SMALLHOLDER DAIRY FARMERS' TECHNICAL EFFICIENCY IN MILK PRODUCTION: CASE OF EPINAV DAIRY PROJECT IN NJOMBE DISTRICT, TANZANIA

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

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ABSTRACT

Smallholder dairy farming has been practiced in many parts of the world including Tanzania aiming at generating income from the sale of milk and providing alternative source of protein to people of all ages in the households. The objective of this study was to analyse technical efficiency of smallholder dairy farmers in EPINAV dairy project in Njombe District, Tanzania. Data were collected by using semi structured questionnaires administered to 120 smallholder dairy farmers randomly selected from 5 sampled villages. Gross margin and Stochastic Frontier were employed as tools of analysis to determine the mean gross profit per cow per year and technical efficiency per farm respectively. The results reveal that major cost structures comprise of initial investment, labour, and feeds costs. The mean gross profit per farmer per cow per year is low. The Stochastic Frontier Analysis revealed that smallholder dairy farmers technical efficiency range between 22% to 99% with mean of 68%. Experience of the dairy farmer negatively influenced inefficiency at 5% level of significance. It is concluded that majority of smallholder dairy farmers' are fairly efficient. The study recommends that smallholder dairy farmers need to organize themselves in groups for bulk purchases of inputs during high season. This will reduce unnecessary cost of transporting and price increase of inputs during low season. Policy that enhances farmers' learning through practical experiences is recommended for reduction of inefficiencies.

DECLARATION

I, A**DIEL PHALES MBILLU** do here by declare to the Senate of the Sokoine University of Agriculture that this report is my own original work and that it has neither been submitted nor concurrently being submitted in any other institution.

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The above declaration is confirmed

………………………………..   …………………….

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(Supervisor)

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DEDICATION

This valuable work is dedicated to my beloved mother Josephine Mbilu who laid down the foundation of my education which made me to be what I am today.

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LIST OF ABBREVIATIONS

AECF	Africa Enterprise Challenge Fund
d	Day
DADPS	District Agriculture Development Plans
DEA	Data Envelopment Analysis
EPINAV	Enhancing Pro-poor Innovation in Natural Resources and Agricultural Value Chains
FAO	Food and Agriculture Organization of the United Nations
FFCO	Farm & Food Care Ontario
GDP	Gross Domestic Product
kg	Kilogram
Max.	Maximum
MDGs	Millennium Development Goals
Min.	Minimum
MLFD	Ministry of Livestock and Fisheries Development
NJOLIFA	Njombe Livestock Farmers' Association
NSGRP	National Strategy for Growth and Reduction of Poverty
OLS	Ordinary Least Squares
PANTIL	Programme for Agricultural and Natural resources Transformation for Improved Livelihood
Stdev.	Standard deviation
T.E	Technical Efficiency
TAMPA	Tanzania Milk Processors Association

TDV	Tanzania Development Vision
TZS	Tanzanian Shilling
UN	United Nations
UNDP	United Nations Development Programme
URT	United Republic of Tanzania
Vetserv.	Veterinary services

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Tanzania Development Vision (TDV) 2025 describes six attributes of which the country is expected to attain by year 2025. One among those attributes is high quality livelihood (URT, 1999). The high quality livelihood among other targets focus on food self sufficiency and food security and absence of abject poverty. Similarly, the Millennium Development Goal number one also aims at eradication of extreme poverty and hunger by year 2015 (UN, 2000).

In order to achieve Tanzania development vision 2025 and millennium development goals (MDGs), Tanzania Planning Commission formulated the National Strategy for Growth and Reduction of Poverty (NSGRP). The NSGRP specified three core outcomes which are growth of economy and reduction of income poverty, improvement of quality of life and social well being and good governance and accountability (URT, 2005). The strategy identify that agriculture is the central to poverty reduction in general and hunger or food poverty in particular. It emphasizes on the increase in factor productivity focusing on technological change with particular attention to agricultural productivity. Different actors play different roles in implementation of NSGRP. Development partners have a role of provision of additional financial, technical and other support in implementation of the poverty reduction strategy (URT, 2005). In line with that role Norwegian government financed a five year Programme for Agricultural and Natural Resources Transformation for Improved Livelihoods (PANTIL) beginning year 2005. This was a collaborative programme between Sokoine University of Agriculture (SUA) and Norwegian institutions, namely, University of Life Sciences (UMB) and Collage of Veterinary Science (NVH). The main objective of PANTIL has been to contribute to national goal of reducing poverty for improved people's livelihoods within the framework of NSGRP, TDV and MDGs.

During the implementation of the PANTIL programme several projects were implemented in pilot villages located across 18 districts in ten regions of Eastern, Southern highlands, Coast, Northern and Lake Zones in Tanzania. In southern highlands the PANTIL project of Dairy cows was being implemented in 3 villages of Njombe district which were Nundu, Itulike and Ibumila. In these villages smallholder dairy farmers were trained in preparation and use of fodder tree gardens, hay making and establishment of pasture, milking practices, handling, processing and marketing. One among several successes of the PANTIL dairy project noted was increased milk production from a range of 5 to 6 litres per cow per day to a range of 12 to 18 litres per cow per day. Despite the successes noted, midterm review identified PANTIL main challenge being the need to disseminate and scale up SUA and PANTIL's transfer of appropriate technologies to a wider audience and to the national level.

In order to address the challenge of PANTIL the Enhancement Programme for Pro poor Innovation in Natural resources and Agricultural Value chains (EPINAV) was started in 2010. EPINAV project in Njombe aims at upscalling and outscalling best practices technologies demonstrated during PANTIL project in dairy cow to a wider population in Njombe district, Southern Highlands and Tanzania in general (SUA, 2011). Through EPINAV project two farmer field schools were established with the aim of training farmers in various productivity enhancing and poverty reducing technologies. The farmer empowerment focus facilitated the formation of 12 dairy farmer groups and trained over 200 dairy farmers through farmer field schools and farmer forums.

1.2 Dairy sub-sector in Tanzania

In Tanzania out of 21 million cattle about 680 000 are improved dairy cattle mainly crosses of Friesian, Jersey and Ayrshine breeds with the Tanzanian Short Horn Zebu. The improved dairy breeds are mainly kept by smallholder dairy farmers concentrated mainly in urban, peri-urban and rural areas of Arusha, Kilimanjaro, Tanga, Iringa, Kagera, Dar es Salaam and Mbeya (URT, 2006). The dairy industry contributed about 30% of the 4.7 % of livestock industry's contribution to Gross Domestic Product (GDP) in 2007/08 which is equivalent to 1.4% of GDP contribution (URT, 2012). The sub-sector has a great potential for improving the living standards of the people and contributing towards reduction of poverty through improved nutrition, arising from consumption of milk and incomes generated from sale of milk and milk products. It is estimated that over 1.3 million households in Tanzania benefit through dairy production (TechnoServe, 2012).

The total milk production is currently estimated to be 2.5 billion litres per year (URT, 2012). The growth in the sector has been mainly contributed by increase in herd size rather than in productivity per head (MLFD, 2011). It has been reported that milk processing industries are operating under capacity due to the low and fluctuating supply of raw milk (URT, 2006). While the processing plants are operating under capacity, reports show that in the year 2008 about 26.14 million litres of milk which accounted for 48% of processed milk were imported in the country causing competition between local and imported milk products (MLFD, 2011).

1. 3 Problem Statement

Dairy industry has greater potential for improving the living standards of people through improved nutrition arising from milk consumption, provision of employment, and incomes gained from sale of milk and milk products (MLFD, 2011). The total milk production is currently estimated to be 2.5 billion litres per year (URT, 2012). The average milk production for improved dairy cow in Tanzania is estimated to be 6 litres per cow/d (URT, 2012) contrary to the recommended international standard of 30 litres per cow/d (FFCO, 2012). Reports from Food and Agriculture Organization (FAO) (2012) indicate that in the period 2008/13 fresh milk production from dairy cows has been growing at an average rate of 7% only. The growth in the sector has been mainly contributed by increase in herd size rather than in productivity per head (MLFD, 2011). It is obvious from this information that dairy sector has been experiencing low yield of milk per cow.

Due to low milk production, Tanzania has been importing milk to supplement milk production deficit in the country. Moreover, low production of milk has led into underutilization of the milk processing capacity in the country. The national milk processing capacity is estimated to be 410 500 litres/ d, but the capacity utilization is about 30% only (MLFD, 2011). The low performance in milk processing which has been caused by low productivity of dairy cows makes the dairy industry uncompetitive in the region and the world in general. The available estimates indicate that dairy products imports have been increasing at the rate of 9% annually (TAMPA, 2011).

Tanzanian government and Non Governmental Organizations (NGO's) have made several efforts to improve performance and productivity of the dairy sector. The efforts which have been undertaken at different levels to promote dairy sector in Tanzania includes upgrading of indigenous cattle by crossing with exotic breeds, privatization of National Ranches, establishment of Tanzania dairy board, establishment of dairy industry act in 2004 and establishment of Artificial Insemination centres. NGOs such as Caritas Tanzania and Heifer International have been helping smallholder dairy farmers to acquire exotic dairy breeds through pass on credit programme. Among all these efforts none of them paid attention to improvement of productivity and efficiency.

Researches done in Tanzania particularly in dairy sector have paid more attention in milk marketing (Chilimila, 2007; Mwijarubi, 2007; Rumanya, 2007) and dairy animal health (Mdegela *et al*., 2007). Little is known about how efficiently smallholder dairy farmers' use limited resources in producing milk.

Report from MLFD (2011) attributed low milk production to the undeveloped production system. In efforts to solve the problem of undeveloped milk production system, PANTIL and its successor EPINAV trained farmers in milk production technologies in order to improve smallholder dairy farmers' performance and productivity. Among the technologies demonstrated by EPINAV included pasture production, fodders conservation and technologies utilization, improved feeding practices, improved milking, milk handling techniques, control of mastitis and milk borne disease, milk quality control and processing (SUA, 2011).

Though farmers apply these technologies and best practices disseminated by EPINAV and have realized increase in milk yield, yet there is no empirical evidence with regard to performance of these technologies in terms of technical efficiency.

This study aimed to generate useful information through analysis of gross margin and technical efficiency of smallholder dairy farmers that can be used as the basis for further improvement of performance of the dairy sector particularly in Njombe district and Tanzania in general.

1.4 Problem Justification

The purpose of this study is to analyse efficiency and actors' profitability in the cow dairy value chain in Njombe district in order to provide useful information for improving smallholder dairy farmers' efficiency and profitability of all key actors in Njombe EPINAV dairy project. The information from this study will help dairy farmers, value chain actors, policy makers and researchers to upgrade the dairy value chain so that it generates more income and hence reduce poverty. This study is in line with Tanzania national livestock development policy of 2006, where by objective number one aims at encouraging the development of commercially oriented, efficient and internationally competitive livestock industry. Moreover, the study is in line with

Tanzania Development Vision 2025 particularly targets number one and five, Livestock Development Program of 2011, Millennium Development Goal number one and National Strategy for Growth and Reduction of Poverty (NSGRP) cluster number one.

1.5 Objectives of the Study

1.5.1 Overall objective

The overall objective of the study was to analyse technical efficiency for smallholder dairy farmers participating in EPINAV dairy project in Njombe district in order to provide useful information for improving their performance.

1.5.2 Specific objectives

The specific objectives of the study were to:

i. Establish major cost structures of smallholder dairy farmers.
ii. Estimate gross profit margin of smallholder dairy farmers.
iii. Analyse smallholder dairy farmers' technical efficiency.
iv. Determine social economic factors influencing smallholder dairy farmers' technical efficiency.

1.5.3 Research questions

(a) What are the major cost structure components facing smallholder dairy farmers in Njombe district?

(b) What is the mean gross profit level of a smallholder dairy farmers' under the EPINAV project in Njombe district?

1.5.4 Research hypotheses

(a) Smallholder dairy farmers in Njombe EPINAV project are technically efficient.

(b) Smallholder dairy farmers' technical efficiency is not significantly influenced by social economic factors.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Definition of Smallholder Dairy Farmer

The definition of smallholder dairy farmers differs between countries and agro ecological zones. In favourable areas of Sub-Saharan Africa with high population densities smallholder dairy farmers may manage up to 10 heads of dairy cows (FAO, 2008). According to Devendra (2001) small holder dairy farmers in developing countries keep between 2-15 cows most of them being the crossbreeds of local and pure breeds in which the milk production is the major component of farm income. In Tanzania it is reported that smallholder dairy farmers keep between 1-5 dairy cattle for the purpose of producing milk (MLFD, 2011). Therefore it is obvious that there is no standard definition of smallholder dairy farmer, this study define small holder dairy farmer as the one who keeps between 1-10 dairy cows for commercial milk production so as to generate income.

