DETERMINANTS OF PROFIT EFFICIENCY AMONG SMALL SCALE DAIRY CATTLE FARMERS IN NJOMBE DISTRICT

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A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN AGRICULTURAL AND APPLIED ECONOMICS OF SOKOINE UNIVERSITY OF AGRICULTURE. MOROGORO, TANZANIA.

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ABSTRACT

The overall objective of the study was to analyse the profit efficiency of smallholder dairy farmers in Njombe District. The specific objectives were to: (i) To analyse the profit profile of smallholder dairy farmers in Njombe District with respect to socio-economic and technical factors (ii) To analyse the profit efficiency of smallholder milk production in Njombe District (iii) To identify factors that influence profit efficiency. Data for the study were collected from 235 milk producers, 155 are under association and 80 are non-associated. Variation in profitability among smallholder milk production in Njombe District was analyzed by cross tables based on profit terciles for selected famer attributes and other economic factors in the production area using the Student t or Chi square test. Farmers who are; Illiterate, distant from the market, practice indoor feeding system, without access to credit, obtained low profit while farmers who are literate, near to market, practice outdoor feeding system, with access to credit obtained a higher than profit. The profitability of every farmer selected for the study was computed in Tshs per litre using a normalized unrestricted profit function. The results showed that the non-associated earned higher profit by Tshs 176 per litre compared to associated dairy farmers, due to milk price differences. The Profit efficiency of smallholder milk production in Njombe District was analyzed using a Cobb-Douglas profit frontier. It was found that the cost feeds, vetenary services, labour and herd size were significant in influencing profit ($p < 0.05$). Among inputs feed had the largest influence on profit elasticity equal to 0.6 for associated dairy farmers and 0.3 for non-associated. The efficiency of farmers in the association and non- association was significantly affected by farmer's education, experience, occupation and distance to the market ($p < 0.05$). The study concludes that the socio-economic and the technical factors hypothesized for the study tend to constrain the profitability and profit efficiency of

farmers and hence dairy development in Njombe District. It is recommended that education should be provided to illiterate and young farmers on dairy best practices. It is also proposed to devise proper input use to overcome the challenge of high prices for dairy feeds and formulate policies that will enable households increase their profit efficiency.

DECLARATION

I, Serapius Severin Mwalongo do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work done within the period of registration and that it has neither been submitted nor being concurrently submitted to any other institution.

_____ _____

Serapius Severin Mwalongo Date

(MSc. Candidate)

The above declaration is confirmed by;

_____ _____

Prof. G.I. Mlay Date

(Supervisor)

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Mwalongo and young brother Mr. Gothard, may the Almighty God have mercy on you all and grant you eternal life. Amen

DEDICATION

This work is dedicated to my wife F. Msoka, my late father S. Mwalongo and my late mother N. Mwinuka for their love. I will always pray for you.

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LIST OF ABREVIATIONS

CMAAE	Collaborative Masters of Agricultural and Applied Economics
DALDO	District Agricultural and Livestock Development Officer
DPT	Dairy Products in Tanzania
DEA	Data Envelopment Analysis
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
NGO's	Non-governmental organizations
NSGRP	National Strategy for Growth and Reduction of Poverty
R&D	Research and Development
TDV	Tanzania Development Vision
Tshs.	Tanzanian shillings
SFA	Stochastic Frontier Analysis
URT	United Republic of Tanzania

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Dairy Sub-sector

Tanzania has more than 25 million cattle of which 3% are improved dairy cattle mostly crosses between Tanzanian Short horn Zebu and Jersey, Friesian and Ayrshine breeds. Total milk production from the dairy herd and Tanzania short Horn Zebu is estimated to be 2.5 billion litres per year, of which 35% comes from improved dairy cattle (URT, 2015). Dairy cattle are mainly raised in Kilimanjaro, Tanga, Iringa, Dar es Salaam, Mbeya and Njombe regions.

Small scale dairying is a potential contributor to income, employment as well as improved nutrition of households and individuals in institutions like schools (USAID, 2010). The dairy sub-sector in Tanzania employs more than 2.6 million households (Techno Serve, 2015). Consumption per capita in the country is expected to increase from the current average per capita consumption of 45 liters per year to at least 100 liters per capita per year by 2020 (DPT, 2017). Also, total milk produced per year covers only 40% of milk required to be consumed in the country and the rest 60% is imported to meet the total demand (URT, 2015).

In order to meet the expected rise in demand for milk, various measures are being undertaken, including removal of technological constraints such as inadequate genotypes of the local breeds through cross breeding, improvement of inputs such as introducing grasses like Rhodes, Seteria and Guatemala which are more efficient in milk production than the local grasses (URT, 2012). Despite, the demand prospects and efforts to meet it, there has been concern over the growing costs of milk production from farmers and

stakeholders which ultimately result in diminishing milk profits in Tanzania (Burchi, 2014).

According to Njombe *et al.* (2011), the dairy farm costs may increase due to various reasons; seasonality of feeds, the primitive means of milk collection that which comprise bulking and transportation. Njombe *et al.* (2011) father argued that, the nature of the roads together with distance to the market have implication on dairy raising costs. The non- existence of societies or associations may lead to the increase in costs of inputs. This scenario may lead to unsustainable milk production and failure to benefit fully in new technology.

However, Mawa *et al.* (2014) argued that, the ability of dairy farmers to adopt new technology and achieve sustainable production depends on their level of profit efficiency, mostly determined by variable input cost and output prices as well as cost of fixed factors of production. Other factors like the experience of the farmer, education, occupation, access to credit and record keeping, would operate to cause changes in farm level profit and its efficiency. Therefore, this study aimed at analyzing determinants of profit efficiency among smallholder dairy cattle farmers in Njombe district.

1.2 Problem Statement and Justification

The government of Tanzania in collaboration with development partners including Non-Governmental Organizations (NGO'S) have been encouraging market oriented smallholder cattle dairying through dissemination of new technology which include the domestication of cross breeds for dairying and promoting the use of improved grass species for pasture improvement. The major aim is to enable resource poor smallholder mixed crop-livestock farmers to raise household incomes (URT, 2012). However, in the

region about 12 farmers have been observed to exit from the dairy sector. The decision to exit the industry by smallholder dairy farmers poses a question, “why do farmers re-think of what to produce as one of three basic economic questions?”. It is known that famers join the firm for many objectives, profit generation being one of the major objectives (Debertin, 2012).

In Njombe District, two studies have been directed at examining the productive efficiency of farmers that specifically focused on technical efficiency of the farmers (Mbillu, 2015 and Mbehoma, 2013). Technical efficiency studies although necessary are not sufficient to explain why farmers decide to exit the dairy sector. Also, the previous study which was conducted in the District was limited to only farmers who were under the association. This calls for attention to analyse economic efficiency of milk production. Cost efficiency being one of the approaches to study economic efficiency offers a partial vision because it addresses only the cost side and excludes the revenue side. Computing profit efficiency provides better results because it addresses both the cost and the revenue parts (Maudos, *et al*., 2003). Therefore, analysing profit efficiency and its determinants which is lacking from the few available literature in Njombe region with regard to application of improved technology of milk production at smallholder level, will address the knowledge gape existing in the study area.

Pertaining to profit efficiency, various studies have been undertaken to study the effects of new technology on profit among smallholder milk production, which includes a study by Bebe *et al.* (2008) in Kenya, who found that adoption of new technology which mainly involved feeding and breeding strategies was profitable and farmers were 80% profit efficient. Meanwhile, Nanyeenya *et al*. (2008) in Uganda found that that majority of farmers who employed new technology in the production of milk didn’t earn a higher

profit compared to farmers who didn't apply improved breeds, improved grasses and vetenary services. These two studies offer contrasting results on profitability arising from the use of new technology among smallholder milk producer. This scenario creates low understanding regarding the determinants of profit efficiency in the study area and suggests the need for further analysis.

Addressing this knowledge gap was useful in order to provide knowledge and information to development planners, policy makers and other stakeholders in the dairy sub-sector in solving problems which make dairy farmers exit and hence increase the availability of milk, reduce imports and increase income generation and employment to smallholder farmers. Therefore, this study aimed at analyzing determinants of profit efficiency among smallholder dairy cattle farmers in Njombe district.

1.3 Objectives

1.3.1 General objective

The general objective of the present study was to analyze the profit efficiency of smallholder dairy farmers in Njombe District.

1.3.2 Specific objectives

1. To analyse profit profile among smallholder milk producers in Njombe District
2. To analyse profit efficiency of smallholder milk production in Njombe District.
3. To identify factors that have significant influence on profit efficiency.

1.3.3 Hypotheses

1. There is no difference in profitability across smallholder dairy farmers.
2. Smallholder dairy farmers are not profit efficient.

3. Farmer's level of experience, distance to the market, record-keeping, extension services, occupation and education status at farm level, jointly and individually don't have effect on profit efficiency.

1.4 Organization of the Dissertation

This dissertation is organized in five chapters. The first chapter provided the background to the study and the dairy sub-sector in Tanzania, the problem statement and its justification, research objectives and the hypotheses tested. The second chapter involves a review of relevant theoretical and empirical literature. Chapter three presents a description of the study area and the methodology employed. Chapter four presents the results and discussion and finally the Chapter five presents the conclusion and recommendations.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Theoretical Framework

The neoclassical theory of the firm provides the theoretical foundation for this study. Household profit maximization is assumed to drive production decision. A producer faces three basic questions in a production process namely, what to produce? how to produce? and how much to produce? given available scarce resources and technology. A producer will strive to combine inputs in the farm in order to maximize profit or minimize the cost of producing a desired level of output. The theory of the firm has three approaches of analysing efficiency, namely, technical, allocative and economic efficiency.

