ANALYSIS OF PROFITABILITY AND EFFICIENCY OF IMPROVED AND LOCAL SMALLHOLDER DAIRY PRODUCTION: A CASE OF LILONGWE MILK SHED AREA

MSc. (AGRICULTURAL AND APPLIED ECONOMICS) THESIS

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UNIVERSITY OF MALAWI

BUNDA COLLEGE

NOVEMBER, 2011

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BSc. (Agric Econ) Malawi

A THESIS SUBMITTED TO THE FACULTY OF DEVELOPMENT STUDIES IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF SCIENCE IN AGRICULTURAL AND APPLIED ECONOMICS

UNIVERSITY OF MALAWI

BUNDA COLLEGE

NOVEMBER, 2011

DECLARATION

I, Ted Nyekanyeka, declare that this thesis is a result of my own original effort and work, and that to the best of my knowledge, the findings have never been previously presented to the University of Malawi or elsewhere for the award of any academic qualification. Where assistance was sought, it has been accordingly acknowledged.

Ted Nyekanyeka

Signature:______________________________

Date: ________________________________

CERTIFICATE OF APPROVAL

We, the undersigned, certify that this thesis is a result of the authors own work, and that to the best of our knowledge, it has not been submitted for any other academic qualification within the University of Malawi or elsewhere. The thesis is acceptable in form and content, and that satisfactory knowledge of the field covered by the thesis was demonstrated by the candidate through an oral examination held on 11th November 2011.

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DEDICATION

Dedicated to

My Mum, Alice Siula (R.I.P)

Grandpa John Bekisa Siula

and

Alicia Fay Nyambura

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ABSTRACT

Dairy development projects have provided technologies to boost milk output and household incomes for smallholder dairy farmers in Malawi. However, there is concern among development agencies and policymakers over the efficiency of smallholder milk producers amidst increasing competition from intensive dairy producers in both urban and peri urban areas. This study was initiated to analyse the profitability and economic efficiency of improved and local dairying in Lilongwe Milk Shed Area (MSA). Data was collected from 161 smallholder dairy farmers, 118 improved and 43 local dairy farmers in the MSA. Gross margin and cost benefit analyses were used to evaluate farm-level profitability while a stochastic profit frontier model was used to estimate level of efficiency and factors influencing inefficiency. Results showed that, on average, farmers had positive gross margins which implies that smallholder dairying brings income to dairy farmers in the study area. Profit efficiency ranged from 0% to 67.5% with a mean of 28.1% among improved dairy farmers while among local farmers it ranged from 0.5% to 56.2% with a mean of 24.7%. Level of education, years of dairying experience and access to credit reduced profit inefficiency. The study recommends improved access to input credit among low income farmers, capacity building of dairy farmers through informal training and better price and tax policies for the dairy subsector to ensure sustainable improvements in smallholder dairy farming. A further study should be conducted in MSAs to capture variation in smallholder dairy efficiency across all agro ecological zones.

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LIST OF ABBREVIATIONS AND ACRONYMS

ADD	Agricultural Development Division
AI	Artificial Insemination
ARDEP	Agricultural Research Development Programme
CBA	Cost Benefit Analysis
CREMPA	Central Region Milk Producers Association
DAHLD	Department of Animal Health and Livestock Development
EE	Economic Efficiency
FAO	Food Agriculture Organization
GoM	Government of Malawi
IDF	Improved Dairy Farmer
LAPE	Lakeshore Agro processors Enterprise
LDF	Local Dairy Farmer
LO’L	Land O’ Lakes
MBGs	Milk Bulking Groups
MSA	Milk Shed Area
NGO	Non Governmental Organization
NSO	National Statistical Office

PE	Profit Efficiency
SSLP	Small Scale Livestock Development Programme
TAPP	Trustees of Agricultural Promotion Partnership

CHAPTER ONE

INTRODUCTION

1.1 Background Information to Malawi

Malawi is a small land locked developing country in Southern Africa. The country lies between the latitudes of $9^0 45'$ and $17^0 16'$ south and longitudes of $32^0$and 36^0 East. It is bordered by Zambia in the west, Tanzania in the north and north east and Mozambique in the east, south and south west. The total land area for Malawi is 11.8 million hectares, 20% of which is water surface (Malawi Government, 2002).

The country is divided into three administrative regions; the Northern, Central and Southern Regions with Mzuzu, Lilongwe and Blantyre as the regional cities, respectively. Each region is divided into districts. There are a total of 29 districts; 6 districts in north, 9 in the center and 13 in the south (Figure 1).