2.2 Theoretical Concept of Efficiency

Efficiency in production is one of the widely used concepts in economic analysis.

Kumbhakar and Lovell (2000) defined efficiency as the degree of success which producers achieve in allocating the available inputs and the outputs they produce, in order to achieve their goals. Economic Efficiency is defined as the product of technical and allocative efficiency (price efficiency). It can be interpreted as the potential reduction in production costs (cost efficiency) or the potential increase in revenue (revenue efficiency) that a farm could apply in order to operate at the point of technical and allocative efficiency. Farrell (1957) in his earliest work on production efficiency analysis founded the two concepts which are technical and allocative efficiency.

2.2.1 Technical efficiency (T.E)

Technical Efficiency refers to the achievement of the maximum potential output from given sets of inputs, taking into account the underlying production function. 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 firm (Battese, 1992).

Technical efficiency can be measured within two main frameworks which are input and output-oriented. In an input-oriented framework, technical efficiency provides the potential input reduction that a farm could apply without reducing its output level. In an output-oriented framework, technical efficiency provides information about the potential output increase that a farm could gain without increasing its use of inputs. This work will apply input oriented scheme for measuring efficiency as it was introduced by Farrell in 1957.

2.2.2 Allocative efficiency (AE)

Allocative efficiency simply is the extent to which farmers equate the marginal value product (MVP) of a factor of production to its price (Px). It measures the distance between the firm and the point of maximum profitability, given market prices of inputs and outputs. In other words, the allocative efficiency shows whether the use of different proportions of production factors guarantees the attainment of maximum production with a particular market price. Allocative efficiency determines how well an enterprise uses production inputs optimally in the right combination to maximize profits (Inoni, 2007). Thus, the allocatively efficient level of production is where the farm operates at the least-cost combination of inputs. Most studies have been using gains obtained by varying the input ratios based on assumptions about the future price structure of products say milk output and factor markets. This study follows Chukwuji *et al*. (2006) reviewed assumptions used by farmers to allocate resources for profit maximization. Such assumptions include, dairy farmers choose the best combination (low costs) of inputs to produce profit maximizing output level; there is perfect competition in input and output markets; producers are price takers and assumed to have perfect market information; all inputs are of the same quality from all producers in the market. Allocative efficiency can also be defined as the ratio between total costs of producing a unit of output using actual factor proportions in a technically efficient manner, and total costs of producing a unit of output using optimal factor proportions in a technically efficient manner. Thus for the farm to maximize profit, under perfectly competitive markets, which requires that the extra revenue (Marginal Value Product) generated from the employment of an extra unit of a resource must be equal to its unit cost (Marginal Cost = unit price of input) (Chukwuji *et al*., 2006). In short if the farm is to allocate resources efficiently and maximize its profits, the condition of MVP = MC should be achieved.

2.2.3 Graphical explanation of technical and allocative efficiency

The concept of producing maximum output with given level of inputs (technical efficiency) and optimal use of these resources to maximize profit given the inputs prices (allocative efficiency) can be illustrated graphically as shown in Fig. 1. This can be explained using a simple example of two inputs (x_1, x_2) and one output (y)

production process as described in Fig.1. Let the production frontier be represented by an isoquant AB that captures the minimum combination of inputs needed to produce a unit of output y. Let x_1 and x_2 be the two inputs used to obtain one output (Y*). Thus, Px Px' will be the isocost line, whose slope is the ratio of input prices (-Px1/Px2)

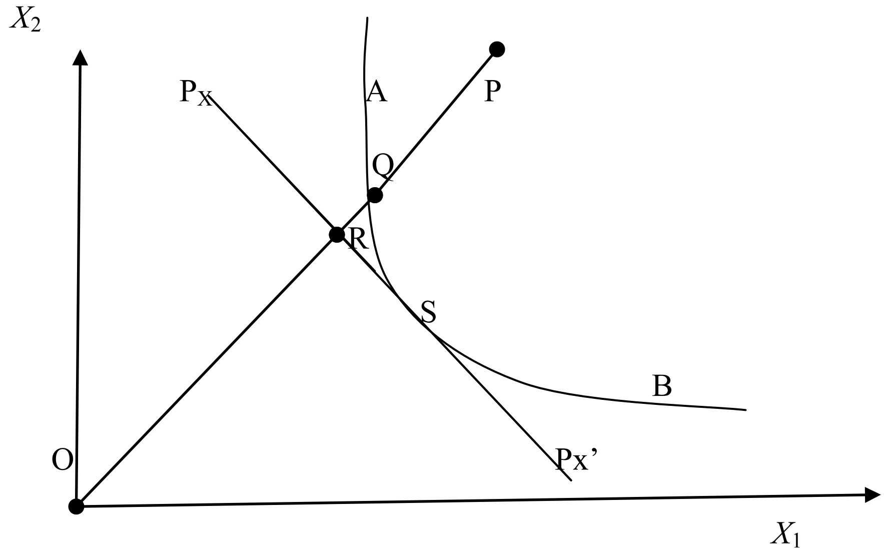

Figure 1: Input oriented scheme measure of technical and allocative efficiency
Source: Coelli *et al.* (2005)

Every combination of inputs along the isoquant is considered to be technically efficient while any point above and to the right of it is technically inefficient (Fig.1). In other words, units that are technically efficient will be located at the frontier AB, while those that are below the frontier are not appearing since they obtain less output than technically possible. The technical efficiency measure can be estimated as the relationship between the obtained output and what would be attained if the unit were located at the frontier. Point P is the observed farm that uses two input quantities to obtain the output. The isoquant AB represents the various combinations of the two factors that a perfectly efficient farm might use to produce the same output. So, the farm Q represents an efficient farm that produces the same output as P but using a fraction OQ/OP of each factor.

Farm P and farm Q use the two inputs in the same ratio. However, farm P produces the same amount as Q but uses a fraction OP/OQ as much of each input. It can also be interpreted as farm Q can produce OP/OQ times as much output as firm P from the same inputs. The ratio OQ/OP is defined as the technical efficiency score of farm P. The ratio OQ/OP equals one minus QP/OP thus it takes a value between zero and one. Therefore, a farm is considered technically efficient if it has an efficiency score of one and technically inefficient if it has an efficiency score lower than one. If information on market price is known and cost minimization is assumed in such a way that the input price ratio is reflected by the slope of the isocost line, allocative efficiency can be derived from the unit isoquant. Point S is the optimal method of production and, as Q, this point represent 100% of technical efficiency. However, the cost of production at Q will be only a fraction, OR/OQ of those at **S**. This is the measure of allocative efficiency (AE). Therefore, the least-cost combination of inputs that produces (y*) is given by point **S** (the point where the marginal rate of technical substitution is equal to the input price ratio (Px1/Px2). Thus the firm producing at point **S** is said to be technically and allocativelly efficient. When the farm is technically and allocativelly efficient, then it is said to be cost effective (Chukwuji *et al.,* 2006).

2.3 Approaches for Analysing Farm Efficiency

The relationship between performance of the farm and efficiency has been analysed under different points of view and using different techniques in investigating the main determinants of efficiency or inefficiency of a production units. There are two main approaches used to analyse efficiency of the farm which are non-parametric and parametric methods.

2.3.1 The non- parametric method

The widely used non-parametric method is Data Envelopment Analysis (DEA). DEA is based on a finite sample of observed production units; it uses a linear programming method and does not need to estimate a pre-established functional form. It follows the Farrell approach (1957) and was originally proposed by Charnes *et al.* (1978). DEA constructs an efficient frontier using the best performing farm business of the sample. The major drawbacks of DEA are high sensitivity of results to outliers and sampling variation, non-specification of functional form and inability to distinguish between technical inefficiency and Statistical noise effects (Cesaro *et al*., 2009). DEA does not provide a room for a researcher to test hypotheses about the significance of the coefficients estimated.

2.3.2 Parametric methods

The stochastic frontier estimation is a parametric approach that considers the deviation from the frontier as due to the random component reflecting measurement error and statistical noise (Ogundele and Okoruwa, 2006). Stochastic frontier analysis of efficiency technique was first proposed independently by Aigner *et al*. (1977) and

Meeusen and Vanden Broeck (1977). When DEA and Stochastic frontier model are compared in terms of their appropriateness in studies related to agricultural sector, Stochastic frontier seems to be more appropriate because of its ability to deal with stochastic noise, accommodate traditional hypothesis testing, and allows single step estimation of inefficiency effects (Kumbhakar and Lovell, 2000). The major weakness of stochastic frontier is lack of a priori justification for the selection of a particular distributional form for the one-sided inefficiency term.

Despite the weakness pointed out, still stochastic frontier approach remains to be the most appropriate model for agricultural related studies (Kumbhakar and Lovell, 2000). This study will use stochastic frontier analysis (SFA) in analyzing efficiency of smallholder dairy farmers. This technique is adopted due to its flexibility, ability to decompose error term into two parts one being symmetric which captures stochastic effects outside the control of the dairy farmer and another being technical inefficiency of the dairy farmer.

2.4 Recent Studies which Used Stochastic Frontier Analysis to Estimate Technical Efficiency

The stochastic frontier approach is one of the widely used parametric models in determining efficiency in different sectors of the economy. Sharma and Singh (2011) estimated technical efficiency in dairy sector in India using stochastic production frontier. The result revealed that the mean technical efficiency in dairying was about 69 %. In measuring economic efficiency for smallholder dairy cattle in marginal zones of Kenya; Karoi *et al*. (2010) used stochastic frontier where the findings indicated that the cost inefficiency ranged from 0.01% to 81.11% with mean of

27.45%. Lapar *et al.* (2005) used stochastic cost frontier to estimate cost efficiency in smallholder dairy farmers in Northeast Thailand where the findings indicated that cost could be reduced by 26% on average. In Tanzania Mlote *et al.* (2013) in their study of technical efficiency of beef cattle fattening farmers in the lake zone they applied stochastic frontier approach and reported mean technical efficiency of 91% among the beef cattle fattening operators.

2.5 Measurement of Technical Efficiency

The level of technical efficiency of a particular firm is characterised by the relationship between realized output and some ideal or potential output (Greene, 1993). The measurement of firm specific technical efficiency is based upon deviations of observed output from the best production or efficient production frontier. If a firm's realized output point lies on the frontier it is perfectly efficient. If it lies below the frontier then it is technically inefficient. The ratio of the actual output to potential output production defines the level of efficiency of the individual firm.

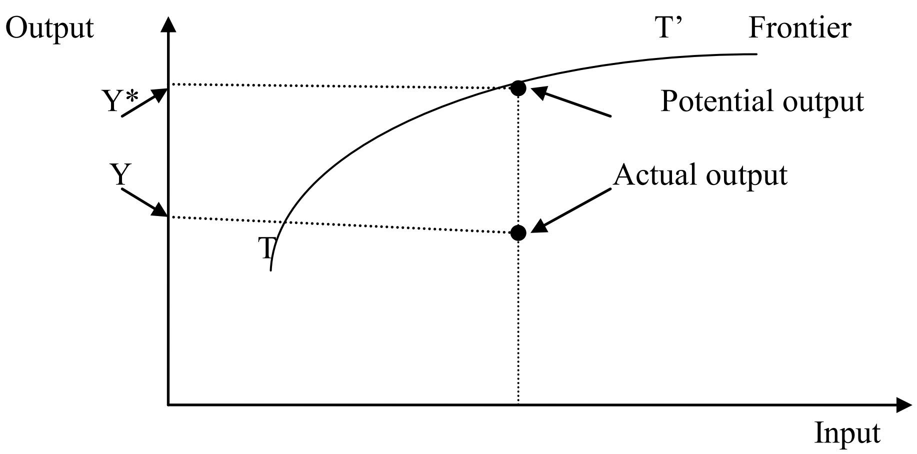

Figure 2: Stochastic production frontier curve showing measurement of technical efficiency

Source: Adapted from Pascoe and Mardle (2003)

From the Stochastic frontier curve given in Fig. 2, technical efficiency can be described as;

*T. Ei=Yi/Y**

$$T.Ei = \frac{f(x_{ij}; B).e^{v_i - u_i}}{f(x_{ij}; B).e^{v_i}}$$

$$T.Ei = e^{-u_i}$$

Technical inefficiency =1-T.E*i*

Because Y*i* is always ≤ Y*, the T.E index exists between 0 and 1.