According to Farrel (1957) technical efficiency is defined as the ability to achieve the highest level of output for a given technology and combination of inputs. Allocative efficiency is the extent to which firms make efficient decisions by using inputs up to the level at which their marginal contribution to value produced is equal to the marginal factor cost while profit efficiency is defined as the ability of a firm to achieve the highest possible profit given the factor and product prices and levels of fixed factors and technology (Ali and Flinn, 1989). According Farrell (1957) economic efficiency (EE) is an overall measure of performance and it is the product of technical (TE) and allocative efficiency (AE).Technical and allocative efficiencies are the necessary conditions for Economic efficiency (Abdulai and Huffman, 2000). A technically efficient farmer will operate along the production frontier (Y_i^*) as shown in figure 1A. Below that point a farmer is said to be inefficient. Since the market price is known and if cost minimization is assumed, allocative efficiency can be derived from the unit isoquant as shown in figure 1B. Therefore, the least-cost combination of inputs that produces (y*) as shown in figure 1B is given by point of tangency between the isoquant and the isocost and the point is

represents economic efficient the point where the marginal rate of technical substitution is equal to the input price ratio (Px_1/Px_2) or the point of tangency between production possibility curve and the isorevenue for a given resource is an economic efficient point as shown in figure 1A (Chukwuji *et al.*, 2006).

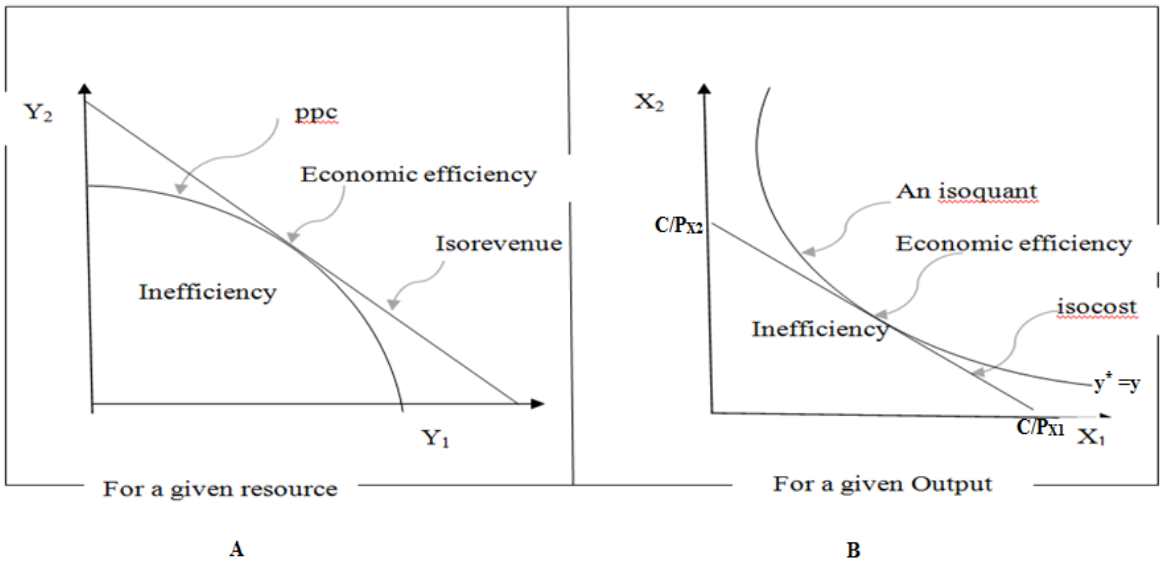

Figure 1: Illustration of the Theoretical concept

2.2 Recent Studies on Farm Level Profit Efficiency

2.2.1 Approaches used to study Farm level Profit Efficiency

There are two widely used methods for measuring profit efficiency; these are Data Envelopment Analysis (DEA) and the Stochastic Frontier (SF). The Data Envelopment Analysis is an optimization technique built to measure the relative efficiency of a farm in the presence of multiple inputs and multiple products (outputs).The DEA provides a method to compare efficiency without knowing the production function, that means, without having to know the functional relationship between inputs and outputs (Hormazabal and Wyngard, 2007).

The problem with the DEA frontier is that it does not account for measurement errors and other sources of statistical noise. Thus, all deviations from the frontier are assumed to be the result of profit inefficiency (Coelli *et al.*, 2005). Its advantage is that there is less room for misspecification and it does not require any assumptions about the functional form. Meanwhile, the stochastic production frontier approach proposed by Aigner *et al.* (1977) has been used by many researchers to study efficiency of economic sectors. The basic model assumes that total production deviates from the optimal production by a random noise and an inefficiency component. Deviation from the frontier due to random events is represented by $vi \sim iid\, N(0, ó_v^2)$ while $ui \sim N^+(u_i, \sigma^2)$ captures deviations from the frontier due to inefficiency.

The stochastic frontier method requires specification of a specific form of production function like Translog or Cobb-Douglas functional forms and it may either allow a one-step estimation of parameters or separate estimation of parameters depending on the users decision (Kivoi, 2010). This study uses the stochastic profit frontier due to its advantages of capturing random disturbances and representation of inefficient component in one step.

2.2.2 Studies that have used Stochastic Frontier Approach

The most widely used functional forms for the SF are Cobb-Doglous stochastic or Translog stochastic profit function, some of those include: Nganga *et al*. (2010) and Delgado *et al.* (2003) who used a Translog stochastic profit frontier model for cross-section data to analyse efficiency of milk producing farmers in Meru south district of Central Kenya and India respectively. The translog stochastic profit frontier showed variation in elasticity among parameters which is true in real life. However, the frontier has a major disadvantage of being subjected to multicolineality that is influenced by

quadratic and interaction variables, hence the tendency to distort the results which may lead to wrong conclusions (Abdulai and Hoffman, 2000).

Leone (2014) conducted a study on profit efficiency among small scale dairy farmers in Kenya and Jiang and Sharp (2013) in Newszealand dairy farms. They estimated cost efficiency employed a Cobb-Doglous stochastic profit function and Cobb-Doglous stochastic cost function respectively. The choice was based on the need to avoid the problem of Multicolineality. However, in the Cobb-Doglous stochastic frontier results showed that the elasticity of parameters was constant, which is not true in real life.

In practice, all the methods carry important message to deliver to the user, for his or her farming decision. Cobb-Doglous profit frontier has ability to handle multiple inputs in its unconstrained form, potential to handle different scales of production and can easily handle Multicolineality and heteroscedasticity although inflexible in the sense that it shows constant elasticity. Meanwhile, Translog profit frontier is flexible such that it can permit the partial elasticities of substitution between inputs variation. The flexibility is useful among dairy farmers to enable them vary one input to the other in order to maximize profit.

Unlike the reviewed studies, the current study found useful concepts from both Cobb-Doglous and Translog profit function which would lead to more doable findings to dairy farmers in Njombe District. However, the accuracy may vary basing on the strength and weaknesses of each method. Therefore, the current study applied both the Cobb-Douglas and Translog stochastic frontier functional forms and further employed the Likelihood Ratio test (LR) to choose one among the two functional forms.

2.3 Determinants of Milk Profit Efficiency among Smallholder Dairy Farmers

While production potential for dairy is high in Tanzania, development of the sub-sector is hindered by a number of factors. Nganga *et al.* (2010) documented inefficient feeds, unskilled labour, inferior genetics, herd size and fluctuating prices as being among those causes. However, the underlying causes of the above mentioned factors are still unknown. Tanzania Milk Processors Association (TAMPA, 2011) argued that an inefficient institutional framework within the formal chain is low response of milk marketing through the formal channel. Meanwhile, Delgado *et al.* (2012), argued that low producer costs and high producer prices in the informal channel leads attract famers to trade informally thus limiting the quantity of milk available to processing plants. The outcome of such inefficient institutional framework is, farmers in the informal channels tend obtain higher profits compared to those farmers in the formal channels.

A study by the government (URT, 2008) showed that high productivity per cow combined with large improved herd that is characterized by efficiency are the main reasons for sub sector development as opposed to having large traditional herd and inherent inefficiencies which lead to low productivity per cow. Again, Leng (2013) asserts that the main criterion for improvement in production is to minimize input costs namely feed cost and labour costs for efficient utilization of available resources than to maximize animal production. Farmers being price takers and with the varying milk prices as a result of seasonality and geography, milk production can be more profitable if farmers produce with minimum possible costs and with an assured milk market which can be put in place if the subjected constraints are known and alleviated (Kurujilwa *et al*, 1995).

The reviewed studies have successfully shown important economic and socio – economic factors that drive the dairy decision of when producing milk, but the underlying cause for the factors are not known. This study, basing on economic theory aims to fill the missing information to the existing literature as follows.