The human population is estimated at 13.1 million people with an average annual population growth rate of 2.8 %. The overall population density is at 139 persons per km^2 (National Statistical Office, 2009).

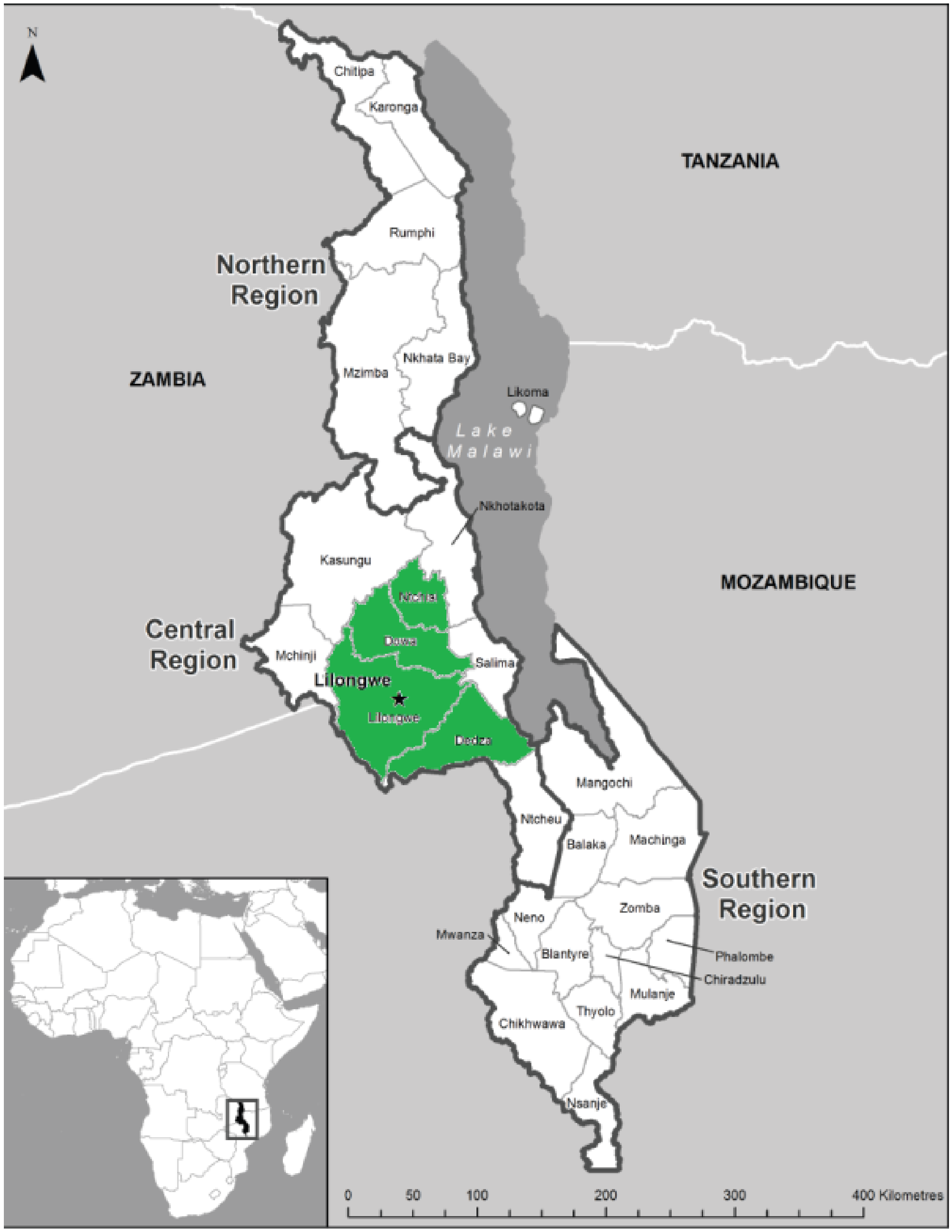

Figure 1.1: Map of Malawi showing districts and Malawi on the African map

1.2 Agriculture in Malawi

Malawi economy remains agro-based with the agricultural sector accounting for over 38% of the Gross Domestic Product (GDP) and 82.5% of foreign exchange earnings. Agricultural sector also employs about 84.5% of the labour force (Government of Malawi, 2003).