The full technically efficient smallholder dairy farmer score 1 and any score less than 1 indicates technical inefficiency in production of the given output.

2.6 Determinants of Milk Output

The literature indicates that many studies use less or more similar input factors when they estimate technical efficiency of dairy farmers. The commonly used in put factors include feed, labour, expenditure on veterinary services, herd size, roughage and mineral salts and other variable depending on the nature of the study. Some of these studies are Mugambi *et al*. (2014) who used roughage, concentrate feed, and mineral supplements as input factors in estimating milk production efficiency in Embu and Meru counties of Kenya. Labour in man days was used by Rahman *et al.* (2012) as an input variable in analysing technical efficiency of rice farmers in Bangladesh. Kibaara and Kavoi (2012) also used human labour as input factor in analyzing technical efficiency of maize production in Kenya. In Ethiopia, Wuibenel and Ehui (2006) used cost on veterinary services, labour (man days) and roughage as input variables in the analysis of technical efficiency of smallholder dairy farmers in central Ethiopian highlands.

2.7 Factors Influencing Technical Inefficiency

In the production process farmers normally achieve different levels of output for the same given input bundles. Due to the differences in efficiency levels among farmers, it is appropriate to determine why some producers do achieve relatively high efficiency whilst others are technically less efficient. Variation in the T.E of producers may arise from socio-economic, managerial decisions and farm specific characteristics that affect the ability of the farmers to adequately use the existing resources under the available production technology (Liu and Juzhong, 2000).

These characteristics are like education, economic status, experience and keeping farm records. However, these characteristics vary from one farm to another and from one country to another. The body of literature contains several studies which explored the effect of social economic characteristics in influencing efficiency of farmers in various farm enterprises in crops and livestock dairy both in developed and developing countries. Kibaara and Kavoi (2012) in their study of technical efficiency in maize production in Kenya reported that education level of the household head has significantly positive influence on efficiency of the farmer. Likewise, Nganga *et al* (2010) revealed that education and experience of smallholder dairy farmer in Kenya influences negatively profit inefficiency. Furthermore, Mlote *et al* (2013) reported similar results in their study of estimating technical efficiency of small scale beef fattening in the lake zone in Tanzania. Nevertheless, Battese and Coelli (1995) in their study of a model for technical inefficiency effects for paddy farmers in Indian village reported that education increases inefficiency. Moreover, contradicting results were reported by Uzmay *et al* (2009) whereby in their study of social factors affecting the technical efficiency in dairy cattle in Turkey education was reported to have no significant positive influence on technical efficiency.

Many studies have identified that number of extension visits has significant positive contribution to efficiency (Kavoi *et al*., 2010; Mlote *et al*., 2013). However, in Njombe EPINAV dairy project it is not clearly known how extension visit improves efficiency when farmers are empowered with farm production and management skills. Karoi *et al* (2010) confirmed results of other studies that keeping farm records for smallholder dairy farmers in Kenya has positive influence on efficiency.

This study aimed at assessing the significance of this variable in influencing technical efficiency of smallholder dairy farmers in Njombe EPINAV dairy project.While literature provides a mixed results on the effects of education in influencing technical efficiency, the influence of economic status which determine the means by which a farmer acquire the first cow. The pass on credit is the means designed to help poor families to acquire a dairy cow from his/her neighbour in the programme. Smallholder dairy farmers who acquire cow through this means have limited choice of better breed. Farmers who start dairying using their own capital to acquire the dairy cow are having wide choice of better breed of dairy cows. Thus, they are assumed to be more efficient than those who get the start up cow through pass on credit programme. There is no known study that explored the influence of this proxy indicator of economic status to the technical efficiency. This study attempts to fill that gap.

CHAPTER THREE

3.0 METHODOLOGY

3.1 Description of the Study Area

The study was conducted in Njombe district in Njombe region. The district was chosen due to the fact that it is located 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). Moreover, Njombe district is one of the districts where EPINAV project of up-scaling, out-scaling technologies for enhancing integrated dairy production system is being implemented. Njombe district is located in 09^{0} 20'S and 034^{0} 46'E and the topography ranges between 100metres to 200metres above sea level. The main economic activities carried out are growing crops, keeping livestock, forestation and small businesses. The major crops grown are maize, beans and Irish potatoes where major livestock kept are cows, goats, pigs and chickens.

3.2 Research Design

The cross sectional research design was used where data were collected at one point in time to give a full picture of smallholder dairy farmers' performance in terms of cost structure, profitability and technical efficiency in Njombe district.

3.3 Sampling Methods and Data Collection

3.3.1 Sample size determination

According to Miaoulis and Michener (1976) there are three criteria that need to be specified in order to determine appropriate sample size. These criteria are the level of precision, the level of confidence or risk and the degree of variability in the attributes being measured. Cochran (1977) specified a formula for calculating sample size which included all the three criteria as follows;

$$\eta_o = \frac{Z^2 * p * (1 - p)}{e^2}$$

Where;

η_o= initial sample size, z=the abscissa of the normal curve that cuts off an area α at the tails (confidence level), e= acceptable sampling error (level of precision),

p= the estimated proportion of an attribute that is present in the population.

The confidence level in this study was set as z=1.96 (at α=0.025), while the degree of precision e=0.05 and the degree of variability was assumed to be maximum at p=0.5.

The initial sample size was then calculated using the formula above as follows;

$$\eta_o = \frac{1.96^2 * 0.5 * (1 - 0.5)}{0.05^2} \approx 384$$

Information from Njombe livestock famers' association (NJOLIFA) office obtained prior to data collection exercise indicated that there were 174 smallholder dairy farmers with lactating cows from July/2012 to June/2013. This population size was used to calculate initial sample size. According to Cochran (1977) when the sample size is greater than 5% of the population, then the adjusted sample size formula can be used to calculate the adjusted sample size. The adjusted sample size formula is expressed as;

$$\eta_1 = \frac{\eta_0}{1 + \frac{\eta_0}{N}}$$

Where η_1= adjusted sample size, η_o=initial sample size and N=Population size.

The equation above was used to calculate the adjusted sample size where the values were taken to be η_o=384 and N=174 and the calculation were as follows;

$$\eta_1 = \frac{384}{1 + \frac{384}{174}} = 119.74 \approx 120$$

Therefore the sample size used in this study was 120.

3.3.2 Sampling methods

This study firstly involved a purposive sampling of 5 villages based on the relatively high prevalence of smallholder dairy farmers and participation in the EPINAV dairy project. The villages selected were Nundu, Itulike, Kilenzi, Ibumila and Maduma. The second stage involved determination of the proportions and number of respondents who would be drawn from each village to constitute the required sample size. The third stage involved simple random selection of respondents from each village based on the list of dairy farmers who produced milk in the previous milk production year June 2012/13 provided by the NJOLIFA group leader at the village level.

3.3.3 Sampling frame and sample distribution

The list of cow milk producers participating in EPINAV dairy project which was obtained from group secretary available in each village, was the sampling frame used for this study. The proportions of farmers selected from each village are presented in Table 1.

Table 1: Distribution of sampled farmers by village (n=120)

Village	Number of respondents	Percent
Ibumila	28	23
Itulike	30	25
Kilenzi	19	16
Maduma	13	11
Nundu	30	25
Total	**120**	**100**

3.3.4 Data collection

The study collected both primary and secondary data. Primary data were collected using Participatory Rapid Appraisal (PRA) methods and semi-structured questionnaire surveys. A pilot study was conducted in the study area to pre-test the questionnaires so as to check relevance of the questions before the survey. Data were collected through face to face interviews conducted by the principal researcher with assistance of two local extension officers who were well trained before data collection exercise.

3.4 Data Analysis

Cost structures were analysed using Excel computer programme where mean costs for major cost structures were established. The mean gross profit margin of the smallholder dairy farmers was determined using gross margin analysis. Parameters of the stochastic frontier production function model were estimated using stochastic Frontier 4.1 statistical software developed by Coelli (1996).

3.4.1 Analysis of the cost structures

Data collected on various components of the cost were classified into two major categories of fixed and variable costs. This categorization was aimed at simplifying estimation of different cost components and also to provide for meaningful interpretation of the results.

3.4.1.1 Variable costs

The variable costs included the cost of labour, veterinary services, maize bran, sunflower seed cake, minerals, milking utensils and transportation cost. The labour cost included family labour and hired labour. The family labour cost was calculated on the basis of payment that could be made if a similar activity of the dairy farm could be done by using hired labour.

The veterinary services cost component included, cost of drugs for treatment of diseases per year, cost of hiring bull service for natural insemination, cost of purchasing teat dips and milking jelly, vaccination cost and cost of buying drugs for ticks control and de-worming. Farmers normally have different skills for managing heath care of their dairy animals. Some farmers purchase the drugs for treatment of their diseased animals and administer treatment to the cows in their own. In this case cost of administering treatment was obtained through asking farmers how much it would have been paid in case hired labour would have been used. On the other hand, for those farmers who used hired labour in treatment of diseases and other services related to health care services of animals the cost of labour was estimated through multiplication of frequency of administering a particular service and labour charge per each service provided.

Cost of maize bran and sunflower seed cake was calculated by taking number of tins (local unit) spent by the given farm to feed milking cows in the year and multiplying by their respective average prices. Mineral cost was quantified through multiplication of price of mineral per kg and quantity spent by a given farm per year. The variable costs were then analyzed using excel computer program and presented using a pie chart.

3.4.1.2 Dairy cow investment cost

Investment cost refers to initial cost of establishing a dairy enterprise. These costs comprise of initial cost of acquiring a dairy cow, cost of construction of a dairy shed, cost of pasture establishment, cost of sprayer and cost of transportation facility. These costs were calculated on the basis of buying price and then the average proportions of investment cost structures established.

3.4.2 Gross margin analysis

Gross margin is the difference between revenues (Quantities of sales time prices the customer pay) and the total variable cost incurred in production and delivery of the product/ service. Gross profit margin analysis aimed at determining mean gross profits obtained by an average farmer per cow per year in milk production in the study area.

The gross margin was calculated as follows:

$GMi = TRi - TVCi$……………………………………………………………..(1)

Whereby;

GMi = Gross margin of a farmer i per cow per year,

TRi = Total revenue of a farmer *i* per cow per year,

TVCi = Total variable cost of a farmer *i* per cow per year.

In order to achieve this objective information on the following variables were collected. These were quantity of milk produced per farm per year, number of lactating dairy cows per farm per year and price of milk in Tanzanian Shillings per litre sold to different marketing channels. This information enabled the quantification of the total revenue (TR).

The major variables which were necessary for the quantification of the total variable costs (TVC) were; cost of feeds, veterinary services, drugs and insemination, labour, milking jelly and milking utensils. The variable cost of feeds consisted expenditure on maize bran, sunflower seed cake, leaf meal and minerals. Information about prices in (TZS) and quantity in (kg) on these feed variables were collected from each dairy farmer and were used to compute the average farm feed cost per farm as well as per cow.

3.4.3 Stochastic frontier approach

The technical efficiency of each individual dairy farmer was estimated using stochastic frontier production function, which is generally expressed as;

$$\boldsymbol{Y_i = f(x_i, B_i)e^{v_i - u_i}} \quad \text{.................................. ....} \quad (2)$$

Where Y_i =output for the ith sample farm, f ( ) = appropriate functional form, x_i= vector of inputs, *Bi*=vector of unknown parameters associated with explanatory variables in the production function, v_i = random error term and u_i= non negative one sided error term that measures inefficiency.