Dairy farmers' profit is effected by a broad range of factors which can enable a producer achieve high milk production (Technical factors) per cow per year on one hand. They include farming practices equipped to the farmer like access to credit, extension services, farmers' characteristics like education and experience. Research and development which include innovation of dairy breeds, feeding system and quality of feeds (Ali and Flinn, 1989). Meanwhile, the dairy farmers' profit fluctuates as milk prices change, the prices changes are virtual to the market size and distance to market. Therefore, this study will consequently contribute to the body of knowledge by filling the gaps indicated above

CHAPTER THREE

3.0 METHODOLOGY

3.1 Conceptual Framework

Profit is determined by quantity of milk produced per cow per year and the price of milk. The quantity of milk produced is affected by research and development such as the dairy breeds available, the type of feeding grasses and farmers' practices as shown in Figure 2. The farmers practices depend on various factors that the dairy farmer is exposed to such as credit access and extension service. On the other hand, the price of output depends on the market size such that the higher the market size the higher the demand for milk will be, prices also depend on farmers distance to the market, where by being far from the market reduces farmers profit, and also prices may be the issue of institutions. Profit efficiency is affected by how the farmer is equipped with education, experience, the farm or off-farm activities and record keeping behaviour may let him or her close to the profit frontier

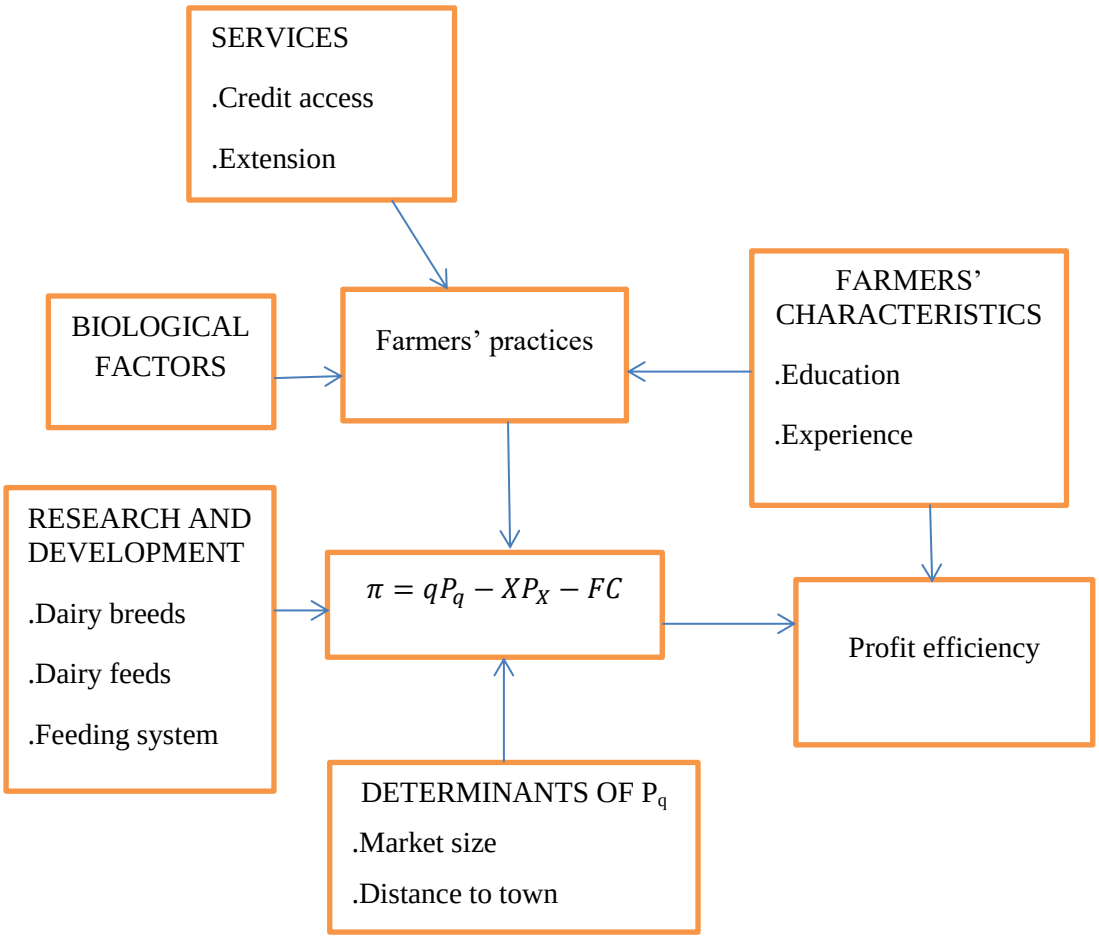

Figure 2: Conceptual framework on factors influencing profit efficiency (own conceptualization)

3.2 Theoretical Models

Profit efficiency is defined as an econometric financial performance measure of how well actual profitability compares to a best practice frontier. Considering a farm that maximizes profit under perfectly competitive input and output markets and production technology that is quasi-concave in the (n x 1) vector of variable inputs, and the (m x 1) vector of fixed factors, z. The profit function which is assumed to be well behaved can be defined as follows: Total Revenue (TR) -Total Cost (TC).

3.2.1 Theoretical model for profitability

Given a production function: h (q_i, x_{ji},,H_i \ z_{ki})……. (1)

Where;

i stands for the farm (1, 2, 3,…..235),

j stands for inputs (1…4) ,

k stands for fixed factors in the ith farm,

q_i= quantity of milk produced in the ith farm,

x_{ij}= jth variable input produced in the ith farm (Feeds, Labour, vetenary service which include drugs and spraying chemicals, herd size),

z_{ik}=kth fixed factor in farm,

H_i = Herd size in the ith farm

Let w =Vector of inputs cost,

p= Price of Milk, the inputs are valued in terms of cost than price because the study uses cross-section data and hence price variation may not be captured.

Then the producer's restricted profit becomes: pq -w'x……..……...…….. (2)

In a production process producers are assumed to choose the combination of variables that maximize profit subject to existing technology.

That is, maxq, x p'q –w'x subject to h (q, x, z,H) =0……..…..(3)

From the first order condition of maximization we get

The input demand function: x =x (p, w, z,H)……...……. (4)

And the output demand function: q =q (p, w, z)…….……..... (5)

If equation 3 and 4 are substituted into the restricted profit function we obtain the indirect profit function: $\boldsymbol{\pi}^*_{\boldsymbol{i}}$ =p'q (p, w, z) –w'x (p, w, z),

$\boldsymbol{\pi}^*_{\boldsymbol{i}}$(pq, w_1 , w_2, w_3, H, z)…… ……..(6)

Where:

Pq =Price of milk per litre,

w_1= cost of health services,

w_2 = Wage rate,

w_3 = Feeds,

H=Herd size,

z =Fixed assets.

Table 1: Prior expected signs for the variables

Profit efficiency variables	Expected sign
Annual milk produced (q)	+
Cost of vetenary services (W_1)	-
Cost of feeds (W_2)	-
Cost of labour (W_3)	-
Herd size	+
Cost of fixed assets	-

3.3 Analytical Frameworks

3.3.1 Objective 1: To analyze profitability of smallholder dairy farmer in Njombe District

Profit margin analysis aimed at determining mean profits obtained by an average farmer per litre in milk production in the study area was obtained as follows:

π_i = TR_i – TC_i ……...…….…….. (7)

This equation can be expressed as

$\pi_i = Pq_i - w_i x_j - z_{ik}$.....(8)

Whereby;

π_i= Profit of a farmer i per litre,

TR_i= Total revenue of a farmer i per litre,

TC_i= Total cost of a farmer i per litre.

P =Price of milk per litre which was either found in the processing plant or other market channels, namely, hotels, restaurants and homes.

q_i =A liter of milk produced by farmer i

w_i = Cost per litre incurred by farmer i in purchasing input j,

x_j = inputs selected considered in production of milk namely, vetenary service, feeds, labour and herd size.

z_{ik} = Cost incurred by farmer i in purchase of a fixed asset k, where k= hut, bicycles, containers and sprayers.

The profit per farm was computed using the two price scenarios, which are first; through the existing price differences among associated farmers who sell milk to the plant and Non-associated farmers who sell milk to other milk channels.

The profile analysis of the profitability of dairy farmers in Njombe District based on the following variables, famers' education, number of milked cows, distance to town, access to credit and feeding system. Profit terciles of profit corresponding to low, average and high profit per litre were used. The Student t was used to test a null hypothesis about two means while Chi square was used to test a null hypothesis about the relationship between two variables at 1% level of significant, for the first hypothesis.

3.3.2 Objective 2: Determination of smallholder dairy farmers' profit efficiency

A frontier profit frontier defines the maximum profit for a given output level, input prices and the existing production technology. Equation (9) presents the stochastic frontier in implicit form.

$\pi_i^* = f(w_j, H_i, z_{ik}).\exp(\varepsilon_i)$.....(9)

Where,

π_i^* is normalized profit of the ith farm

w_j is cost of the j^{th} input faced by the i^{th} farmer divided by output prices,

z_{ik} = is the level of the k^{th} fixed factor in the i^{th} farm;

ε_i =is an error term,

k= 1,2 and 3 and i =1,., 235, is the number of dairy farms in the sample.

ε_i is a composite error term which can be decomposed into two components v_i and u_i. Deviation from the frontier due to random events is represented by $v_i \sim iid\ N(0, \sigma_v^2)$ while $ui \sim N^+(u_i, \sigma^2)$ are deviations from the frontier due to inefficiency.

The profit efficiency of farm i in the context of the stochastic frontier profit function is defined as:

$PE_i = E[\exp(\frac{-u_i}{\varepsilon_i})] = E[\exp(-\partial_0 - \sum_{i=0}^{z} \partial_{zi} / \varepsilon_i)]$……..……...……(10)

Where;

PE= Profit efficiency

E=Expected operator

Profit efficiency (PE) is achieved by obtaining expressions for the conditional expectation u_i upon the observed value of ε_i

The method of maximum likelihood is used to estimate the unknown parameters, with the stochastic frontier and the inefficiency effects functions estimated simultaneously. The likelihood is expressed in terms of the variance parameters:

$\sigma^2 = \sigma_u^2 + \sigma_v^2$ and $\gamma = \frac{\sigma_u^2}{\sigma_u^2 + \sigma_v^2}$

Where,

σ^2 =Total variance for the combined error term ε_i,

σ_u^2 =Constant variance for the symmetric error term v_i,

σ_v^2 = Constant variance for the symmetric error term u_i,

γ = ratio of farm - specific efficiency effects to the total output variance.

