFFECTING THE TECHNICAL AND ECONOMIC EFFICIENCY OF DAIRY MILK PRODUCTION IN NIFAS SILEK LAFTO , KOLFIE KERANEO SUB CITY OF ADDIS ABABA CITY AND SEBETA ADMINSTRATIVE TOWN OF OROMIA REGIONAL STATE FOR THIS PURPOSE, I AM GATHERING AGRICULTURAL AND SOME GENERAL SOCIO-ECONOMIC INFORMATION FROM RANDOMLY SELECTED DAIRY MILK PRODUCERS IN THIS TOWN. YOUR FARM IS ONE OF THESE RANDOMLY SELECTED FARMS AND I WOULD LIKE TO MAKE A SHORT INTERVIEW OF ABOUT ONE HOUR WITH YOU. THE INFORMATION I GATHER FROM YOU WILL REMAIN STRICTLY CONFIDENTIAL AND YOUR ANSWERS WILL NEVER BE USED FOR ANY OTHER PURPOSE EXCEPT FOR THIS RESEARCH.

Section one: Identification

1	Date of interview (DD/MM/YYYY)	
2	Name of the interviewer/enumerator	
3	Name of the Dairy Milk farm	
4	Kebele (PA) name	
5	Village (gott/gare) name	
6	Name of the interviewee (dairy farm head/manager)	
7	Is the Farm manager/head also the owner?	1. Yes 2. No

Section two: General description of the farm SITE

8. Date of established the diary farm _____year of experience____

9. Is the site of the farm free from water logging? 1. Yes 2. No

10. Is the farm has access of potable drinking water? 1. Yes 2. No

11. Is electricity is available at the farm site? 1. Yes 2. No

12. Haw many meters (km) is the farm away from main road? _____

13 Is the farm well connected to road for easy transported? 1.Yes 2. No

14. Does the size of the house adequate to accommodate the cows? 1. Yes 2. No

15 Is veterinary aid with vaccines and medicines available at approachable? 1. Yes 2. No

16.Is concentrate feed at cheaper rate available in nearby market? 1. Yes 2. No

17. Is marketing facility for milk and cows at reasonable rates available nearby?1 .Yes 2. No

18. Distance of the farm from all-weather road
    1. In Kilometers……
    2. Walking distance in minutes ……..
19. Distance of the farm from kebele agricultural extension office
    1. In Kilometers ……..
    2. Walking distance in minutes ……
20. Distance of the farm from district capital
    1. In Kilometers ……
    2. Walking distance in minutes

Section three: General Information: Demographics and socio-economics

1	Age of the Farm Owner	
2	Age of the Farm Manager (if different from Owner)	
3	Sex of the Farm Owner	
4	Sex of the Farm Manager (if different from Owner)	
5	Marital status of the Farm Owner	
6	Marital status of the Farm Manager (if different from Owner)	

7	Education level of Farm Owner	
8	Education level of the Manager (if different from Owner)	
9	How long have the Owner been engaged in dairy business?	
10	For how many years has the Manager practicing dairy farming?	
11	Ownership type of the dairy farm	

Code:

Sex: 1= Male, 2=Female

Marital status: 1= Marred, 2 = Not married, 3= Divorced, 4= Widowed

Schooling: 0 = Illiterate, Number (in grades) = literate, ALPC= If adult literacy program certificate (ALPC), 13= Certificate13, 14= Diploma, 15= Degree, 16= Msc and 17=PhD

Ownership type: 1= Individual proprietor , 2= Partnership share company 3= Cooperative public, 4= Private limited company, 5=Others (specify) …….

Section Four: Farm size and Livestock inputs (quantity and price)

21. How many cattle does the farm own in total?

	Number of cattle type	
	Local/indigenous Breed	Exotic/Crossbred
Oxen/steers		
Cows		
Bulls		
Heifers		
Calves		

22. How many milking cows did the farm have in the last production season?

1) Local breed cows? .....
2) Crossbreed cows? .....

23. How big is the barn size for the cattle in meter squares? .....
24. How many laborers work on the farm in a usual day? .....
25. How many of the laborers are employed from outside? ……
26. What is the size of the grazing land used by the farm last year (in Hectares)? ...
27. What proportion of the grazing land is:
    1. Owned (own holding) ……..
    2. Leased (long term lease from the government) …….
    3. Rented from other holders …….
    4. 4. Other (specify) ……
28. In the last production season, what pastures did you grow for your animal?