3.4.4 Model specifications

Translog and Cobb-Douglas are two functional forms which are commonly used to represent the stochastic frontier production functions. In order to select the best functional form that will provide adequate representation of the sample data hypothesis testing was conducted for the parameters of the stochastic production frontier. This helped to determine which one between the Cobb-Douglas and translog functional forms explained the best underlying production function. The Cobb-Douglas and translog production function models were specified as follows:

3.4.4.1 Cobb-Douglas stochastic production function model specification

Cobb-Douglas production function is generally expressed as;

$$lny_{it} = lnA + \sum_{i=1}^{n} \beta_i \, lnx_i + v_{it} - u_{it}$$

The Cobb-Douglas production function was specifically expressed as;

$$lnY_{it} = \beta_0+\beta_1 lnX_1+\beta_2 lnX_2+\beta_3 lnX_3+\beta_4 lnX_4+\beta_5 lnX_5+ V_{it} - U_{it} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. (3)$$

3.4.4.2 Translog stochastic production function model specification

The translog stochastic production function is generally expressed as;

$$lny_{it} = ln\,A + \sum_{i=1}^{n} \beta_i \, lnx_i + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} \beta_{ij}(lnx_i)(lnx_j) + v_{it} - u_{it}$$

The function was specifically expressed as;

$$lny_{it} = \beta_0 + \beta_1 lnx_1 + \beta_2 lnx_2 + \beta_3 lnx_3 + \beta_4 lnx_4 + \beta_5 lnx_5 + \beta_{12} lnx_1 lnx_2 + \beta_{13} lnx_1 lnx_3 + \beta_{14} lnx_1 lnx_4 + \beta_{15} lnx_1 lnx_5 + \beta_{23} lnx_2 lnx_3 + \beta_{24} lnx_2 lnx_4 + \beta_{25} lnx_2 lnx_5 + \beta_{34} lnx_3 lnx_4 + \beta_{35} lnx_3 lnx_5 + \beta_{45} lnx_4 lnx_5 + 1/2\beta_{11}(lnx_1)^2 + 1/2\beta_{22}(lnx_2)^2 + 1/2\beta_{33}(lnx_3)^2 + 1/2\beta_{44}(lnx_4)^2 + 1/2\beta_{55}(lnx_5)^2 + v_{it} - u_{it}$$

……………………………………………………………………………….(4)

Where the symmetrical condition holds: $\beta_{ij} = \beta_{ji}$

ln =Natural logarithm

The definition of variables and their unit of measure were as follows:

Yit= Volume of milk produced by i^{th} farm per year (Litres),

X_{1i} = Quantity of feeds (purchased or homemade concentrates) used by i^{th} farm per year (kg),

X_{2i} = Labour used by i^{th} farm per year (Man days),

X_{3i}=Herd size in i^{th} farm per year (number of lactating cows),

X_{4i} =Value of veterinary services (expenditure on veterinary services) for i^{th} farm per year (TZS),

X_{5i} =Quantity of roughage feeds for i^{th} farm per year (kg),

β_0=Constant,

β_i=Parameters to be estimated. Where i=1, 2...5.

V_i =Random error term which is assumed to be independently and identically distributed having N (0, δ_v^2) distribution and U_i=One sided error term, reflecting technical inefficiency which is assumed to be independent of V_i, such that U_i is non-negative truncation (at zero) of the normal distribution with mean U and variance δ^2.The relationship between technical efficiency and the factors influencing were estimated by using the inefficiency model.

3.4.5 Choice of the translog stochastic frontier production function

Cobb-Douglas and translog stochastic frontier production functions are widely used functional forms in estimating technical efficiency in agriculture. The literature indicates that each of them has its strengths and weaknesses. One of the strengths of Cobb Douglas production function is its simplicity in interpretation of the coefficients of the input variables. When the Cobb-Douglas production function is expressed in logarithmic form, coefficients of input variables are interpreted as elasticity of production. When translog production function is used then all variables of the stochastic frontier production function need to be transformed by dividing all variables by their mean so as the coefficients of the input variables could be interpreted as elasticity of production. Literature contains several efficiency studies which applied translog stochastic production function to determine efficiency of various firms in agriculture enterprises. Some of these studies were done by Wilson *et al*., (1998); Awudu and Huffman (2000), Awudu and Eberkin (2001) and Baten *et al.* (2009). In Africa some of the studies used this functional form include Mlote *et al.* (2013) and Kavoi *et al*. (2010).

In this study the choice of translog stochastic frontier production function was made after evaluation of models specified under Cobb-Douglas and translog production functions as presented by equation 3 and 4 respectively. This was done under the null hypothesis which stated that Cobb-Douglas production function provides an adequate representation of the data set. Statistically the hypothesis was stated as H_0***:*** *Bij=0* Maximum Likelihood Estimation was used to estimate parameters of stochastic production frontiers. The null hypothesis testing with regard to the appropriateness of the Cob-Douglas functional form was conducted using the generalized likelihood ratio (LR) test.

The generalized likelihood ratio was statistically defined by:

$$\lambda = -2[\ln(H_0)/\ln(H_1)]$$

$$\lambda = -2[LLH_0 - LLH_1] \ldots\ldots(5)$$

Where; LLH_0=Log likelihood of the restricted model (Cobb-Douglas Stochastic Production function) and LLH_1= Log likelihood of the unrestricted model (Translog Stochastic production function) and λ= Test statistic to be calculated. 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 degree of freedom equal to the number of restrictions under the null hypothesis model.

3.4.6 Technical inefficiency effect model

The technical inefficiency effect model is generally expressed as:

$$U_i = \delta_o + \sum_{i=1}^{n} \delta_i z_i$$

Where zi's are explanatory variables representing farmers specific characteristics on the technical efficiency in milk production. The inefficiency effect model was generally and specifically expressed as:

$U_{it}=\delta_0+\sum_{i=1}^{n}\delta_{it}z_{it}$

$U_{it}=Z_1\delta_1+Z_2\delta_2+Z_3\delta_3+Z_4\delta_4+Z_5\delta_5$……………………………………………………..……..…(6)

Where;

Z_1=Education of a farmer (measured in number of years of schooling)

Z_2=Experience of a farmer (years)

Z_3=Economic status of a farmer (dummy variable measured in terms of own capital=1, 0=otherwise)

Z_4=Farm records (dummy variable measured in 1= if a farmer kept farm record and 0= if a farmer did not keep a farm record)

Z_5=Number of extension visits (measured in number of contact between a farmer and extension service officer per year)

δ_0= constant and δ_1, δ_2, δ_3, δ_4, δ_5 are coefficients of variables assumed to influence inefficiency that are to be estimated.

3.4.7 Prior expectations of signs of variables influencing technical inefficiency

Education level of the smallholder dairy farmer is expected to reduce inefficiency in milk production. This is because more educated farmers have relatively higher ability of learning and applying correctly good dairy husbandry practices. Likewise the experience of the farmer in dairying is expected to reduce inefficiency 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 curative measures immediately, plan appropriate time of vaccination, feed properly and milk the cow accordingly. The variable economic status of the dairy farmer is also expected to influence inefficiency negatively. This means that those farmers who are relatively well off are expected to be more efficient as they have ability of buying sufficient and best quality inputs which are very essentials for milk production. 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. Table 2 provides a summary of variables which are sources of inefficiency and their prior expected signs.

Table 2: Expected signs of variables that are sources of inefficiency

Variable	**Parameter**	**Expected sign**
Education	δ_1	-
Experience	δ_2	-
Economic status	δ_3	-
Farm records	δ_4	-

The signs of coefficients of variables influencing efficiency are interpreted as positive sign indicates that a variable increases inefficiency while negative sign implies that a given variable decreases inefficiency.

The model for inefficiency was expressed in terms of (Coelli and Battese, 1996) as;

$\delta_s^2 = \delta_v^2 + \delta_u^2$……………………………………………………………………..(7)

$\gamma = \frac{\delta_u^2}{\delta_s^2}$ ……………………………………………………………………………… (8)

Where γ = inefficiency effects which lies within the limit defined by $0 \leq \gamma \leq 1$

If $\delta_u^2 = 0$ it means that γ=0 which implies that there is no inefficiency in the model.

Therefore the term U_{it} is irreverent and hence should be omitted in the stochastic production function models represented by equations 3 and 4. Before estimation of the translog stochastic production frontier model represented by equation 4 and inefficiency model presented by equation 6, it was worth to test various null hypotheses with regard to these models (Table 3).

Table 3: Hypotheses with regard to stochastic production function and inefficiency models

Null hypothesis	Mathematical expression
1.Technical inefficiency effects are absent in the model	$H_0: \gamma = \delta_0 = \delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = 0$
2.Technical inefficiency effects are not stochastic	$H_0: \gamma = 0$
3.Technical inefficiency effects are not influenced by farm specific factors	$H_0: \delta_0 = \delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = 0$
4.Inefficiency effect follows the half normal distribution	$H_0: u_0 = 0$

The value of γ was calculated using maximum likelihood estimates for parameters of the stochastic frontier models by using computer programme frontier version 4.1 developed by Coelli (1996). Then hypotheses testing were done to assess if the calculated values of γ are significantly different from zero at α=0.05 level of significance.

3.4.8 Estimations of parameters

This study followed the method of modelling both the stochastic and the technical inefficiency effects in terms of observable variables. The parameters of the stochastic production frontier can be estimated using Maximum Likelihood estimation under either two step analyses or one step analysis. In two step analysis the efficiency scores are firstly obtained and then predicted firm efficiency scores are regressed upon firm specific variables assumed to influence inefficiency. However, despite the long usefulness of the two step analysis, it has been viewed to violet the assumptions regarding independence of the inefficiency effects (Coelli, 1996). Due to the weakness of the two step analysis approach, in this study parameters of both stochastic production function and technical inefficiency model were estimated by method of Maximum Likelihood Estimation applying single step analysis as developed by Battese and Coelli (1992, 1995). Since data used came from cross sectional survey, the model used was time invariant stochastic frontier given a sample of 120 milk producers for one time period. The smallholder dairy farmers were assumed to produce a single output which is milk using labour, roughage, herd size, veterinary services and feeds (concentrate) as input variables. Roughage included fodders, hey and silage while feeds included maize bran, sunflower seedcake, minerals and leaf meal.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Social Economic Characteristics of the Respondents

4.1.1 Sex of respondents

The results indicate that among the sampled population, 42.5 % of all respondents were male and 57.5% were female (Table 4). This finding implies women participate more in the dairy enterprises activities compared to the men. This result conform with that of Kimaro *et al.* (2013) where in the study of gender roles in smallholder dairy farming in Arumeru district in Tanzania they found low participation of men in managing dairy enterprises. Within females respondents interviewed majority are located in Ibumila while Kilenzi village had the lowest percent of women participating in dairy enterprise (Table 4). The low participation of women in Kilenzi may be explained by the fact that the village has been engaged in the milk cow production in recent years compared to other villages. Thus due to the newness of that agricultural enterprise in that village women might be more risk averse than men as argued by Croson and Geezy (2009).

4.1.2 Age of respondents

The sampled population had the mean age of 42 years with 22 years being the minimum age of the dairy farmer and the maximum age being 75 years (Table 4).

The mean age of 42 years indicate that dairy enterprise in the study area is mainly dominated by middle aged people. When age groups among respondents were examined across the villages, Ibumila and Nundu were found to have high proportions of youth aged between 18-30 years participating in dairy enterprises.

Itulike and Nundu were observed to have relatively high proportions of smallholder dairy farmers in the middle age of 31-40 years (Table 4).

4.1.3 Education level of respondents

Among all respondents 5.6% had been educated beyond primary school, 84% had attained primary level education, and 6.5% had not completed primary education while 2.5% had not gone to school at all (Table 4). This indicates that majority of the smallholder farmers have basic ability of acquiring new skills and adopting technology for efficiency management of their dairy farms. When education status of respondents were examined across villages it was observed that Ibumila had the highest proportion of smallholder dairy farmers who did not complete primary education while Nundu and Kilenzi had the highest proportions of respondents who attained primary and post primary education respectively.

4.1.4 Occupation of respondents

Several primary occupation activities are practiced in the study area. These include crop production, dairy farming, formal employment and dairy farming together with crop production. It was observed that Itulike had the highest proportion of smallholder dairy farmers whom dairy farming was their primary occupation while Kilenzi had the lowest. These results imply that there were some elements of specialization in dairy farming in Itulike compared to other villages. Ibumila had the highest proportion of smallholder dairy farmers who take both dairy farming and crop production as their primary occupation as presented in Table 4.