The empirical specification of the model

The study used a Cobb-Douglas and Translog profit function. The frontier models estimated was defined as follows:

The Cobb-Douglas profit function was expressed as;

$$ln\ \pi_i^* = \beta_0 + \beta 1 lnw_{i1} + \beta_2 lnw_{i2} + \beta_3 lnw_{i3} + \beta_4 lnw_{i4} + v_i - u_i \quad \ldots\ldots(10)$$

The Translog profit function was expressed as;

$$ln\pi_i^* =$$

$$\beta_0 + \beta_1 lnw_{i1} + \beta_2 lnw_{i2} + \beta_3 lnw_{i3} + \beta_4 lnw_{i4} + \beta_{12} lnw_{i1} lnw_{i2} + \beta_{13} lnw_{i1} lnw_{i3} +$$

$$\beta_{14} lnw_{i1} lnw_{i4} + \beta_{23} lnw_{i2} lnw_{i3} + \beta_{24} lnw_{i2} lnw_{i42} + \beta_{34} lnw_{i3} lnw_{i4} +$$

$$1/2\beta_{11}(lnw_{i1})^2 + 1/2\beta_{22}(lnw_{i2})^2 + 1/2\beta_{33}(lnw_{i3})^2 + 1/2\beta_{44}(lnw_{i4})^2 + \beta_{15} lnH_i +$$

$$v_i - u_i \ldots\ldots \quad (11)$$

Where:

To select the functional form, hypothesis test based on the generalized likelihood ratio (LR) test was conducted. The null hypothesis was set which stated that Translog profit function provides an adequate representation of the data set. Maximum Likelihood Estimation was used to estimate parameters of stochastic profit frontiers.

The following formula was used to carry out the likelihood ratio test. $\lambda = -2(I_R - I_U)$

Where, I_R = log likelihood of the restricted equation (Cobb-Douglas model); I_U = log likelihood of the unrestricted equation (Translog model).

The calculated value of the test statistic (λ) was then compared to the critical value of the chi-square distribution table at α=0.05% level of significance and appropriate 10 degrees of freedom under the null hypothesis model.

3.3.3 Objective 3: To analyse the factors that influence profit inefficiency at the farm level

The determinants of profit inefficiency expressed below were analyzed simultaneously from equation 8 and 9

$$u_i = \partial_0 + \partial_1 z_{i1} + \partial_2 z_{i2} + \partial_3 z_{i3} + \partial_4 z_{i4} + \partial_5 z_{i5} + \partial_6 z_{i6} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (12)$$

Where: z_1 = Education (0=Illiterate, 1= formal educated), z_2 =Farm records (Yes=1 or No=0), z_3 =Experience (number of years), z_4 =Access to credit (Applied=1 or Didn't apply = 0, z_5=Distance to farmer's residence per year (Kms), z_6 = Off-farm (0= No off-farming,1= have off-farming and the $\partial' s$ are coefficients assumed to influence the profit inefficiency.

Table 2: Description of profit efficiency variables

Variable	Description	Unit	Expected sign
Education level of the farmer	0 = Illiterate 1 = Literate	Dummy	-
Extension services	0 = No contact for dairy related activities 1 = Contact for dairy related activities	Dummy	-
Town distance	Total distance from town by the farmer	Km	+
Experience	Number of Years in industry	Years	-
Off-farm income	0 = No off farm income 1 = off farm income	Dummy	-

Education level of the smallholder dairy farmer is expected to increase efficiency in milk production. This is because more educated farmers have relatively higher ability of learning and applying correctly good dairy husbandry practices, ability to bargain the prices of both inputs and milk.

Likewise, the experience of the farmer in dairying is expected to increase efficiency due to the fact that several years of engaging in the enterprise provide a farmer with an in depth practical understanding of the farming practices. This understanding enables the farmer to discover early symptoms of diseases and take healing measures immediately, plan appropriate time of vaccination, feed properly, storing techniques, best combination of inputs and their prices to achieve high profits.

Keeping farm record is very necessary for efficient farm management. It helps to determine the appropriate quantity of feeds and minerals that is demanded by each dairy cow in the farm. Thus, keeping farm records among other benefits, help in reducing wastage of feeds and other resources associated with dairy enterprise. Therefore, keeping farm records is expected to have negative influence to efficiency of the smallholder dairy

farmer. Distance to town is expected to affect positively the inefficiency level of a farm since long distance increase prices and milk becoming bad because milk is a perishable product. Off-farm income was expected to reduces inefficiency Although this is not always the case as argued by Huffman (1980) that increased off farm activities reduces financial constraint, particularly for the resource-poor farmer and thus enables them to purchase productivity enhancing inputs.

3.4 Description of Study Area

The study was conducted in Njombe district in Njombe region. The reason of choosing the district was its location which is within the Southern Highlands zone which ranks the third after Lake and Northern zones where 19 % of households rearing cattle in Tanzania are found within this region (TechnoServe, 2012). Njombe district is located in 090 20'S and 0340 46'E and the topography ranges between 1000 metres to 2000 metres above sea level. The residents in the region are mainly Kinga, Bena and pangwa, and their main activities are growing crops, keeping livestock, lumbering and small businesses. The major crops grown are maize, beans and Irish potatoes where major livestock kept are cows, goats, pigs and chickens.

3.5 Survey Design

3.5.1 Sample size determination

Applying the standard method as proposed by Krejcie and Morgan (1970) as following:

$$n = \frac{X^2 Npq}{d^2(N-1) + X^2 pq}$$

Where n = the sample size required, X^2 = the square of the table value of chi-square for 1 degree of freedom at the desired confidence level, (at 95% confidence level, χ^2 = 1.96;

X^2= 1.96*1.96=3.8416≈ 3.84), N = Population size (N = 1212), p = population proportion considered to be 0.5 to provide maximum sample size q = (1-p) and, d = degree of accuracy expressed as a proportion (0.05).

Therefore $S = \frac{X^2 Npq}{d^2(N-1) + X^2 pq} = \frac{3.84*1212*0.5*(1-0.5)}{0.05^2*(1212-1)+3.84*(1-0.5)}$ = 235 households

3.5.2 Sampling Design

Njombe region has a total of 1212 households keeping dairy cattle of which 800 households are associated producers and 412 are not associated producers (Burchi, 2014). The smallholder dairy farmers are located in 25 villages of which 14 villages have producers who are associated and 11villages are in non-associated producers. A two stage sampling with stratification was used. Two strata were defined, villages under associated producers formed the first stratum and those villages in non-associated producers formed the second stratum. In the first stage, villages were used as sampling units and a simple random sampling technique was applied because villages have almost equal size. From the first stratum 6 villages were selected and from the second 5 villages were selected. In the second stage, households producing milk were used as the sampling frame so that a required sample of 235 households was obtained, the households were sampled through simple random sampling technique. Hence from the first stratum 800/1212*235=155 households (26 households per village) and 412/1212*235=80 households (16 households per village) in the second stratum were studied.

3.5.3 Data collection

In collecting the primary data from the sampled milk producer's structured questionnaires having both open and closed questions were used. Data collected included household characteristics, herd size, cost of inputs, prices of output and the Socio-economic factors

(distance to town, access to credit, record keeping, education, off-farm income). During data collection daily checks were done on the questionnaires that were filled, to make sure that the accuracy in data collection and recording were maintained.

3.5.4 Recruitment and training of the enumerator

On June 2, 2017, the enumerator was recruited and trained. He was a degree holder in Agricultural economics and Agribusiness from Sokoine University. The recruitment criteria were, experience in data collection of not less than a year and the academic qualification (minimum education of a degree).June 3, 2017, training was conduction based on getting familiar to economic terms, words and questions in the questionnaires. Also, the enumerator was trained on how to administer an interview and he was finally tested in a practical way. The administration of questionnaires was done for 17 days from 3rd June to 19th June, 2017.

3.5.5 Transformation of variables

Several variables were constructed based on data collected. The inputs were measured in terms of cost per litre instead of price per litre due to cross-section nature of data which caused spatial variation. The intended variables include cost of feeds, cost of labour, the cost of vetenary services, cost of fixed assets and herd size in cow equivalents. Each variable is as explained below.

Feeds, the expenditure of a farmers hay, maize bran and seedcake in kg/liter were identified for zero grazing while for semi-zero grazing system, the cost for free fed grasses was imputed from a monthly wage of an individual hired to graze. The obtained result was a cost/price of feeding per month (Nyaki, 2014). Their volumes and cost were converted in units of Tshs per litre

Imputed cost of feed = $\frac{Market\ value\ of\ a\ cow}{Months\ of\ grazing}$

Labour, the cost for labour was obtained by dividing total payments to employed labour plus adjustments made for family labour, by the number of full time equivalent workers (FTEs). Total of paid full time equivalent (FTE) employed and unpaid full time equivalents per day was obtained such that for a full time employed laborer had 40hrs per week which is equivalent to 1FTE .Also the unpaid full time equivalent include unpaid family labour and unpaid family management Jiang and Sharp (2013).

Herd size, in every household the number of cows, heifers, bulls and calves was identified by physical counting, then cow equivalents was obtained such that a bull was valued equal to 1, a heifer equal to 0.8 and a calf equal to 0.4 (Alarm, 2007).

Veterinary services, the frequently used drugs and sprays from every farmer were identified and their volumes and cost were converted in units of Tshs per litre.

Fixed assets, the assets were identified from each farmer in the in the sample namely cows' hut, bicycle, sprayer and container. Then, the cost and lifespan of each asset was identified, the total cost each item was obtained through depreciation by straight line method, the salvage value was deducted, finally the resulting cost was divided by number of years to obtain the cost of each item per year as shown in Appendix 2 illustrates.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

This chapter starts by presenting the milk production, milk marketing, profitability of dairy industry, characterization of milk producers by profit in Tshs per litre present in the study area. This is followed by results and discussion from empirical analysis of profit, their constraint and the profit efficiency.

4.1 Dairy Cattle Production

4.1.1 Number and types of cow breed that are kept by dairy farmers

From the sampled farmers, the average number of cows that are kept by dairy farmers in Njombe is two cows per household with the maximum of six cows for household that keep a large number of cows and only one cow for the household which keep the least number of cows. The average number of dairy cows kept in Njombe varies among farmers' category, Associated-farmers kept an average two cows per household, while non- associated farmers kept an average of three cows per household. The results propose that there was a chance for farmers to benefit from economies of size.