Malawian agriculture is dualistic comprising two sub sectors, the smallholder and the estate sub-sectors. The estate or commercial sub-sector operates land under leasehold and freehold tenure systems and grows mostly export crops such as burley and flue cured tobacco, tea, coffee and sugarcane on plantations. The estate sub-sector produces about 15% of the country's agricultural produce for local staple demand, but accounts for 70% of all agricultural exports. On the other hand, the smallholder sub-sector comprises about 2 million smallholder farmers, operating under customary land tenure system and cultivating an average of 0.5 hectares of land. The smallholder sector largely produces food crops like maize, cassava, vegetables, beans and groundnuts (Government of Malawi, 2005). The smallholder sub sector accounts for 85% of the agricultural output (Government of Malawi, 2006).

1.3 Livestock Production in Malawi

Livestock production is an integral part of agricultural production in Malawi. Compared to crop production, livestock constitutes a relatively small component of Malawi's agriculture contributing 7% to the agricultural GDP and just 12 % of the total value of agricultural production (Government of Malawi, 2006). The livestock sector is typically a low-input-low-output management system with over half a million smallholder families (Banda *et al*., 2000).

The country's population of cattle, goats, sheep, pigs and poultry is estimated at 889,734, 3,106,271, 188,520, 1,229,468 and 44,049,155 animals, respectively. About 13% of the smallholder farmers own cattle (Department of Animal Health and Livestock Development (DAHLD), 2008).

The national livestock development policy of Malawi as embodied in the 2004 statement aims at achieving self sufficiency in safe locally produced livestock and livestock products and export the surplus that may arise. The policy also underpins government intentions to ensure sustainable livestock development to improve nutritional well being of Malawians and to improve rural livelihoods (DAHLD, 2004).

1.4 The Dairy Sub Sector in Malawi

Dairy production in Malawi is an age-old practice especially in rural areas with the Malawi Zebu cattle representing the majority of the milking cows. Dairying started with colonial settlers in the Southern Region of Malawi before independence in 1964. The settlers grew crops but kept a few cattle mostly Jerseys, Ayrshires and Friesians for the production of milk. The beginning of, and growth of townships such as Blantyre and Zomba created demand for milk for both estate and rural farmers (Munthali *et al.*, 2000). Dairy farming in Malawi involves small and large scale dairy farmers. The industry like any other agricultural sub sector is dominated by small-scale farmers. The major differentiating features between smallholder and large-scale dairy farmers are the holding size, the genotype of cattle raised and the level of management applied. There are about 3,600 smallholder farmers who use over 6,000 Holstein Friesian x Malawi Zebu cows of different grades and about 1,700 smallholder farmers who use an unknown number of Malawi Zebu cattle for commercial milk production in the peri-urban setting. In addition to the smallholder farmers, there are 15 private large-scale dairy farms with about 2,200 milking cows. The predominant genotype on the large-scale dairy farms is the Holstein Friesian although some of these farms also have few Aryshire and Jersey cattle (Imani, 2004).

The smallholder dairy farmers are organized in three Milk Shed Areas (MSAs) around the three major cities of Malawi i.e. Blantyre in the south, Lilongwe in the center and Mzuzu in the north. These operate under corporate approach where at local level, farmers belong to milk bulking groups (MBGs). Farmers from within a radius of 8 kilometers bulk their milk at a cooling centre twice daily. The milk is collected from these centers by bulk tankers or churn lorries one or two days and then transported to the nearest processing plant in each milk shed. In addition, some larger estates deliver their milk directly to the plant in all the cities.

Regional associations of bulking groups were formed to guide and direct the activities of the bulking groups. Blantyre MSA has 20 registered milk bulking groups (MBGs) organized under Shire Milk Producers Association (SHMPA); Lilongwe Milk Shed Area has 18 registered MBGs although only 10 are operational, and are organized under Central Region Milk Producers Association (CREMPA) while Mzuzu Milk Shed Area has 6 registered MBGs organized under Mpoto Dairy Farmers Association (MDFA) (Imani, 2004).

The dairy sub sector has proved to be vital particularly in the smallholder sub-sector where milk is an important source of protein to young children and supplementary income to often cash starved farm households. In addition, the dairy industry is capable of supplying meat as by product to both rural and urban population thereby reducing malnutrition. The dairy cow is a biologically efficient animal in converting inedible roughages to milk. As a ruminant she can obtain as much as 70% of her total feed intake from non human food sources such as forages and non – protein nitrogen (Walshe, 1991). This places dairy production in a strong competitive position as a major supplier of high quality human food unlike other enterprises like pig production which compete with humans for food.