4.1.5 Experience in dairy farming

The average number of years that smallholder dairy farmers have been engaging in dairy cow keeping is 7.5 with 19 being the number of years of the most experienced farmer and 1 number of years of the least experienced farmer. The cross tabulation results in Table 4 indicate that Itulike and Ibumila have the highest proportions of farmers with more than 10 years experience of keeping dairy cow while Maduma and Kilenzi have the least proportions of farmers within that category. Majority of farmers with less than 5 years of dairy cow keeping experience are located in Kilenzi. This is due to late involvement of the village in DADPS but also the village was not among the first list of villages selected to participate in Caritas and Heifer International dairy cows pass on project

Table 4: Social economic and demographic characteristics of the respondents across villages (n=120)

Item	Name of the village					Total
	Ibumila (%)	Itulike (%)	Kilenzi (%)	Maduma (%)	Nundu (%)	(%)
Sex of respondents						
Male	11.8	35.3	27.5	7.8	17.6	100.0
Female	31.9	18.8	7.3	13.0	29.0	100.0
Age of respondents (years)						
18-30	33.3	16.7	0.0	16.7	33.3	100.0
31-40	22.2	28.9	13.3	6.7	28.9	100.0
41-60	23.4	25.0	18.8	12.5	20.3	100.0
61 >	20.0	20.0	20.0	20.0	20.0	100.0
Experience in dairy (years)						
<5 years	13.7	17.6	31.4	11.8	25.5	100.0
5-10 years	30.0	33.3	3.3	16.7	16.7	100.0
>10 years	30.8	30.8	5.1	5.1	28.2	100.0
Educational Level of respondent						
Didn't go to school	33.3	33.3	33.3	0.0	0.0	100.0
Didn't complete primary education	44.4	11.1	22.2	22.2	0.0	100.0
Primary education	21.8	26.7	11.9	10.9	28.7	100.0
Post primary Education	14.3	28.6	57.1	0.0	0.0	100.0
Occupation of respondents						
Crop production only	17.0	21.6	18.2	13.6	29.5	100.0
Employed	0.0	50.0	50.0	0.0	0.0	100.0
Dairy farming	26.3	52.6	5.3	5.3	10.5	100.0
Dairy farming and crop production	72.7	9.1	9.1	0.0	9.1	100.0

4.2 Milk Production

The farmers use zero grazing farming system where dairy cows are supplied with feeds, water, minerals and veterinary services at their dairy sheds. An average farmer own 1.4 lactating cows per year while the farmer with largest herd own 4 lactating cows per year. These farmers acquire their cows through pass on cow credit system where a farmer is given a seed cow from either DADPS project or Heifer international and is required to repay a calf of six month to the neighbour identified by the donating project.

4.2.1 Types of dairy cows kept

There are various species of dairy cattle kept by different farmers worldwide. The choice of dairy breed to be kept normally depends on the factors like availability of the breed, productivity, climatic condition, adaptability factors, disease tolerance levels and the cost of the particular breed. In Njombe EPINAV dairy project, among the interviewed farmers about 81% keeps cross breed of Local and Friesian, 12% keeps cross breed of Local and Ayrshire, 2% keeps Cross breed of Local and Jersey, while 5% keeps cross breeds of the fore mentioned cow breeds (Fig.3).

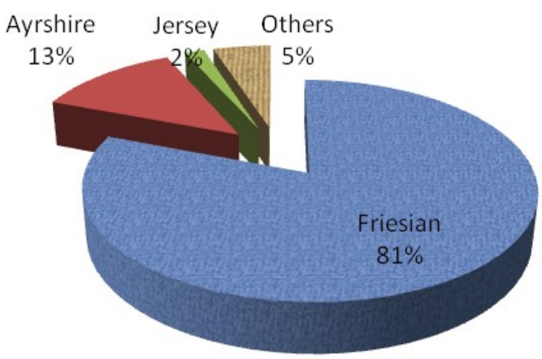

Figure 3: Distribution of different types of dairy cow cross breeds kept by interviewed farmers.

Among dairy farmers keeping cross breed of Friesian and Local, the majority are found in Itulike and the minority are in Maduma (Table 5). The cross breed of local and Ayrshire is kept mostly in Kilenzi (35.7%). The comparison of proportions of dairy farmers keeping cross breed of Friesian and Ayrshire across villages indicated that the breed is mostly kept in Ibumila (75%).

Table 5: Proportions of farmers by village across different cow breeds (n=120)

Type of dairy cow cross breed	Name of the Village (%)					Total
	Ibumila	Itulike	Kilenzi	Maduma	Nundu	
Friesian and Local	23.7	25.8	14.4	11.3	24.7	100.0
Ayrshire and Local	14.3	28.6	35.7	7.1	14.3	100.0
Jersey and Local	0.0	0.0	0.0	0.0	100.0	100.0
Friesian and Ayrshire	75.0	0.0	0.0	25.0	0.0	100.0
Jersey and Friesian	0.0	100.0	0.0	0.0	0.0	100.0
Jersey and Ayrshire	0.0	0.0	0.0	0.0	100.0	100.0
Others	0.0	100.0	0.0	0.0	0.0	100.0
Total	**23.3**	**25.8**	**15.8**	**10.8**	**24.2**	**100.0**

4.2.2 Motivation to dairy cow keeping

When motive towards dairy keeping was examined across sex of respondents it was observed that among respondents motivated by income generation 55.3% were female and among those motivated by nutritional requirements 75% also were female. Moreover, female accounted for 61.3% of respondents who were motivated in dairy cow keeping because of getting manure for farm application (Table 6).

Table 6: Comparison on motivation of farmers to dairy cow keeping by sex (n=120)

Sex	Motivation to dairy enterprise involvement (%)			Total
	Income generation	Nutritional requirements	Manure	
Male	44.7	25.0	38.7	42.5
Female	55.3	75.0	61.3	57.5
Total	100	100	100	100

Among respondents who are motivated by income generation the majority (28.2%) are from Itulike and minority (10.6%) are from Maduma. Milk is well known to be the source of protein and other nutritional ingredients. Therefore some smallholder farmers may keep dairy cows in order to get nutrients from milk. The cross tabulation in Table 7, indicates that among farmers being motivated by nutritional factor, majority (50%) are found in Ibumila. About 32.3% of all farmers who are motivated by getting manure for farm application are found in Nundu while minority (9.7%) are found in Kilenzi village.

Table 7: Distribution of respondents according to village by motive to dairy farming (n=120)

Motivation to dairy	Name of the Village					Total
	Ibumila (%)	Itulike (%)	Kilenzi (%)	Maduma (%)	Nundu (%)	(%)
Income generation	22.4	28.2	17.6	10.6	21.2	100.0
Nutritional requirements	50.0	0.0	25.0	0.0	25.0	100.0
Manure	22.6	22.5	9.7	12.9	32.3	100.0

4.2.3 Major inputs

The dairy farmers use zero grazing production system where the major input factors being forage (roughage) collected by family labour and purchased feeds. The purchased feeds consist of maize bran and sunflower seed cake which are available in Njombe town. Veterinary services are mainly provided by Para- veterinarians available in each project village. Farmers have to purchase drugs for treatment of diseases and also contributed for the cost of vaccine normally provided by the government. The average smallholder dairy farmer uses 134 man days to work in dairy farm per year. These results imply that dairy enterprise in Njombe EPINAV project is labour intensive. In addition, the average farmer spent TZS 77 762 per farm for veterinary services and medicine per year. In terms of feeds, the average farmer uses 2083kg to feed dairy cows of an average herd size of 1.4 per year. Moreover, the average of 59 726 kg of roughage is used per farm to feed dairy cows per year (Table 8). This quantity indicates that dairy cows in EPINAV dairy project farms are overfed with roughage compared to the recommended standard of 46 200kg (see Appendix 5).

Table 8: Summary statistics of input and output variables used in milk production per farm per year

Variable	Measuring units	Sample mean	Min.	Max.
Milk output /farm	ltrs	4 482	1 050	15 000
Feeds/farm	kg	2 083	461	12 136
Labour/farm	Man day	131	9	472
Herd size/farm	Cow	1.4	1	4
Veterinary services and medicine/ farm	TZS.	77 762	3 000	306 500
Roughage/farm	kg.	5 9 726	9 125	182 500

4.2.4 Milk yields

The average milk production for smallholder dairy farmers in EPINAV project is estimated to be 4482 ltrs per farm per year (Table 8). Results from individual village production indicate that on average farms in Itulike produce more milk per year than farms located in other villages. The village dairy farms owned by smallholder farmers' in Itulike yield more than twice when compared to the farms in Maduma village (Table 9). This might have been caused by Maduma being the new member in the EPINAV project therefore its farmers are still learning the new technologies from the EPINAV project. Further results on milk production per cow per year reveal that dairy farmers milk between 1050 to 6870 ltrs per year (Appendix 2). The average milk production per cow per year being 3145.74ltrs.When more analysis was done to examine milk output in litres per cow per day; the results indicate that farmers produce between 3.5 ltrs to 22.9 ltrs of milk per cow/d (Appendix 2). The average milk yield per cow/d is 10.7 ltrs. This average is above the national average estimate by 78%. However, it is lower than average production of 15.4ltrs reported by Anthony (2012) in Babati Urban in Manyara region. Thus, there is still an opportunity for an average small holder dairy farmer to double volume of milk produced to attain the level of the most productive smallholder farmer.

Table 9: Summary statistics for milk yield per farm per year across villages

Village	Mean (ltrs)	Max.(ltrs)	Min.(ltrs)	Stdev.(ltrs)
Ibumila	4 147.75	15 000	1 590	3 041.304
Itulike	6 210.00	12 600	2 400	2 683.027
Kilenzi	3 476.53	7 200	1 050	1 588.669
Maduma	2 815.39	4 500	1 800	798.797
Nundu	4 424.80	9 600	2 100	1 817.687

4.2.5 Raw milk marketing

Different market channels exist for milk sale where 95% of the total marketed per farm is sold to milk processing factory (CEFA), 3% is sold to restaurants within the study area and 2% is sold to neighbours. The average volume of milk marketed by an average farmer through different market channels per year is presented in Table 10.

Table 10: Average volume of milk supplied through different market channels per farm per year (n=120)

Marketing channel	Average volume supplied per farm per year (ltrs)	Percentage
CEFA	3 922.8	95
Neighbours	102.8	2
Restaurants	122.8	3

The processor (CEFA) offer a price of TZS 415 per litre, restaurants offer an average price of TZS 600 per litre and neighbours offer an average price of TZS 490 per litre. Milk purchased by processor (CEFA) is collected through milk collection centres managed by farmers. In these centres milk quality is monitored using lactometers before being delivered to the milk transporting truck. Farmers who deliver their milk to CEFA are paid after every 14 days of delivering milk while farmers selling milk to other marketing channels they are normally paid on sport.

4.3 Major Cost Structures Facing Dairy Farmers

4.3.1 Average investment cost structure for a dairy farm.

Investment costs are initial start up amount of funds required to finance establishment of the business structures before starting production of goods and services. The initial investment cost provides a highlight on how it is easier or difficult for smallholder dairy farmers to participate in milk production. Data were collected on the various components of the fixed costs on fresh milk production. These components were initial cow investment cost which was calculated based on the cow purchase price. In case the cow was obtained by other means apart from purchasing, the farmer valued the particular cow based on the market price if he/she could have purchased. Other fixed cost components were initial pasture establishment, dairy shed construction and sprayer costs. The initial pasture establishment cost refers to the cost of acquiring land for planting pasture grasses and cost incurred by a farmer for land preparation, fertilization, purchasing grass seedlings at initial stage of pasture establishment.

The mean investment cost per farm size of one cow is TZS 1 194 700. This cost is high for poor smallholder farmers to be able to afford in their own taking into consideration that GDP per capita in Tanzania for the year 2012 was only TZS 1 025 038 (UNDP and URT, 2014). Further results revealed that, initial cow investment cost formed the largest cost component with 46% of overall investment cost (Fig. 4). This was followed by dairy shed construction cost which accounted for 33% of overall investment cost. The cost of transportation facility, initial pasture investment and sprayer accounted for 11%, 6% and 4% respectively.

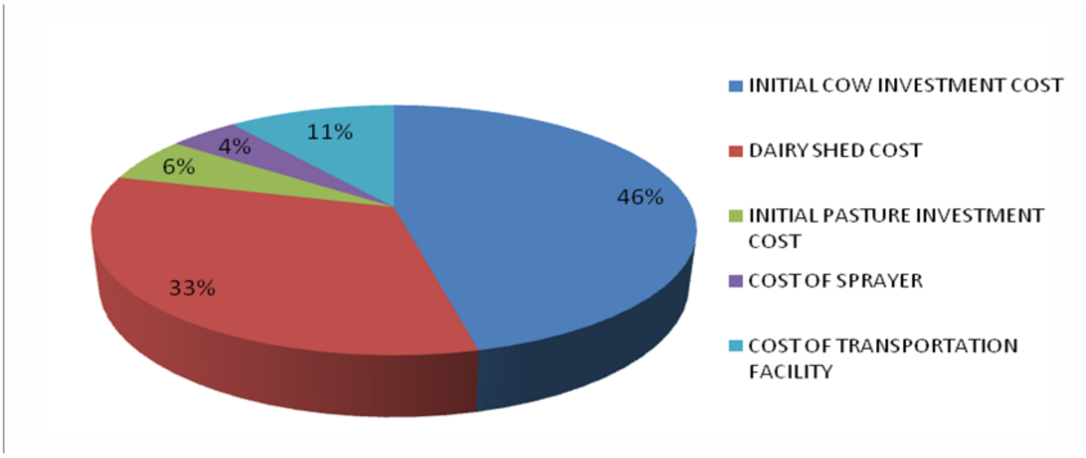

Figure 4: Distribution of proportions of average investment cost structures

4.3.2 Average variable cost structure for dairy farm in Njombe EPINAV Project

Variable costs are costs that change with the level of production in the given production cycle. The variable costs are relevant to the economic decision making in the short run. The variable cost of production of milk was classified into various categories for ease of analysis. These categories were labour, maize bran, sunflower seed cake and leaf meal, veterinary services and insemination, mineral salts and milking utensils and transportation costs.