Among the breeds, Friesian is the most preferred breed compared to Ayrshire for both associates and non-associated farmers who were sampled for the study. Among associated farmers, about 59% of dairy cattle keep Fresian breed, while only 9% of the dairy cattle farmers keep Aryshire. Meanwhile for non-associated farmers about 43% of the dairy farmers in Njombe districts are keeping Friesian type of cow, and about 31% of the farmers are keeping Ayrshire breed as shown in Table 3. The results on the proportion of cows kept by dairy cattle farmers are similar to those found by Mbillu (2015). According to Mbillu (2015), the choice of dairy breed to be kept in Njombe

district depend mostly on availability of the breed such that Friesian is the most available breed in Njombe district. However, other reasons are productivity, climatic condition, disease tolerance levels and the cost of the particular breed.

Table 3: Type of breed, herd size and percentage by farmers' category

Farmer category	Type	n	%	Mean	Std. Deviation
Associated	Fresian	70	59	1.7	1.0
	Ayrshire	11	9	1.7	1.0
	Fresian and Ayrshire	38	32	2.2	1.1
	Total	119	100	1.9	1.1
Non-associated	Fresian	48	43	2.4	1.4
	Ayrshire	35	31	1.9	1.1
	Fresian and Ayrshire	29	25	3.8	.8
	Total	112	100	2.6	1.4

4.1.2 Feeding system used by dairy farmers

The Majority (53.5%) of dairy farmers raise their dairy cattle in zero grazing system. The rest of farmers practice semi-grazing system as shown in Table 4, most of the farmers are capable of practicing zero and semi grazing system due to the small number of cows that they keep. The result propose that associated dairy cattle farmers have the advantage of getting better knowledge on their farms since the dairying environment can be controlled easily and hence more milk per compared to non- associated farmers.

Table 4: Distribution of farmers by feeding system and membership to association

Feeding system	Associated		Non-associated		Total	
Zero grazing	n	%	n	%	n	%
	114	95.0	8	7.4	122	53.5
Semi grazing	6	5.0	72	92.6	78	46.5

4.1.3 Types of grasses used, supplementary feeding and amount of land allocated for fodder

Rhodes grasses are the most common type of grass being used by majority (56.2%) of dairy farmers in Njombe District. More than quarter (29.6%) of farmers use Guatemala grass for feeding their cows, and only 14.2% of the farmers feed Setaria grass to their animals as shown in Table 5.The result suggest that, dairy cattle farmers have discovered the benefits of Rhodes grass compared to the rest since it has unique advantages over others; resistance to drought, highly productive in milk, they are more effective in milk production when they are in young stage of their maturity (FAO, 2012). Hence it was expected that the milk output per cow would be high. Also, the results proposed that most of the associated dairy farmers purchase grasses which may increase their operation cost, because the sellers of grasses need also to maximize their profit.

Table 5: Distribution of farmers by type of grasses and by group membership

Type of grasses	Associated		Non-associated		Total	
	N	%	n	%	n	%
Rhodes	60	59.4	35	51.5	95	56.2
Setaria	22	21.8	2	2.9	24	14.2
Guatemala	19	18.8	31	45.6	50	29.6
Total	101	100	68	100	169	100

The mean land size allocated for obtaining these grasses is 1.7 acre per household with a maximum and minimum allocation of 1.0 acre and 3.0 acres respectively. The other purchased supplementary feed and minerals includes hay, maize bran and salt. The amount of purchased hay on a daily basis is 1.4 kg per household. Maize bran is the

most used supplement with daily average use of 15.9 kg. On average 1.4 Kg of mineral salts is given to the dairy cows per household per day as shown in Table 6.

Table 6: Quantity of feed per cow in kilogram by group membership to association

Farmer category		n	Mean	Std. Deviation
Associated	Quantity of used fodder	116	12	6
	Quantity per year in kg	116	3014	1938
	Quantity of maize bran used /day	120	15	8
	Quantity of seed cake used per day in kg	108	1	1
Non-associated	Quantity of used Fodder	112	14	7
	Quantity per year in kg	112	2176	1093
	Quantity of maize bran used /day	107	16	7
	Quantity of seed cake used per day in kg	82	2	1

4.1.4 Labour use in dairy cattle production

Less than quarter (13.2%) of dairy farmers depend entirely on family labour when attending their cows while 86.8% use both family labour and hired labour in raising their cows. Most of the hired labour are paid on the monthly basis and only a few of them are paid on weekly a basis. The main activities which are performed by the hired labor includes grazing, grass cutting, collecting local feeds, cleaning sheds, milking, spraying, transporting and marketing milk. The dominance of hired labour in attending dairy cows suggests that there is more room for increasing milk production through provision of motivating contracts which is sometimes difficult to achieve through family labour.

4.2 Milk Production in Dairy Farming

On average the capacity of producing milk per individual dairy farmer in Njombe district is about 5809.7 litres per year, with a maximum capacity of 22875.0 litre for the best producer and 1215.0 litre per year. Milk production is higher among associated

(6440 .0litres) farmers compare to non-associated farmers (5235.0 litres) as shown in Table 7. Most of the dairy farmers sell their produced milk, only 4.0% of the total milk is used for home consumption while 96% of the produced milk is sold to various marketing channels (Figure 3). The low percentage of milk left for home consumption shows that dairy cattle industry in Njombe region is one the major sources of income, therefore dealing with farmers constraints on milk production will be beneficial.

Table 7: Milk production per year in litres per farm by membership to association

Descriptive Statistics	Minimum	Maximum	Mean	Median	Std. Deviation
Total milk produced	1215.0	22875.0	5809.7	4400.0	4038.6
Associated	2550.0	22875.0	6440.0	4650.0	3883.2
Non- associated	1215.0	20250.0	5235.5	4200.0	4271.3

4.3 Marketing of Milk among Dairy Farmers

A significant amount of milk produced is sold (96%) to different market outlets in Njombe district. The various outlets through which the milk is being sold includes processing plants, collection center, neighbor and to the hotel/restaurant. The main processing plant available for farmers to sell their milk is CEFA which seems to take a large amount of milk that is sold.

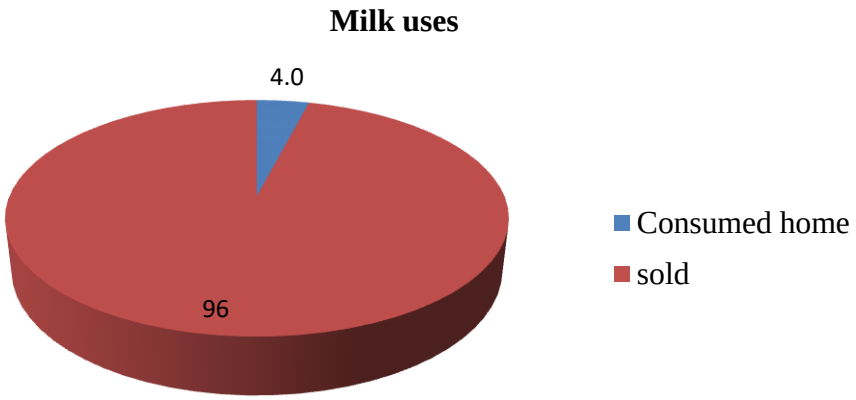

Figure 3: Milk uses

The results from Figure 3 show that about 52% of the total sold milk is taken to the processing plant, 18% is sold to neighbors of the dairy farmers, 16% is sold to hotels/restaurants and the remaining 15% is sold to available milk collection center. The average price offered by these channels per liter of milk is Tshs 1000 for neighbor, hotels/restaurants and collection canter, Tshs 500 is offered from processing plant where large volume of produced milk is taken to. Even though milk price is low among associated still more milk is sold to the plant.

Table 8: Motive for Market outlet choice by group membership

	Associated		Non-associated	
Motive	n	%	n	%
Contract on cow credit	111	71	11	14
Price	44	28	69	86
Total	155	100	80	100

The price differences are institutional which refers to set of formal contracts that govern the relationship in prices between the associated producers and the processing plant (CEFA). The enforcement of contracts with the processing plant and producers at this level is highly dependent on trust and reputation which has been built through acquisition of cows by credit for new entrants in the association and repeated interaction between the plants' official who perform training, veterinary services to the associated farmers as shown in Table 8. Being involved in this form of contracts is said to reduce ex-post transactions costs in the adaptation of hybrid structures of exchange (Martino, 2010). This form of contracts is known as relational contracts (Garbe-Madhin, 2009).

On the other hand, in the non- associated farmers, milk quality is not a key point of observation such that producers and buyers concentrate more on quantity than quality of milk produced even though buyers may sometimes detect few cases of poor quality milk from producers by their naked eyes such the change of milk colour and test of sour milk but can't go beyond that in examining mastitis effects in milk as is done at the plant. It is a fact that non- associated producers face high risks of loss from transaction failure due to significant investments in specific assets and uncertainty in prices, product and/or transaction partners, and thus they may often wish to engage in bilateral contracts or even in vertically integrated hierarchical contracts rather than spot-market transactions to reduce risks. The scenario of non-associated producers is supported by a study done by Dorward *et al.* (2009).

4.4 Profitability of Dairy Industry

4.4.1 Milk Profit obtained by farmer in litres per farm by membership to association

The result from this scenario revealed that, non-associated farmers had attained a profit of Tshs 25 445 per farm per year which is larger than Tsh 22 160 per farm attained by associated farmers as shown in Table 9 in the row Profit (A), although the profit difference may also be attributed to sampling errors. In the second scenario an assumption was made that, if both the associated and non- associated farmers sold milk at the same price per litre, which is Tsh1000, then the associated farmers would be Tsh 18 875 higher than the Non-associated farmers as shown in Table 9 row Profit(B). The ratio of profit to the total cost was 0.1. This value is low which implies that every shilling invested in total cost of dairy enterprise by a farmer returns only 1 cent.