Dairy production is an important source of manure for crop production. Therefore incorporating dairying with crop production ensures a symbiotic relationship. Since dairy production is labour intensive, the sector reduces unemployment by creating jobs for Malawians. Thus, smallholder dairy production is a catalyst for agricultural development. It has the potential to increase income generation and employment with subsequent enhancement of food security and improvement of livelihoods (Kavoi *et al*., 2010).

1.5 Problem Statement and Justification

Poverty reduction and achievement of sustained economic and infrastructural development remain priority goals of the Government of Malawi. The government formulated the Malawi Growth and Development Strategy (MGDS) as the overarching strategy for poverty reduction to attain the Millennium Development Goals (MGDs) (GoM, 2006). Encouraging market oriented smallholder dairying has been one approach to enable resource poor smallholder mixed crop-livestock farmers to raise household incomes (Land O' Lakes, 2006). However, there is concern among development agencies and policymakers over the efficiency of smallholder milk producers amidst increasing competition from intensive dairy producers in both urban and peri urban areas (FAO, 2005).

In the study area (Lilongwe MSA), smallholder dairying offers an alternative important source of income as farmers continue to face dwindling prices of tobacco which was the major source of income for food insecurity and wealth creation. Considerable development efforts have been made to generate and disseminate dairy technologies among farmers through various projects by Land O Lakes, SSLP, ARDEP and Malawi Government, among others. However, access to utilization of recommended technologies and practices among dairy farmers has not been widespread as anticipated in Lilongwe MSA (Imani 2004; Phiri 2008). This has resulted in low milk production at about 50% below the potential in Lilongwe MSA (GoM 2004).

Noteworthy, little or no attention has been given to the relationships between efficiency of smallholder dairying attributes, market indicators and household characteristics in Lilongwe MSA. An understanding of these relationships could provide policy makers with information to design programmes that can contribute to measures needed to expand the milk production potential (Ng'ang'a, 2005; Rhaman, 2003). In many instances, policy decisions on livestock production and particularly smallholder dairying in Malawi seem to be taken in absence of vital information unlike in the crop production sector (Banda 2009).

Furthermore, available studies on efficiency of smallholder dairy focused on analyzing technical efficiency. For instance, Lockie *et al*. (2008) used a deterministic Cobb-Douglas (C-D) frontier production function to estimate technical efficiency for dairy production in northern and southern MSAs. Given that technical efficiency could be achieved even at a higher cost, an economic point of view suggests use of inputs in optimal quantities while keeping their cost in proportion to price received for outputs.

It is therefore recommended to examine factors affecting overall economic efficiency rather than only technical efficiency (Tchale, 2009). This study builds on previous studies by directly determining smallholder dairy farm-specific efficiency and socioeconomic factors influencing inefficiency using stochastic profit frontier model (SPFM). The profit function framework was applied in estimating efficiency in the study to avoid problems of endogeneity which occur when production functions are used (Adesina and Djato, 1997).

1.6 Objectives

The underlying objective of the study was to assess farm level profitability and economic efficiency of smallholder dairy production in Lilongwe Milk shed Area. The specific objectives were:

1. To assess profitability of improved and local smallholder dairy farming in Lilongwe MSA.

2. To assess profit efficiency of improved and local smallholder dairy farmers in Lilongwe MSA.

3. To examine the determinants of profit efficiency in improved and local smallholder dairy farming in Lilongwe MSA.

1.7 Hypotheses

The following hypotheses were tested in the study:

1. Improved and local smallholder farm milk production is not profitable.
2. Improved and local smallholder dairy farmers are not profit efficient.
3. Farmer characteristics such as labour, dairying experience and education do not influence profit inefficiency of smallholder dairying.

1.8 Summary and Thesis Organization

The rest of the thesis is organized as follows: Chapter Two reviews selected literature on studies that have been done on smallholder dairy production and related topics. The chapter highlights the problems facing the smallholder dairy sector, reviews the dairy improvement programmes and the gaps in research. Methods used in economic analysis of smallholder dairy production are also reviewed. Chapter Three presents the methodology of the study. The chapter focuses on the description of the study area, sampling method used in the study and the analytical framework.