The labour cost comprised of hired labour and family labour. The opportunity cost of the family labour was calculated based on the wage rate per man per day for hired labour. The veterinary services and insemination cost component comprised of disease treatments, vectocides, teats dips, vaccination, de-worming, teats softening cream and insemination costs. Most of dairy enterprise variable costs such as maize bran, sunflower seed cake, mineral salts, milking utensils and veterinary services and insemination costs were calculated on the basis of market prices. The labour cost formed the largest cost component which accounted for 43% of overall variable cost incurred (Fig.5). This was followed by cost of maize bran which accounted for 31% of the total variable cost incurred by the farmer. When all percentages of all cost forming the feed component like maize bran, sunflower seedcake and leaf meal and mineral salts is grouped together it forms 45% of the total variable cost. This finding is similar to the smallholder dairy farmers in Tanga where feed is among the largest cost component of dairy farmers (AECF, 2011). Likewise in central region of Kenya it was identified that feeding constituted the largest cost structure estimated to be 70% of the variable cost of production in dairy cows (Mbugua *et al*, 2012).

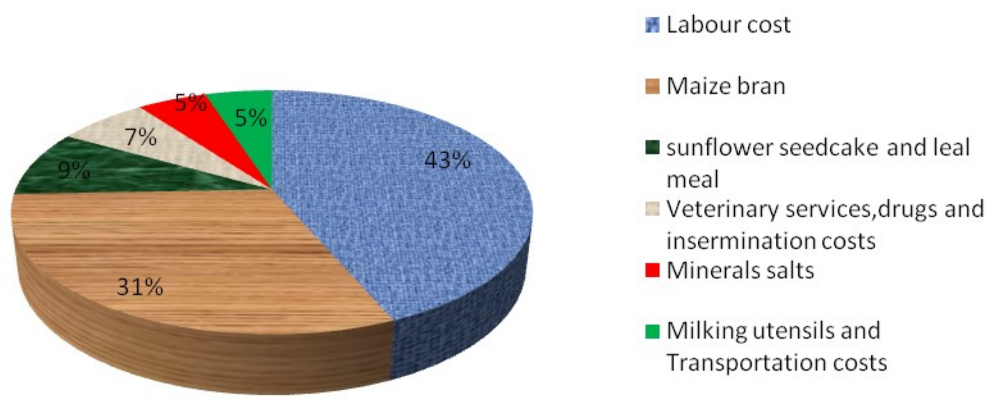

Figure 5: Average variable cost structures for an average dairy farm

When further analysis was made in the veterinary services cost, it was observed that out of 7%, disease treatment accounted for 41% of all expenditures in veterinary services category. This finding is similar to findings of AECF (2011) where they found cost of medicine for cow treatment formed the largest cost component for dairy farmers in Tanga.

4.4 Average Gross Profit Margin

Results of gross margins for all smallholder dairy farmers interviewed in the selected villages are presented in Table 11. The gross revenue included the value of milk sold to different market channels and consumed by the household. Milk consumed at home was valued by multiplying the volume of consumed at home per year and the weighted average price. The formula for calculation of average weighted price of milk is presented in Appendix 3.

The results indicate that the average gross profit margin per cow per year is TZS 333 799. This amount is approximately equivalent to average gross profit margin of TZS 27 817 per cow per month. The ratio of gross margin to the variable expenses was 0.32. This value is low which implies that every shilling invested in variable cost of dairy enterprise by a farmer returns only 32 cents.

Table 11: Gross margins per cow for sampled smallholder dairy farmers

Revenue	**TZS/year**
Milk sales	1 254 132
Value of milk consumed at home	110 434
Total Revenue (TR)	**1 364 566**
Variable costs	
Maize bran	317 662
Sunflower seedcake	86 523
Leaf meal	3 981
Veterinary services and cost of drugs	62 046
Labour cost	449 299
Mineral salts	53 035
Insemination cost	6 917
Milking utensils and towels	9 778
Milk transportation costs	41 526
Total Variable Cost (TVC)	**1 030 767**
Gross Profit Margin	**333 799**

4.5 Technical Efficiency of Smallholder Dairy Farmers

4.5.1 Model choice

A generalized Likelihood Ratio test (LR) was performed to test whether or not Cobb-Douglas production function could be used as appropriate functional form to estimate technical efficiency for this study. Using the equation (5) the value of Likelihood Ratio calculated was equal to 47.36.This value was greater than the critical value of $\chi 2_{(15,\ 0.05)}$ which was equal to 25.00. According to these results the null hypothesis H_0:β_{ij}=0 ,which stated that Cobb-Douglas production function is an adequate representation of the production function is confidently rejected at 5% level of significance in favour of translog production function. The results for hypotheses testing are presented in Table 12.

4.5.2 Maximum Likelihood estimates of trans-log production function of the sampled farms

The results of Maximum Likelihood Estimates of the translog stochastic production function are presented in Table 12. In this table the coefficients of the estimated variables, standard errors and t-ratios are presented. The results indicate that feeds, labour, herd size, veterinary services and roughage are significant input variables at 5% level for milk production. The input variable feed, labour, herd size and roughage have expected signs. These results are similar to the findings of Wubeneli and Ehui (2006) where in assessing smallholder dairy farmer's technical efficiency in Ethiopian highlands they found that concentrate feeds, labour, roughage and veterinary services cost were significant determinants of milk output.

However, contrary to the findings of Wubeneli and Ehui (2006) the input variable on veterinary services cost has negative sign. This can probably be explained by the observation that about 41% of all expenditure for veterinary services is used for treatment of diseases. Due to quality assurance and safety rules in the milk value chain, farmers normally do not milk their cows when they fall sick or receive treatments. In case they milk they dispose it off without measuring volume of milk obtained. Thus in the short run the inverse relationship may exist between cost of veterinary services particularly treatment of diseases and volume of milk produced in a farm. However further research should be conducted focusing in this.

Table 12: Summary results of stochastic frontier translog production function

Variable	Parameter	Coefficients	Standard Error	t-ratio
Constant	β_0	0.3164*	0.0263	12.0486
Feeds (kg)	β_1	0.0887*	0.0701	12.6562
Labour (man days)	β_2	0.088*	0.0142	6.2087
Herd size (cow)	β_3	0.5894*	0.0540	10.9070
Veterinary services and medicine (TZS)	β_4	-0.0707*	0.0171	-4.1380
Roughage (kg)	β_5	0.2715*	0.0546	4.9736
Feeds*Labour	β_6	0.2427*	0.0490	4.9548
Feeds*herd size	β_7	-0.1772	0.0972	-1.8237
Feeds*Vetserv.	β_8	-0.1406*	0.0207	-6.8011
Feeds*Roughage	β_9	-0.0491	0.0450	-1.0923
Labour*herd size	β_{10}	-0.0362	0.0984	-0.3681
Labour*Vertserv.	β_{11}	0.1500*	0.0283	5.3108
Labour*Roughage	β_{12}	0.0433	0.0814	0.5318
Herd size*Vetserv	β_{13}	-0.2353*	0.0786	-2.9934
Herd size*Roughage	β_{14}	-0.3368*	0.0784	-4.2942
Vetserv*Roughage	β_{15}	0.0707*	0.0266	2.6601
$Feeds^2$	β_{16}	-0.0272	0.1082	-0.2512
$Labour^2$	β_{17}	-0.1420*	0.0540	-2.6277
$Herdsize^2$	β_{18}	1.4077*	0.2293	6.1396
$Vetserv^2$	β_{19}	0.0135	0.0388	0.3490
$Roughage^2$	β_{20}	0.3165*	0.0966	3.2753
Log likelihood		-4.1597		

* Significant at α=0.01.

In order to overcome the difficulties in interpretation of coefficients of translog production function all variables of stochastic translog production function were transformed by dividing by their respective means. Therefore, the coefficient of input variables can be interpreted as elasticity of production about their mean value. The increase in usage of concentrate feed by 1% will increase milk produced by about 8.8%. The same applied for increase in labour in man days. The coefficient for roughage is 0.2715 and significant at 5% level. This implies that an increase in roughage usage by 1% may increase milk production by about 27.2% *ceteris peribus.*

4.5.3 Technical efficiency score results

The technical efficiency of smallholder dairy farmers ranges from 22% to 99% with mean technical efficiency of 68% (Appendix 4). Table 13 presents summary of efficiency score results for sampled smallholder dairy farmers. This result implies that 68% of potential output is being realized by the smallholder dairy farmers in Njombe EPINAV dairy project. This finding is similar to the findings of Sharma and Singh (2011) in India. Moreover, the results conforms to the findings of Thiam *et al*. (2001) who generalized that technical efficiency in developing countries range from 17% to 100% with a mean of 68%.

The mean efficiency of smallholder dairy farmers in Njombe EPINAV dairy project indicate that there is a shortfall in efficiency by 32% and the farmers can improve their milk production by 32% without requiring additional inputs and without the need for new technology. The least efficient farmer can improve by 46% to attain the efficiency level of the average smallholder dairy farmer. The efficiency scores for all individual sampled farms are presented in Appendix 4.

Table 13: Summary of efficiency score results (n=120)

Variable	Efficiency score
Mean	0.68
Variance	0.04
Range	0.77
Minimum	0.22
Maximum	0.99

The efficiency level of the farmers is widely distributed with 62.5% having efficiency level above 60% while 37.5 % have efficiency level below that. Table 14 presents the summary for distribution of efficiency scores.

Table 14: Result summary of efficiency scores in percentage

Efficiency scores	Percent
0.80-0.99	27.5
0.60-0.79	35.0
0.40-0.59	30.8
0.20-0.39	6.7
Total	100.0

When technical efficiency was examined across villages there were small variations among five villages as indicated in Table 15.

Table 15: Summary statistics of technical efficiency according to the village

Village	Mean	n	Std. Deviation
Ibumila	0.67	28	0.19 594
Itulike	0.77	30	0.18 231
Kilenzi	0.67	19	0.19 693
Maduma	0.65	13	0.19 255
Nundu	0.63	30	0.19 593

The technical efficiency scores in Table 15 indicate that Itulike has the highest mean technical efficiency of 77% while Nundu has relatively lowest mean technical efficiency level of 63%. The reason for Itulike to have highest level of efficiency compared to other villages may be due to its long experience in keeping dairy cows compared to other villages. When technical efficiency is examined according to the herd size the results shows that small holder dairy farmers with herd size of 1 and 2 cows all have the same mean efficiency of 68% while small holder dairy farmers with herd size of 3 and 4 cows have mean technical efficiency of 75% and 99% respectively (Table 16). However when correlation coefficient was analysed the results indicated the correlation coefficient of 0.034. This value was not significant at 5% level of significance. This finding indicates that there is no significant linear association between the herd size and the technical efficiency level of the dairy farmer.

Table 16: Technical efficiency according to the herd size (n=120)

Herd size	n	T.E levels	Minimum	Maximum
1	78	0.68	0.22	0.99
2	38	0.68	0.37	0.99
3	3	0.75	0.48	0.99
4	1	0.99	0.99	0.99
Correlation Coefficient		0.034		

4.6 Effects of Social Economic Factors on Technical Inefficiency

The Maximum Likelihood Estimates of the stochastic frontier model indicates that the value of gamma is 0.99. The hypothesis testing for the significance of the value of gamma was conducted using Likelihood Ratio test presented by equation 5. The log likelihood function of the OLS estimates of the translog stochastic production function was -17.86 while that of Maximum Likelihood Estimates of Stochastic translog production function was -4.16.These values were used to compute the LR using equation 5, where by the calculated test statistic was 27.40. The critical value for $\chi^2_{(0.05,7)}$ from Kodde and Palm (1986) statistical table is 11.91. Hence the null hypothesis that inefficiency effect is absent from the model is confidently rejected (Table 17). This result implies that about 99% of the random variation in the model is explained by technical inefficiency. The null hypothesis stating that technical inefficiency effects are not stochastic is also confidently rejected implying the appropriateness of the application of stochastic production frontier. The third null hypothesis stating that the inefficiency effect follows the half normal distribution is strongly rejected as indicated in the Table 17. Lastly the hypothesis which states that inefficiency effect are not influenced by social economic factors is confidently rejected at 5% of significance implying that social economic factors jointly influence inefficiency of smallholder dairy farmers.