Table 9: Milk Profit (Tshs) per household in litres by membership to association

Cost involved	Associated			Non-associated		
	Mean	Median	Std. Deviation	Mean	Median	Std. Deviation
Feed cost	1 187 909	2 042 000	415 138	1 039 206	857 400	613 108
Labour Cost	304390	240000	149131	185357	20000	15102
Veterinary cost	27219	30000	11250	29933	25000	10408
Total variable cost	2268470	1322650	790265	1629552	1968500	1214709
Fixed cost	116143	10500	26335	102947	10166	19949
Total Cost	2293647	57101	151	1658499	1985666	231771
TR1	2130897	5103000	3964355	2510499	2325000	2396113
TR2	426174	10206000	372654	2510499	2325000	2396113
Profit(A)	-162750	22160	220	852000	25445	65509
Profit(B)	8138	44320	215	852000	25445	65509

Furthermore, profitability among farmers was computed to per litre for every farmer selected for the study, results show that, non- associated farmer got a profit of Tshs 318 per liter of milk, while a farmer under association got a profit of Tshs 142 when selling a

litre of milk as shown in Table 10. However, if the price of Tsh 1000 was the same for both farmers in the association and who are not in the association, then the associated farmers would get a profit of Tshs 642 when selling one liter of milk which is Tshs 500 higher than among the non- associated farmers. Therefore, the price at which farmers who are associated face may be the reason for farmers to exit in the sub-sector. These result show that among the associated dairy farmers, total cost is higher than the non-associated farmers especially in feeds. Although in economics this scenario was expected to be the reverse due to synergistic tendency among associated farmers. However, the higher costs in feeds may be deduced from the quantity of fodder per dairy cow in litres which is 838kg higher than in non-associated as shown in Table 10. Most associated farmers seem to purchase grasses rather producing themselves compared to non-associated farmers who have their own farms. This tendency may increase the feed cost because grass producers need to maximize profit which becomes an expense of the dairy producer. The results are close to those found by Mbillu (2015), even though he computed gross margin instead of profit.

Table 10: Profit Obtained when a farmer sells one litre of milk in (Tshs)

Farmer Category	**TC**	**Median profit**	
Milk Price (Tshs)		**Different**	**same(1000)**
Associated	570	142	642
Non-associated	290	318	318

4.4.2 Distribution of profit per litre of milk sold in Tsh for both associated and non-associated

The profit per litre of milk sold for both associated and non-associated farmers was not normally distributes but right skewed implying that the mean is greater than median values shown in Figure 4. Thus, median values best describe the results.

Figure 4: Frequency polygon

4.4.3 Characterization of Milk producers by profit in Tshs per litre

The characterization of milk producers for the associated and non- associated was done on the basis of hypothesized socio-economic characteristics namely the farmers' level education, size of dairy herd, distance to the market, access to credit and feeding system on profit per litre of milk produced. Among associated farmers, low profit of milk production per litre ranged from a minimum of Tshs.19.15 to Tshs 87.15 per litre. Households within this range were said to be in the low profit group while those with a profit of Tshs 119 to Tshs 324 per litre of milk produced were said to be in the high profit tercile as shown in Table 11. Among non- associated, producers were said to be low profit producing if their profit per litre of milk produced ranged from Tshs. 65 to Tshs. 232 and high profit group if their profit per litre of milk produced was between Tshs. 524 and Tshs. 870 as shown in Table 11. Thus, the characterization of milk producers followed these ranges for a more descriptive understanding of their behaviour across the formal and informal milk chains.

Table 11: Descriptive statistics of profit of milk per litre in the associated (A) and non- associated (B)

Group	Profit tercile	N	Mean	Std. Deviation	Minimum	Maximum
	Lower tercile	67	53	72	19	87
A	Middle tercile	23	123	81	100	197
	High tercile	55	210	120	225	477
	Total	155	386	640	247	477
B	Lower tercile	20	212	69	66	232
	Middle tercile	30	388	82	346	232
	High tercile	30	903	399	524	870
	Total	**80**	**570**	**286**	**66**	**870**

4.4.3.1 Distribution of milk producer by education and profit tercile

Farmers who are literate have higher profit than those who are illiterate. Furthermore, the chi-square revealed that there is a significant association between profit terciles and farmers' level of education (Chi^2= 15.4, with $p<0.001$) as shown in Table 12. The results are pertinent to the fact that skilled small scale dairy cattle farmers in Njombe District are also more productive and can efficiently engage in dairying by maximizing returns, where education cultivates new farming skills (Kumar and Staal, 2010).

Table 12: Distribution of milk producer by education by profit tercile (%)

	Associated					Non-associated				
Education	n	Low tercile	Middle tercile	High tercile	Total	n	Low tercile	Middle tercile	High tercile	Total
Illiterate	72	42.80	37.5	39	100	36	42.4	28.8	28.8	100
Literate	83	24.1	42.2	33.7	100	44	18.37	18.37	63.26	100
Total	155	30.5	22.2	30.3	100	80	32.5	33.56	34.2	100
χ^2	15.4					13.5				
p	<0.001					<0.001				

4.4.4 Distribution of number of cattle milked by profit tercile

Farmers with large number of cows milked have higher profit than those with low number of cows milked. Also both groups of milk producers significant association was found between low profit in terms of number of cows milked when ($p<0.001$) as shown in Table 13. This implies that the farmers profitability is linked to economies of scale. The study has similar findings as that done by Kavoi *et al.* (2010) where increase in the number of cows milked was found to increase profit.

Table 13: Distribution of milk producers by cows in milk by profit tercile

	Associated			Non-associated		
Dairy herd	n	Mean	Std. Deviation	n	Mean	Std. Deviation
Low tercile	50	13	10.50	20	7	13.33
Middle tercile	53	15	8.38	39	2	4.29
High tercile	52	32	26.80	20	28	10.09
Total	155	21	20.96	80	16	5.52
χ^2	4.6			7.8		
p	<0.001			<0.001		

4.4.5 Distribution of milk producers by distance to the market and profit tercile

Farmers close to the market have higher profit than those far from the market. For both groups of milk producers a significant association was found between low profit in terms of distance to town when ($p<0.001$) as shown in Table 14. This implies that that distance to the market leads to profit ineffectiveness among small scale dairy farmers in Njombe District. The results are similar to those found by Rahman (2002), that distance to the market is reduces the level of profit efficiency, since long distance increase prices of transport. Therefore, distance adds the cost to a farmer in accessing inputs and distributing inputs to the sells points.

Table 14: Distribution of milk producers by distance to the market and profit tercile

			Non-associated			Associated
Distance to market(km)	n	Mean	Std. Deviation	n	Mean	Std.Deviation
Low tercile	15	9	13.51	47	5	14.36
Middle tercile	39	14	7.88	48	2	4.29
High tercile	20	28	21.80	60	9	9.09
Total	80	21	19.96	155	5	6.52
t	3.83			2.84		
p	<0.001			<0.001		

4.4.6 Distribution of milk producers by access to credit and profit tercile (%)

Most farmers with access to credit have high profit terciles while those farmers without access to credit most fall under low profit tercile. The finding was found to be true to both groups as shown in Table 15, and significant association has been found between profit terciles and access to credit at $p<0.001$. Credit help farmers to increase the farmers ability to run the dairy farm, because it provides liquid money to meet the dairy farm purchases, hence increase the profit level of efficiency. The results of this study are similar to those found by Nganga *et al.* (2010).

Table 15: Distribution of milk producers by access to credit and profit tercile (%)

			Associated					Non-associated		
Credit	n	Low tercile	Middle tercile	High tercile	Total	n	Low tercile	Middle tercile	High tercile	Total
Yes	72	26	26.2	47.6	100	36	35	11.6	52.9	100
No	83	33	49.3	18.2	100	44	25	64.8	9.7	100
Total	155	33	34.6	33.2	100	80	30	35.2	34.9	100
χ^2	18.12					10				
P	<0.001					<0.001				

4.4.7 Distribution of milk producers by feeding system and profit tercile (%)

Most farmers who practice indoor feeding system have low profit terciles while those farmers who practice outdoor feeding system most fall under high profit tercile as shown in Table 16, these findings was found to be true for both groups. Also a significant association was found between profit terciles and feeding system at $p<0.001$. However, for non-associated incidence it can be can be explained that, outdoor feeding system used small or not- prepared inputs as opposed to outdoor ones.

Table 16: Distribution of milk producers by feeding system and profit tercile (%)

	Associated					Non- associated				
Feeds	n	Low tercile	Middle tercile	High tercile	Total	n	Low tercile	Middle tercile	High tercile	Total
Indoor	72	57.7	40.8	1.5	100	36	45.8	45.8	8.3	100
Out door	83	23.0	33.6	43.3	100	44	10	9.4	80.6	100
Total	155	34.2	33.56	32.25	100	80	32.89	32.89	34.2	100
χ^2	24.1					17.1				
P	<0.001					<0.001				

4.5 Profit Efficiency for Smallholder Dairy Cow Farmers in Njombe District

The stochastic profit frontier estimation based on Equation 10 and 11, presented the effect of input cost and herd size on the total profit of the dairy farm. It was hypothesized that small holder dairy farmers are not profit efficient. The maximum likelihood estimates of the Cobb-Doglous and translog Profit frontier for milk producers among the associated and non-associated are shown in Table 17 and Appendix 2.

Through the generalized Likelihood Ratio test (LR), a Cobb-Doglous function form was found an appropriate functional form to estimate profit efficiency results for this study. The value of Likelihood Ratio calculated was equal to 24.26.This value was greater than

the critical value of **$\chi 2$ (10, 0.05)** which was equal to **3.84**. According to these results the null hypothesis, which stated that Translog profit function is an adequate representation of the production function is confidently rejected at 5% level of significance in favour of Cobb-Doglous profit function. The results for hypotheses testing are as shown in Table 17.