    1…… 3……

    2…… 4……
29. Besides grazing, do you supplement your dairy herd with other types of feed?

    1. Yes 2. No
30. If yes, what kind of feeds do you supplement with?

    1…… 3.……

    2…… 4……
31. If no, what are the three main reasons for not using supplementary feed?

    1……

    2……

    3……
32. Do you give priority for the cows in cattle feeding? 1. Yes 2. No
33. How much money does the farm spend on supplementary feed per month on average? .....
34. Approximately how much money do you spend on the following expenses per month?

1) Workers salary: .....

2) Deworming the animals: .....

3) Veterinary services including AI and breeding: .....

4) Purchased grass/hay: …….

5) Cost of supplementary feed (concentrates or industrial bi-products): …….

6) Purchased crop residue: ……

7) Renting/lease of grazing land if the land is rented/leased: …….

Other expenses: .....

Amount and cost of purchased input (for livestock) during the production year

Type of input	Main supplier of the input (use code	Amount purchased during the year (mention the	Total Cost of the input	Distance to main supplier	
				km	Walking time
Green					
Hay					
Crop residue					
Grain as					
Compound					
Urea					
Molasses					
Bran					
Oilcake					
Salt					
Vaccine					
Drugs					
Artificial					
Bull service					
Veterinary					
Watering					
Other					

Suppliers code: 1=government 2= NGOs (specify) 3= Private shops 4=farmers; 5) Other (specify) 6= Cooperatives

35. Feeding and watering system

Cattle type		Feeding		Amount fed per animal / day (in						Frequen		Distance	
		Rainy	Dry	Concentrates	Bran	Oil	Cereal straw/	Molasse	Ha	Rainy	Dry	Rainy	Dry
Co	Local												
	Cross												
Ot	Bulls												
he	Oxen/												
	Heife												
	Calve												

Feeding system Code: 1 = only grazing (free-range or tethered); 2= only stall feeding (zero grazing); 3 = mainly grazing with some stall feeding; 5= mainly stall feeding with some grazing; 6 = on transhumance 7=other (specify)

Section Five: Milk production and income from all sources

36. What is the average lactation period (in Months) of the dairy animals in the herd?

    1. Local breed cow? .....
    2. Crossbreed cow? .....

37. On average, how many liters of milk does each cow produce per day?

	Fist lactation	Second lactation	third lactation
Local breed cow			
Crossbreed cow			

38. How many times on average do you milk the cows on one particular day? ----

39. At what time (s) of the day do you milk the cows? ----------

40. How does the milking method mostly take place?

    1. By hand 2. By machine

41. Selling price of milk per liter ----------

42. Do you process milk on the farm? 1. Yes 2. No

43. What type of dairy products the farm is producing

    1. Milk
    2. Butter
    3. Cheese
    4. Yoghurt/ergo
    5. Others specify? .....

44. Approximately how much money does the dairy farm make from selling milk and other dairy products in a year? .....

45. What other livestock (and how many of them) do you own besides cattle? Indicate the annual income from livestock source type

NO	Type of animals	Number Owned	Annual Income (Average)	Remark
	Oxen			
	Poultry			
	Heifer			
	Horse			
	Donkey			
	Sheep			
	Goat			
	Bee hives: modern			

46. Does the farm owner earn any income from non-farm and off-farm activities?

1. Yes 2. No

47. If yes how does this compare to the income from dairying? .....

48. Do you belong to any dairy related groups/co-operatives?

2. Yes 2. No

49. Did the farm have contact with the extension agent (DA) for advice on production of the specific commodities? 1. Yes 2.No

50. If yes, how frequently did you have contact with the DA in the production season? ----------

51. Did you or any of your family members receive training or any capacity development support from extension on milk production? 1. Yes 2.No

52. Did you receive linkage support/facilitation from extension on dairy?

3. Yes 2. No

53. Credit access and Use

1	Did your household need credit during the production season?	1=yes 2=no
2	If yes, did you receive credit in the specified period?	1=yes 2=no
3	If Yes, specify from which sources you access the credit?	1.---------- 2.…… 3.----------
4	How much total credit did you take in the last production year?	
5	If credit needed but not received why?	

54. According to you, what are the three most important challenges or constraints to milk production in this woreda?

1. ……
2. ……
3. ……

55. Do you have any general comments regarding dairy production in this area?

56. Fixed inputs and depreciation cost of farm……

END OF QUESTIONS

THANK YOU FOR YOUR PARTICIPATION!

In case if I want to talk to you again, may I have your phone number please?