Table 17: Likelihood ratio test of hypotheses of the parameters of stochastic translog production function and inefficiency models

Null hypothesis	Log-likelihood function	Df	Test statistic λ	Critical value	Decision
H_0: B_{ij}=0	-27.84	15	47.36	25.00	Reject H_0
H_0: $\gamma=\delta_0=\delta_1\ldots\delta_5=0$	-17.86	7	27.40	13.40*	Reject H_0
H_0: $\gamma=0$	-18.96	6	29.62	11.91*	Reject H_0
H_0: $\delta_0=\delta_1\ldots\delta_5=0$	-18.48	6	28.66	12.59	Reject H_0
H_0: $\delta_0=0$	-16.77	1	25.24	3.84	Reject H_0

* The critical values are obtained from Kodde and Palm (1986) statistical table.

The results of Technical inefficiency effect model are presented in Table 18. A negative sign on a parameter means that a variable decreases inefficiency, while a positive sign on a parameter means variable increases inefficiency. The results reveal that the experience variable of the dairy farmer is negative and significantly reduces inefficiency in smallholder dairy farming at 5% level. This implies that one year increase in experience of the dairy farmer decreases inefficiency by 2.5%. This result is similar to Mlote *et al.* (2013) in their analysis of factors influencing technical efficiency in beef fattening in Lake Zone of Tanzania, they found that an increase in the year of experience of beef fattening significantly increases efficiency. The variable on the educational level is negative but insignificant at 0.05% level of significance. However this variable is significant at 0.1% level of significance. This implies that an increase in one year of schooling significantly increases efficiency by 4.2% in the use of productive resources of the smallholder dairy farmers.

Table 18: Results summary of inefficiency effect model

Variable	Parameter	Coefficient	Standard Error	t-ratio
Constant	∂_0	0.7803*	0.2552	3.0569
Education	∂_1	-0.0419**	0.0312	-1.3419
Experience	∂_2	-0.0248*	0.0116	-2.1288
Economic status	∂_3	-0.0625	0.1216	-0.5141
Farm records	∂_4	-0.0553	0.1023	-0.5405
Extension visit	∂_5	-0.0467	0.0386	-1.2078
Sigma- squared	δ^2	0.1967*	0.0208	9.4626
Gamma	γ	0.9999*	0.000	26 872 521

* indicates significance at 0.05, ** indicates significance at 0.1

The variable on economic status of the dairy farmer is negative which implies that obtaining dairy cow using own source of fund reduces inefficiency by 4.2 % relative to the farmers who obtain dairy cow by other means. However, this variable is not statistically significant at 5% level of significance. The farm record variable is negative implying that keeping farm record reduces inefficient among smallholder farmers. This variable is not significant at 5% level. Extension visit variable has negative sign indicating that increasing number of extension visit to the dairy farmer reduces inefficiency. The variable for extension visit is not significant at 5% level of significance.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

This study aimed at analysing technical efficiency of smallholder dairy farmers within EPINAV project in Njombe district. More specifically the study aimed to achieve the following objectives;

(i) to establish cost structures of smallholder dairy farmers within EPINAV project,

(ii) to estimate gross profit of smallholder dairy farmers within EPINAV project,

(iii) to analyse technical efficiency of smallholder dairy farmers within EPINAV project,

(iv) to determine social economic factors affecting technical efficiency of smallholder dairy farmers within EPINAV project.

Data for the study were collected from sample of 120 smallholder dairy farmers using semi structured questionnaires. The respondents were randomly selected from five villages where the EPINAV project of up-scaling, out-scaling technologies for enhancing integrated dairy production system in Njombe is being implemented. This chapter presents the conclusions and recommendations emerging from the major findings of the study.

5.1 Conclusions

5.1.1 Cost structures in smallholder dairy farming in Njombe.

From the cost analysis of variable costs and fixed costs the following conclusions have been reached.

(i) The average initial investment cost per farm of one cow is estimated to be TZS.1 194 700. Large proportions of investment costs are required to establish dairy shed and purchase the initial dairy cow. These two categories of costs account for 79% of the dairy enterprise establishment cost. Therefore due to high establishment cost, it becomes difficult for poor farmers with limited resources to enter in the dairy enterprise.

(ii) Large proportions of variable costs are used for labour and purchasing feeds. Therefore, milk production in the study area is labour intensive and due to high dependence of family labour in milk production farmers are forced to manage few dairy cows. An average smallholder dairy farmer uses about 40% of total variable costs for purchasing maize bran and sunflower seed cake. The mean total variable cost was estimated to be TZS.1 030 267 per cow per year.

5.1.2 Gross profit for smallholder dairy farmers

From Gross profit margin analysis the following conclusion can be made. The farmers in the study area are earning normal profit where by the mean gross profit per cow per year is TZS.334 299. Smallholder dairy farmers approximately earn 32 cents for every shilling they invest in running cost of the dairy enterprise.

5.1.3 Technical efficiency of smallholder dairy farmers

The efficiency analysis conducted using stochastic frontier production function shows that smallholder dairy farmers in EPINAV dairy project in Njombe are moderately efficient. Their mean technical efficiency is estimated to be 68%. There is evidence that most of smallholder dairy farmers can improve their technical efficiency by approximately 32 % without requiring additional inputs and without a need of new production technology.

5.1.4 Factors influencing inefficiency of smallholder dairy farmers in EPINAV project

The inefficiency model analysis indicates that experience in dairy keeping of smallholder dairy farmers reduces inefficiency significantly. Education level, farm records, economic status and number of extension visit showed expected signs despite of being insignificant. Therefore, these farm specific factors need to be improved further from the current level in order for the dairy farmers to improve their efficiencies.

5.2 Recommendations

5.2.1 Cost structures of smallholder dairy farmers

From the findings of cost structures facing smallholder dairy farmers this study recommends that farmers can reduce significant cost of sunflower seedcake by growing more trees that will be used to prepare leaf meals instead of purchasing sunflower seedcake. The farmers' organization in Njombe (NJOLIFA) has to support farmers through bulk procurements of maize bran during high season and supply to farmers in their respective villages at reasonable prices during low season. This will ensure availability of this major feed component during low season and also reduce unnecessary cost incurred by famers due to price rise during low season.

5.2.2 Gross profit margin of smallholder dairy farmers

The gross profit margin of smallholder dairy farmers can be improved through reduction of feed cost and increasing volume of milk production through being more efficient in production. Moreover, component of veterinary services cost can also be reduced through taking preventive measures through regular vaccination of cows. This will reduce cost incurred by farmers in treating disease and therefore increasing gross profit levels.

5.3.3 Technical efficiency of smallholder dairy farmers

The finding of this study indicates that the average efficiency of smallholder dairy farmer in the study area is 68%. From this finding this study recommends that there is a room of improving farmers' level of efficiency by 32% through better use of the available productive resources.

5.3.4 Factors influencing inefficiency

This study recommends that the government and other farmers supporting organization should promote more training to new farmers who enter in the dairy enterprises so that they get experience that will reduce inefficiencies. Better policies that will promote education and nature experiences are recommended.

5.3.5 Recommendations for further studies

This study recommends that further study should be conducted to evaluate the economic performance of smallholder dairy farmers in the integrated production system and also assessment of contribution of dairy farming in crop production for farmers in integrated production system.

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APPENDICES

Appendix 1: Questionnaire for smallholder dairy farmers

SMALLHOLDER DAIRY FARMERS' TECHNICAL EFFICIENCY: A CASE OF EPINAV PROJECT IN NJOMBE DISTRICT, TANZANIA.

Questionnaire number…………………....Name of respondent……......................
Date of interview…………………………Name of enumerator...…………………………..

District…………………………………....Division...………………………………………

Ward……………………………………Village/Street…………………………….…..

A: BASIC INFORMATION

1. Age of the respondent (Years) ………………………………………………………
2. Sex of the respondent………… 1=Male 2=Female
3. Education level of the respondent (years of schooling)…………………………………..
4. What is your primary occupation? (Circle the appropriate) 1= farming, 2= employed, 3= business, 4= others (specify)…………………………………….............................
5. What is your secondary occupation? (Circle the appropriate) 1= farming, 2= employed, 3= business, 4= others (specify)……………………………….................................
6. Household size and composition (number of people living together and sharing the same kitchen) [1] Adults…………………………[2]Children………………………

Age group	**Number**
0-7	
8-17	
18-64	
65 +	
Total	

7. What motivated you to start keeping the dairy cows? Circle the appropriate response. 1=Income generation 2=Nutrition 3= others (specify)………………………

B: MILK PRODUCTION INFORMATION

8. For how long have you been keeping dairy cow(s)? ……………………………………
9. What type of dairy cow breed do you keep? 1=Friesian 2= Ayrshire 3= Jersey 4=Cross Breeds (specify)…………………………………………………………………
10. 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………………

11. How many milking cow did you have at the beginning of the last year (2012)? …..........
12. 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…………

13. How did you get your starting dairy cow? 0=given through pass on credit 1=Bought
14. 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)………………….

15. If you bought using credit, what was the source of credit you received?

    {1}=Bank, {2} = SACCOS, {3} =NGO, {4} Church {5} others specify………………

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

17. What is your average monthly income? (Tshs)…………………………………………
18. What is the average number of cows you milked per day last year? …………………..
19. Do you keep farm records? (Circle the appropriate response) 1=Yes, 2= No
20. Where do you get extension services concerning proper keeping of dairy cow and/or milk production? 1=Government, 2= NGO, 3=Neigbour, 4=Others (Specify)…………
21. What is the average number of extension visit did you receive per month in the last (2012) year………………………………………………………………………………
22. 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)			

23. What is the average lactation period of your cow(s)? (Days)..
24. What is the amount of milk in litres did you produce last year? ………………………..
25. Where do you normally sell your milk? ……………………………………………….
26. What is the average selling price per litre at your delivery point?

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

27. 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 2012.

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				
Total				

C: INFROMATION ON INVESTMENT COSTS

28. What is the number of cow(s) that produced milk last year?……………………
29. When were they received/ purchased (year) ………………………………………
30. What was the initial animal cost during purchase/ receiving………………………...
31. What was the value of cow (s) when they began to produce milk in the year (2012).
32. How much did it cost you to construct dairy cow shed? ………year…....................
33. Interest paid per year in case the startup capital was obtained through loan………
34. What was the initial pasture establishment cost……………………………………..
35. Please estimate the cost 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)…………				

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

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

37. What is the pasture management cost per year (Tshs)………………………………….
38. What is the size of the piece of land is allocated for each of the following type of grasses1.Rhodes…… 2. Setaria……3. Guatemala……4.Elephant …5.Others (specify)………………………………………………………………………………

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

S/N	Item	Drugs per dose/unit	Number of cows involved	Veterinary doctor per service(Tshs)	Veterinary doctor per cow(Tshs)	Frequency 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. Please indicate the quantity/ and cost estimate for feeding cows per month 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 cost					

41. What type of breading method do you use?
    1=Natural breeding 2= Artificial insemination 3=Both Natural and Artificial Insemination
42. What is the breading cost per service…..……………………………………………..
43. What type of feeding system do you practice? {1} Zero grazing {2} Semi grazing {3}Grazing
44. What size of pasture land do you own…………………………………………….acres

45. What is the average cost do you incur for marketing your milk?

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

46. Who do attend the dairy cows?

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

47. If hired labour how do you pay them?

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

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

49. Please indicate the labour cost 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	Cost per (Man day)
1	Grazing/ Grass cutting and Feeding				
2	Collection of local feeds				
3	Milking				
4	Spraying				
5	Marketing/selling				
6	Shed cleaning				
7	Others (specify)				

D: INFORMATION ON MILK MARKETING

50. Where do you sell your milk?

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

6= others (specify)……..