The coefficients of the variables are profit elasticities. The profit elasticity show the percentage change in dairy farm profit with respect to a percentage change in a given variable input cost or fixed input cost *ceteris Peribus.* This means that the increase costs of the inputs; Feed, Labour, Veterinary services would lead to decrease of farm profit level and vice versa.

The result indicate that most of the dairy farmers' profit elasticities with respect to input costs among the associated and non-associated farmers were negative as it was expected in theoretical section. Results also show that profit elasticities are statistically significant at five probability level. Among the variables feeds were observed to have largest influence on the profit elasticity equal to 0.65 among the associated and 0.42 to non-associated meaning that, 1% increase in feed cost results in an estimated decrease in profit by about 0.65% for associated and by 0.42% for the non-associated. Likewise, results were also observed with respect to normalized labour cost and veterinary cost in which , a percentage increase in the labor cost for producers led to 0.22 % for associated and 0.07% non-associated decrease in the profit of production. A percentage increase veterinary cost led to 0.001% for associated farmers and 0.13% for non-associated farmers decrease in the costs of production. The coefficient of herd size among the associated was observed to be negative and significant at 5% level.

Table 17: Stochastic Frontier Estimated Results for Profit Efficiency among dairy farmers from Cobb-Douglass Function

	Associated			Non-Associated		
Variable	Coefficient	Z-ratio	P > | Z|	Coefficient	Z-ratio	P > | Z|
Feed cost	-0.7	-2.6	0.0	-0.4	-24.6	0.1
labour cost	-0.2	-8.2	0.1	-0.1	-1.7	0.0
Veterinary cost	-0.1	-7.0	0.0	-0.1	-5.3	0.6
Herd size	-0.2	-8.6	0.1	-0.1	-4.3	0.0
Constant	6.2			3.8	19.1	
Sigma-squared	0.2			`0.2		
Gamma(γ)	0.3			0.3		
n	155			80		
χ^2	24.6					

The variance was estimated to 0.2801 as a parameter from gamma (γ) which is significantly different from zero. This means that there 28.01% are only statistical noise, which implies low level of profit inefficiencies. These results are similar to those found by Kivoi (2010) in Kenya. Also, the Cobb-Douglas results revealed that non- associated were profit efficient by 73% and associated by 56%. However, Appendix 2, shows the results for translog profit function.

4.5.1 Distribution of profit efficiencies

The predicted profit efficiencies of the dairy cattle farmers in the study area differed noticeably ranging from 8% to 99%. About 15% among the associated farmers belonged to the most efficient category while among non- associated only 3% belonged to the most efficient category. More than 50% for both associated and non-associated dairy farmers have profit efficiency below 50%. This shows that the dairy farmers in study area are less profit efficient and efforts must be taken to increase the profit efficiency in the study area.

Table 18: Distribution of profit efficiencies

Profit efficiency (PE,%)	Associated Number of farmers	%	Non-associated Number of farmer	%
<21	62	40	27	34
21<41	33	21	18	23
41<61	23	15	16	21
61<81	15	10	15	19
81-100	22	15	4	3
Total	155	100	80	100
Average	56		73	
Minimum	8		20.3	
Maximum	81		99	
Std. Dev	25.2		19.8	

4.6 Factors explaining inefficiency of improved dairy farmers

The average profit efficiency was 73% for non- associated and 56% for associated farmers, which implies that with the recent cost of inputs, the dairy farmers would increase their milk profit by 27% for non-associated and 46% for associated farmers by improving their technical and allocative efficiencies. In regressing the socio – economic and farm specific factors on profit efficiency of dairy farmers in Njombe District both negative and positive signs were observed as shown in Table 18. The coefficients that bear a negative sign of an explanatory variable in profit function imply that the variable improves milk profit efficiency. Meanwhile, the coefficient that bear a positive sign of an explanatory variable in profit function imply that the variable lowers milk profit efficiency. The farming experience tends to increase profit efficient significantly ($p< 0.001$). These results are in line with the theoretical expectation as it was stated in the theoretical part. It implies that as the farming experience increase the farmers' milk profit increase. The similar findings have been reported by Masuku *et al*. (2014).

Off-farm income of the respondents has been found to have significant (P< 0.01) and bears a negative sign in line with the prior expectation. It implies that off-farm income has potential of increasing profit efficiency among the smallholder dairy farmers in Njombe district because it reduces financial constraints. The results are similar to those found by Huffman (1980) that increased off farm activities reduces financial constraint, particularly for the resource-poor farmer and thus enabling them to purchase productivity enhancing inputs.

Farmers' level of education the results are in line with the prior expectations that, as the farmer attains education his or her farms' level of profit increase. This implies that the more educated farmers have higher profits than those with low education. This could be explained that more educated farmers have better access to information on input costs, output prices, dairy technical issues and better management decisions. This result is in conformity with Abdulai and Huffman (1998). Access to credit, and record keeping have been observed to reduce in efficiency as it was prior predicted because it enables the dairy farmer access to have enough fund for purchasing the inputs necessary in dairying.

Distance to town result is positive in line with the prior expectation and statistically significant (p <0.001). It implies that as the distance to town increases also profit inefficiency level of a farm increase. Long distance to the market increase input costs and milk prices. Also with long distances to town milk being a perishable product.

Keeping farm record was expected to have negative sign implying that inefficiency is reduced with the tendency of the farmer to keep record. The result conform to the expectation and statistically significant. It implies that with the practice of record keeping, a farmer can be able to determine the appropriate quantity of feeds and minerals that is

demanded by each dairy cow in the farm. Thus, keeping farm records among other benefits, help in reducing wastage of feeds and other resources associated with dairy enterprise. The Table 19 below gives evidence for above information.

Table 19: Estimated results of determinants of profit efficiency among smallholder dairy producers

Variable	Associated Coefficient	Z-ratio	P > |z|	Non-associated Coeffient	Z-ratio	P>|z|
Farmers experience	-0.8	-2.5	0.0	-1.9	-0.2	0.0
Level of education	-0.6	-3.3	0.1	-0.1	-10.1	0.0
Occupation	-1.5	-2.9	0.1	-0.7	-1.0	0.3
Access to credit	-0.1	-3.9	0.0	-3.4	-5.9	0.0
Record keeping	-0.9	-7.2	0.0	-0.1	-3.3	0.1
Distance to the market	0.2	1.6	0.0	0.4	4.7	0.0
Constant	7.3	3.5	0.1	6.6	3.4	0.0

The deliberated variables affecting profit efficiency were all observed to be significant at 5 % level. Thus, there is enough evidence to reject the third hypothesis which stated that Farmer's level of experience, distance to the market, record-keeping, extension services, occupation and education status at farm level, jointly and individually don't have effect on profit efficiency.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The general objective of this study was to analyze the profit efficiency of smallholder dairy farmers in Njombe District. The specific objectives were (i) to analyse profit profile among smallholder milk producers in Njombe District (ii) to analyse profit efficiency of smallholder milk production in Njombe District. (iii) to identify factors that have significant influence on profit efficiency.

Characterization of smallholder dairy farmers has shown that farmers who are Illiterate, far from the market, practice indoor feeding system, lack access to credit obtained low profit while farmers who are literate, near to the market, practice outdoor feeding system, access to credit obtained high profit.

For specific objective two, among the variables feeds were observed to have largest influence on the profit elasticity equal to 0.65 for the associated and 0.42 to non-associated meaning that, 1% increase in fodder cost results in an estimated decrease in profit by 0.65% for associated and by 0.42% for the non-associated and farmers were profit efficient by 73% for non- associated and 56% for associated. For specific objective three farmer's level of experience, distance to the market, record-keeping, extension services, off-farm income and education status at farm level, jointly and individually have effect on profit efficiency. Therefore, the hypothesis that profit did not vary across smallholder dairy farmers rejected at 5% level of significance. Also, some milk producers were observed to be profit efficient and hence the second hypothesis was rejected and the

third hypothesis, Farmer's level of experience, record-keeping, extension services, off-farm income and education had significant link with farm level efficiency.

5.2 Recommendations

i. Based on the results that, milk production among associated dairy farmers produce an average of 2,625 more than non-associated dairy farmers, in which the sources of variation arise from grazing system, amount of feeds and the farmer's membership in association. This study recommends that, the non-associated farmers should exercise a zero grazing system to easily control dairy cows due to easy acquisition of knowledge. Non-associated farmers should increase the amount of feeds per cow to produce more milk. Given the prices available to channels other than the plant channel, non-associated farmers may make more profit.

ii. Based on the results that, a large percent of associated farmers obtain dairy feed by purchasing than producing themselves and the profit elasticity feed being large than the rest of inputs used in the study, the current study recommends that associated farmers should establish their own farms to reduce the cost of feeds. The approach is essential even though it taken a long time to realize the rewards.

iii. Based on the result that the dairy farmer's profitability is linked to literacy for both associated and non-associated, number of cows milked, distance of the dairy farm to town. This study recommends that for non-associated farmers education should be promoted on dairying pertaining production and marketing of both inputs and outputs. It father recommends that, dairy farmers may increase the number of cows to be milked considering that the same dairy hut, amount of

labour and other fixed assets. Success to adopt this suggestion implies that the farmers enjoy the economies of scale.

iv. Based on the result that, dairy farmer's profitability is linked to literacy for access to credit. The study recommends that, awareness should be created to farmers on the existing financial institutions, however the farmers bank has been closed which was known as Njombe Community Bank (NJOCOBA), both the government and farmers have an obligation to search for a another Bank which will take over the vision of NJOCOBA.

v. Based on the result that, profit efficiency is affected by distance of the farm to town, then the study recommends that the government should invest in road construction to easy transportation of milk to town.

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APPENDICES

Appendix 1: Questionnaire for Milk Producers in Njombe district in 2016/17

Questionnaire number……....Name of respondent…….....

Date of interview……...Name of enumerator...…….……..

District…….....Division...……...…….

Ward……Village/Street…….…….……..

A: Basic Information

1. How do you consider yourself in terms of education?(Circle the appropriate)1=Illiterate 2=Literate

2. What is your primary occupation? (Circle the appropriate) 1= farming, 2= Off-farm

3. Household size and composition (number of people living together and sharing the same kitchen) Adults……..[2]Children……

B: Milk Production Information

4. For how long have you been keeping dairy cow(s)……

5. What type of dairy cow breed do you keep? 1=Friesian 2= Ayrshire 3= Jersey 4=Cross Breeds (specify)……

6. Please indicate the number of each type of cattle category you had in the last year?

{1}cows……{2}Heifers……..{3}Bulls……..{4}Steers……{5}Calves……

7. How many milking cow did you have at the beginning of the last year (2016)? ….....

8. Please indicate the number of cattle you had in each of the following category at the beginning of the last year.

{1} cows……. {2}Heifers……. {3}Bulls……. {4Steers…… {5}Calves……

9. How did you get your starting dairy cow? 0=given through pass on credit 1=Bought

10. If you bought, what was the source of fund that financed the purchase of dairy cow? 1=own source, 2= Formal credit, 3= Informal credit, 4= Family/ Friend, 5=others (Specify)……

11. If you bought using credit, what was the source of credit you received? {1}=Bank, {2} =SACCOS, {3}=NGO, {4}Church {5}others specify……

12 How long since your dairy cows have started producing milk? ……

13. What is your average daily income? (Tshs)……

14. What is the average number of cows you milked per day last year? ……

15. Do you keep farm records? (Circle the appropriate response) 1=Yes, 2= No

16. Where do you get extension services concerning proper keeping of dairy cow and/or milk production? 1=Government, 2= NGO, 3=Neighbour, 4=Others (Specify)……

17. What is the average number of extension visit did you receive per month in the last (2016) year……...

18. What is the amount of milk did you get within following time period in last year's period of milk production per cow per day?

Period	Wet season (Jan-June)	Dry season (July-Dec)	Average milk produced per cow per day
Number of cows milked			
Average milk produced per cow per day (Litres)			

19. What is the average lactation period of your cow(s)? (Days).....

20. What is the amount of milk in litres did you produce last year? ……

21. Where do you normally sell your milk? ……

22. What is the average selling price per litre at your delivery point?

{1}During wet season…… {2} during dry season…….

23. What motivates you to sell milk at that point? 0=high prices, 1= forced by the contracts, 2=Easy to transport.

24. If a contract, how much input do you have in making decision about the business contract

1=No input, 2=.Input into very few decision 3= Input into some decisions 4=.Input into most decision 5= Input into all decisions.

25. If there is input what is the level of response from the other part of the business

0=Poor, 2= Satisfactory, 3=good, 4=Very good, 5=Excellent

26. Please estimate the average quantity of milk in litres that you sell to the different market channels and set aside for home use on daily basis and average price per litre in wet and dry season for the calendar year 2016.

Item	Wet season (litres)	Price (Tshs)	Dry season (litres)	Price (Tshs)
Sell to processing plant				
Sell to hotels/restaurants				
Sell to neighbours				
Sell to milk collection centers				
Consumed at home				
Remained unsold				
Others (specify.) a.				
b.				
Total				

C: Information on Investment Costs

27. What is the number of cow(s) that produced milk last year……

28. When were they received/ purchased (year) ……

29. What was the initial animal price during purchase/ receiving…….....

30. What was the value of cow (s) when they began to produce milk in the year (2016) Tsh.

31. What was the prices of the following shed items during construction? Tshs year…...

Item	Quantity	Year Purchase	Unit Cos	Total Cost(Tzs)
Poles				
Roofing				
Labour charge (If hired)				
Transporting materials				
Other (Specify)				
Total				

32. Interest paid per year in case the startup capital was obtained through loan……

33. What was the initial pasture establishment cost……

34. Please estimate the price of the following equipment if you are using them in your milk Enterprise.

	Item	Quantity	Year purchased/ Received	Unit cost (Tshs)	Total Costs
1	Milking containers				
2	Sprayer				
3	Feeding equipment				
4	Water drinking equipment				
5	Containers for storing milk				
6	Milk carrying containers				
7	Milk filtering equipment				
8	Milk transporting facility (Specify)……				
9	Others (specify)……				

35. Cost of other materials used for supporting milking and milk hygiene

Item	Quantity used per year	price per unit (TSh.)	Number of cows milked	Cost per year
1.Towel				
2.Teats softening cream				
3. Soap				
4. Teat Dips				

36. What is the pasture management cost per year (Tshs)……

37. What is the size of the piece of land is allocated for each of the following type of grasses 1. Rhodes… 2. Setaria…3. Guatemala…4.Elephant …5.Others (specify)…….

38. Please indicate the quantity/ and price estimate for feeding cows per day in each item indicated in the table?

In put type	Quantity used in a given period	Period	Price per unit (Tshs.)	Quantity per year	Total Cost per year
1.Purchased Hay/fodder/ silage					
2.Own produced Hay/fodder/Silage					
3.Local Feeds purchased					
• Maize bran (bags)					
• Sunflower seed cake(tins)					
• Others (specify)……					
4.Own produced local feed					
❖ Maize bran (bags)					
❖ Sunflower seed cake (tins)					
❖ Others (specify)……					
5.Concentrate purchased (kg)					
Mineral & Normal salt					
➢ Normal salt (Kg)					
➢ Powdered mineral salt (Kg)					
➢ Animal Lick Rock salt (Kg)					
Total					

39. What is the average price per each item of veterinary services that you received.....

S/N	Item	Drugs per dose/ unit	Number of cows involved	Veterinary doctor per service Tsh	Veterinary doctor per cow(Tshs)	Frequency of use Per year	Cost per year
1	Deworming						
	Injection						
	Oral suspension						
2	Ticks control						
3	Vaccination (specify) a.						
	b.						
4	Artificial inseminations						
5	Treatment of diseases (specify) a. b.						
6	Tsetse flies control						

40. What type of breading method do you use?

1=Natural breeding 2= Artificial insemination 3=Both Natural and Artificial Insemination

41. What is the breading price per service…..……..

42. What type of feeding system do you practice? {1} Zero grazing {2} Semi grazing

{3}Grazing

43. What size of pasture land do you own…….acres

44. What is the average cost do you incur in milk marketing?

Item	Milk marketed (litres) per day	price per day(Tshs)	Total cost for Volume of milk per Day/week/month/year
1. Communication			
2. Transportation			
3. Tax/levies			
Total			

45. What is the distance of your enterprise from the market……Kms

46. Do you belong to any dairy association/group? 0=Yes, 1=No { }

47. Who attends your dairy cows?

[1]=Family labour only [2] =Hired labour only [3]= Family and Hired Labour

48. If hired labour how do you pay them?

[1]=per hour, [2] = per day,[3]= per week,[4]= per month

49. What is the wage rate……...……...…Tshs

50. Please indicate the labour price estimate used in each of the operation indicated.

S/N	Item/ operation	Hired labour used(Man days)	Hours used by Family labour per day/week	Man days used by Family Labour	price per (Man day)
Grazing/ Grass cutting and Feeding					
Collection of local feeds					
Milking					
Spraying					
Marketing/selling					
Shed cleaning					
Others (specify)					
Total					

D: Information on Milk Marketing

51. Where do you sell your milk?

1= Neighbours, 2= Milk collectors, 3=Milk processors, 4= Restaurants, 5=Consumers

6= others (specify)…….....

52. What is the price per litre at your selling point(s)? (Tsh)……

53. Who determines the price of milk you have been selling? 1= Government, 2= Yourself (as milk producers), 3=Processors, 4=collectors, 5= consumers

54. What system do you use for selling your milk?

1= Monthly billing, 2=Two weeks billing, 3=Cash on delivery,

4= others (specify)……

55. Are you satisfied with the price offered at your delivery point? 1= Yes 2= No

56. If No, what price level do you think will satisfy you? ……

E: Future Prospects, Challenges And Recommendations

57. What is your future prospect about your dairy enterprise……

58. What are the common problems that you normally face in running you dairy enterprise……

59. What do you think should be done the government and other actors in the milk value chain in order to develop dairy sector in our country.....

60. Do you have any comment/experience to share in dairy cow keeping? …….

Appendix 2: Transformation of fixed assets cost.

Asset	Life span	Cost(Tshs)	Salvage value(Tshs)	Depreciation cost
Hut	5 years	420,000	30,000	78,000
Bicycle	7 years	120,00	0	17,143
Milk can	7years	30,000	9,000	3,000
Sprayers	5years	90,000	0	18,000
Total		630,000	39,000	116,143

Appendix 3: Translog Profit Function Results

Variable	Coefficient	P-value
Ln feed cost	-0.44145	0.0000
Ln Health cost	-0.02219	0.0000
Ln Labour cost	-0.36081	0.5320
Ln Herd size	-0.03674	0.0000
1/2ln feedcost^2	-0.32993	0.0000
1/2ln healthcost^2	-0.1771	0.0000
1/2ln labour cost^2	-0.10820	0.0109
1/2ln herd size^2	-0.07641	0.0000
Lnffeedc*lnhealthcost	-0.00744	0.0000
Lnfeedc*lnLabourcost	-0.00201	0.0000
Lnfeedc*lnherdsize	-0.06298	0.0106
Lnhealthc*lnLabourcost	-0.0742	0.0000
Lnhealthc*lnherdsize	-0.1438	0.0000
Lnlobourc*lnherdsize	-0.0160	0.0000
Constant	1.4227	0.0000
Gamma	0.3476	
Sigma squared	0.189	