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

52. Who determines the price of milk you have been selling?
    1= Government, 2= Yourself (as milk producers), 3=Processors, 4=collectors,
    5= consumers
53. What system do you use for selling your milk?
    1= Monthly billing, 2=Two weeks billing, 3=Cash on delivery,
    4= others (specify)…………………………………………………………………

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

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

E: FUTURE PROSPECTS, CHALLENGES AND RECOMENDATIONS

54. What is your future prospect about your dairy enterprise……………………………….
    ………………………………………………………………………………………………
    ……………………………………………………………………………………..
54. What are the common problems that you normally face in running you dairy enterprise………………………………………………………………………………
    ………………………………………………………………………………………………
    ………………………………………………………………………………………………
55. 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?
    ………………………………………………………………………………………………

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

………………………………………………………………………………………………
………………………………………………………………………………………………
………………………………………………………………………………………………
……………………………………………………………………………………

Thank you for your cooperation.

Appendix 2: Milk Yields Information.

Milk yields summary statistics per cow per day

Village	Mean (ltrs)	Maximum(ltrs)	Minimum(ltrs)	Stdev (ltrs)
Ibumila	9.36	22.90	4.20	3.8473
Itulike	12.73	18.50	4.75	2.8481
Kilenzi	10.33	16.00	3.50	3.0432
Maduma	9.38	15.00	6.00	2.6627

Appendix 3: Calculation of Averages used in Computation of Gross Margin

(i) Average weighted price of milk (Pi) = $\frac{QcPc + QrPr + QnPn}{Qc + Qr + Qn}$

Where; Qc=Quantity of milk sold to CEFA, Pc=Price offered by CEFA,

Qr=Quantity of milk sold to Restaurant, Pr=Price offered by Restaurant,

Qn= Quantity sold to neighbours, Pn=Price offered by Neighbours

(ii) Milk sales = *Avmpc*Pi*

Where *Avmpc*= Average volume of milk produced per cow

Pi= Average weighted price of milk

*(iii)*Value of milk consumed at home= *Avmch*Pi*

Where *Avmch*= Average milk consumed at home

Pi= Average weighted price of milk

(iv) Average cost of maize bran= *Avntmb*Pmb*

Where *Avntmb* = Average number of tins of maize bran consumed per cow per year

Pmb=Average weighted price of maize bran per tin

1 Tin of maize bran is equivalent to 8 kg maize bran.

(v) Average cost of sunflower seedcake cost= *Awssc*Psc*

Where Awssc=Average weighted sunflower seedcake consumed per cow per year and Psc=Weighted price of sunflower seedcake *(vi)* Average cost of leafmeal=*Awlfm*Plf*

Where Awlfm=Average weight (kg) of leafmeal consumed per cow per year.

Plf= Average weighted price of leafmeal.

(vii) Cost of veterinary services and drugs= *Avvs + Acd*

Where *Avvs*=Average veterinary services cost per cow per year

Acd=Average cost of purchased drugs per cow per year.

(viii) Average labour cost per cow per year=*Avmd* Awr*

Where *Avmd*= Average number of man working days per cow per year

Awr=Average wage rate per day of 8 hours.

(ix) Average cost of mineral salts per cow per year=*wlrs*Plr+ Nst*Pnl*

Where *wlrs*=Average weight of animal lick Rock salt (kg) per cow per year

Plr=Average price of lick rock salt per kg

Nst=Average weight of Normal salt (Table salt) in kg per cow per year

Pnl =Average price of normal salt per kg.

(x) Insemination cost=*AcAI + Acb*

AcAI=Average Artificial insemination cost per cow per year

Acb=Average cost of hiring bull service per year.

Appendix 4: Technical Efficiency Scores Estimate for Individual Farms across Villages

Village name	*Smallholder dairy farm number*	*Time period*	*Efficiency score*	*Percentage*
Ibumila	*1*	*1*	*0.9111*	*91.11%*
Ibumila	*2*	*1*	*0.6727*	*67.27%*
Ibumila	*3*	*1*	*0.9997*	*99.97%*
Ibumila	*4*	*1*	*0.9996*	*99.96%*
Ibumila	*5*	*1*	*0.3418*	*34.18%*
Ibumila	*6*	*1*	*0.5918*	*59.18%*
Ibumila	*7*	*1*	*0.5403*	*54.03%*
Ibumila	*8*	*1*	*0.7081*	*70.81%*
Ibumila	*9*	*1*	*0.4290*	*42.90%*
Ibumila	*10*	*1*	*0.9745*	*97.45%*
Ibumila	*11*	*1*	*0.7557*	*75.57%*
Ibumila	*12*	*1*	*0.4950*	*49.50%*
Ibumila	*13*	*1*	*0.7904*	*79.04%*
Ibumila	*14*	*1*	*0.6755*	*67.55%*
Ibumila	*15*	*1*	*0.4160*	*41.60%*
Ibumila	*16*	*1*	*0.5953*	*59.53%*
Ibumila	*17*	*1*	*0.6684*	*66.84%*
Ibumila	*18*	*1*	*0.7593*	*75.93%*
Ibumila	*19*	*1*	*0.5781*	*57.81%*
Ibumila	*20*	*1*	*0.4159*	*41.59%*
Ibumila	*21*	*1*	*0.8357*	*83.57%*
Ibumila	*22*	*1*	*0.9997*	*99.97%*
Ibumila	*23*	*1*	*0.5644*	*56.44%*
Ibumila	*24*	*1*	*0.7107*	*71.07%*
Ibumila	*25*	*1*	*0.6716*	*67.16%*
Ibumila	*26*	*1*	*0.7959*	*79.59%*
Ibumila	*27*	*1*	*0.6188*	*61.88%*
Ibumila	*28*	*1*	*0.3763*	*37.63%*
Itulike	*29*	*1*	*0.7789*	*77.89%*
Itulike	*30*	*1*	*0.7320*	*73.20%*
Itulike	*31*	*1*	*0.4151*	*41.51%*
Itulike	*32*	*1*	*0.7156*	*71.56%*
Itulike	*33*	*1*	*0.8690*	*86.90%*
Itulike	*34*	*1*	*0.5258*	*52.58%*
Itulike	*35*	*1*	*0.9849*	*98.49%*
Itulike	*36*	*1*	*0.8217*	*82.17%*
Itulike	*37*	*1*	*0.9831*	*98.31%*
Itulike	*38*	*1*	*0.7739*	*77.39%*
Itulike	*39*	*1*	*0.9057*	*90.57%*
Itulike	*40*	*1*	*0.7295*	*72.95%*
Itulike	*41*	*1*	*0.7577*	*75.77%*
Itulike	*42*	*1*	*0.9997*	*99.97%*
Itulike	*43*	*1*	*0.4378*	*43.78%*
Itulike	*44*	*1*	*0.4750*	*47.50%*
Itulike	*45*	*1*	*0.4506*	*45.06%*
Itulike	*46*	*1*	*0.8150*	*81.50%*

Itulike	*47*	*1*	*0.6367*	*63.67%*
Itulike	*48*	*1*	*0.9649*	*96.49%*
Itulike	*49*	*1*	*0.5386*	*53.86%*
Itulike	*50*	*1*	*0.7508*	*75.08%*
Itulike	*51*	*1*	*0.9997*	*99.97%*
Itulike	*52*	*1*	*0.7597*	*75.97%*
Itulike	*53*	*1*	*0.6222*	*62.22%*
Itulike	*54*	*1*	*0.9998*	*99.98%*
Itulike	*55*	*1*	*0.5468*	*54.68%*
Itulike	*56*	*1*	*0.8330*	*83.30%*
Itulike	*57*	*1*	*0.9998*	*99.98%*
Itulike	*58*	*1*	*0.9995*	*99.95%*
Kilenzi	*59*	*1*	*0.3466*	*34.66%*
Kilenzi	*60*	*1*	*0.9999*	*99.99%*
Kilenzi	*61*	*1*	*0.7206*	*72.06%*
Kilenzi	*62*	*1*	*0.5495*	*54.95%*
Kilenzi	*63*	*1*	*0.7210*	*72.10%*
Kilenzi	*64*	*1*	*0.7020*	*70.20%*
Kilenzi	*65*	*1*	*0.9412*	*94.12%*
Kilenzi	*66*	*1*	*0.9998*	*99.98%*
Kilenzi	*67*	*1*	*0.6178*	*61.78%*
Kilenzi	*68*	*1*	*0.2621*	*26.21%*
Kilenzi	*69*	*1*	*0.7005*	*70.05%*
Kilenzi	*70*	*1*	*0.6116*	*61.16%*
Kilenzi	*71*	*1*	*0.7266*	*72.66%*
Kilenzi	*72*	*1*	*0.4429*	*44.29%*
Kilenzi	*73*	*1*	*0.6035*	*60.35%*
Kilenzi	*74*	*1*	*0.9629*	*96.29%*
Kilenzi	*75*	*1*	*0.5319*	*53.19%*
Kilenzi	*76*	*1*	*0.5719*	*57.19%*
Kilenzi	*77*	*1*	*0.8461*	*84.61%*
Maduma	*78*	*1*	*0.6263*	*62.63%*
Maduma	*79*	*1*	*0.7188*	*71.88%*
Maduma	*80*	*1*	*0.5835*	*58.35%*
Maduma	*81*	*1*	*0.8486*	*84.86%*
Maduma	*82*	*1*	*0.5463*	*54.63%*
Maduma	*83*	*1*	*0.5609*	*56.09%*
Maduma	*84*	*1*	*0.5309*	*53.09%*
Maduma	*85*	*1*	*0.9998*	*99.98%*
Maduma	*86*	*1*	*0.4158*	*41.58%*
Maduma	*87*	*1*	*0.5696*	*56.96%*
Maduma	*88*	*1*	*0.5045*	*50.45%*
Maduma	*89*	*1*	*0.7109*	*71.09%*
Maduma	*90*	*1*	*0.9419*	*94.19%*
Nundu	*91*	*1*	*0.3613*	*36.13%*
Nundu	*92*	*1*	*0.7063*	*70.63%*
Nundu	*93*	*1*	*0.7250*	*72.50%*
Nundu	*94*	*1*	*0.4916*	*49.16%*
Nundu	*95*	*1*	*0.5523*	*55.23%*
Nundu	*96*	*1*	*0.9822*	*98.22%*
Nundu	*97*	*1*	*0.7243*	*72.43%*
Nundu	*98*	*1*	*0.6911*	*69.11%*
Nundu	*99*	*1*	*0.4518*	*45.18%*

Nundu	*100*	*1*	*0.2788*	*27.88%*
Nundu	*101*	*1*	*0.5468*	*54.68%*
Nundu	*102*	*1*	*0.4216*	*42.16%*
Nundu	*103*	*1*	*0.9960*	*99.60%*
Nundu	*104*	*1*	*0.4645*	*46.45%*
Nundu	*105*	*1*	*0.3882*	*38.82%*
Nundu	*106*	*1*	*0.4072*	*40.72%*
Nundu	*107*	*1*	*0.9260*	*92.60%*
Nundu	*108*	*1*	*0.5900*	*59.00%*
Nundu	*109*	*1*	*0.6286*	*62.86%*
Nundu	*110*	*1*	*0.6384*	*63.84%*
Nundu	*111*	*1*	*0.7914*	*79.14%*
Nundu	*112*	*1*	*0.5494*	*54.94%*
Nundu	*113*	*1*	*0.9998*	*99.98%*
Nundu	*114*	*1*	*0.4809*	*48.09%*
Nundu	*115*	*1*	*0.9997*	*99.97%*
Nundu	*116*	*1*	*0.6828*	*68.28%*
Nundu	*117*	*1*	*0.6229*	*62.29%*
Nundu	*118*	*1*	*0.6849*	*68.49%*
Nundu	*119*	*1*	*0.6121*	*61.21%*
Nundu	*120*	*1*	*0.4693*	*46.93%*

Mean Efficiency=68.33%

Appendix 5: Calculation of average roughage consumption per herd size

Dry season

Recommended roughage per cow/d during dry season = (70-80) kg

Average recommended roughage /d = (70+80) /2 =75kg/d

Average number of days during dry season in Njombe = 4×30=120days

Roughage for dry season for herd size of 1.4= 75×120×1.4=12600 (a)

Wet season

Recommended roughage feeding per cow per day during wet season = (90-110) kg

Average recommended roughage per day= (90+110)/2 = 100kg/d

Average number of days during wet season in Njombe= 8×30=240days

Roughage for wet season for herd size of 1.4 = 100×240×1.4=33600 (b)

Thus, average recommended roughage feeding for herd size of 1.4 per year is given by (a) +(b)=12600+33600=46200kg