Chapter Four presents the research results and discussions including; socioeconomic characteristics of the farmers involved in the study; analysis of profitability of smallholder dairy production; results of the stochastic profit frontiers including the inefficiency models are for improved and local daily farmers. Chapter Five concludes the study with policy recommendations for the development of the dairy sub sector in Malawi.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews selected literature on smallholder dairy production. The emphasis is on improved smallholder dairy production technologies and economic analyses. Furthermore, the chapter reviews literature on application of stochastic profit frontier model.

2.2 Overview of Dairy Sector in Malawi

Intensive smallholder dairy production in Malawi commenced in 1969. Processing plants were installed in Blantyre (1969), Lilongwe (1973) and Mzuzu (1974) to collect and process milk and meet growing urban demand. This activity was organized by Government under Malawi Milk Marketing (MMM). Farmers were organized into milk bulking groups (MBG's) to operate collection and checking centres. In 1985, under a structural adjustment programme MMM was reorganized and a statutory body called Malawi Dairy Industries (MDI) took over the three MMM dairy plants and three dairy farms. MDI was given mandate to operate on commercial lines (Imani, 2004).

MDI served as a treasury fund with the overall purpose of improving and multiplying livestock for the production of milk and the manufacturing, processing and distribution of milk products. MDI was privatized between 1998 and 2000, and was split into three separate companies namely: Dairiboard Malawi Limited in Blantyre, New Capital Dairy in Lilongwe and Northern Dairies Limited in Mzuzu (Malawi Privatization Commission, 2007).

The government has three main objectives for establishing the dairy sector: (1) to provide fresh milk for the increasing population to avoid incidents of nutritional diseases; (2) to reduce the imports of milk and milk products and; (3) to provide an alternative source of income to farmers (GoM, 2004). However, in Malawi it is illegal to sell raw/unprocessed milk in urban and semi urban areas due to the health risks involved. For this reason within the dairy sector there are formal and informal subsectors. The formal subsector is the sector where processed milk is marketed to the consumer whereas the informal subsector is where raw milk is sold to consumer (Chitika, 2008).

Currently, there are an estimated 4,000 smallholder dairy farmers in the formal sector and around 5 medium or large-scale producers with 12,000 cows. Total formal milk production is estimated at 6,500 tons. The milk produced by the informal sector is mainly produced from Zebu cattle and either home consumed or sold as raw milk to local consumers.

It is generally accepted that the present total cattle population is about 800,000, of which 25% (200,000) are cows. The Malawian Zebu cattle have an average lactation yield of 450 liters and an average calving interval of 600 days. This gives a production per cow per year of 275 liters, or an average of 0.75 liters per day. Out of this, half is for human consumption which results in total informal milk supply of around 27,000 tons for consumption per year (Imani, 2004).

The total milk supply is below the demand and this result in significant importation of milk and milk products from neighboring countries. The country imports 13-15,000 metric tones of milk equivalents, representing about 38 percent of the annual milk consumption (FAO, 2005). The total milk supply is 55,000 liters a year out of which 34,000 liters are from domestic production in the formal and informal dairy sectors. With a population of 13.1 million people (NSO, 2009), the estimated milk consumption is at 4- 5 kg per capita. This average is very low even when compared to 20 liters for SADC and FAO requirement of 200 liters per capita (FAO, 2005; Banda, 2008).

2.3 Dairy Production Systems

In the production set up, Chindime (2007) reported that there are two categories of dairy farmers in Malawi: (1). modern (improved) dairy farmers who use exotic cows; artificial insemination; feed animals with dairy meal; use mineral supplements; and (2) traditional (local) dairy farmers who use only pure local zebu cows; practice open grazing with no fodder conservation; no artificial insemination and no improved housing. Chintsanya *et al*. (2004) reported that dairy production in Malawi is a medium input system which involves use of local and exotic breeds. It is therefore recommended to separate the production systems when studying the dairy sub sector in Malawi.

2.4 Innovations in Smallholder Dairying in Malawi

Recognizing the potential of smallholder dairying, Malawi Government and other dairy development agencies have implemented projects aimed at disseminating improved dairy technologies to enhance milk productivity. The Malawi Government's efforts started with introduction of high quality breeds in the Southern Region between 1968 and 1970. These were crosses of Friesian bulls and Malawi Zebu. The dairy cattle multiplication project then followed in 1970. In this project, crossbred dairy cattle were multiplied at Government owned dairy farms namely Mikolongwe, Likasi and Choma. The multiplied dairy cattle were distributed to farmers through a loan scheme run by a Government board (Phiri, 2007).

Similar multiplication programmes followed with the largest being the National Livestock Development Project implemented in 1990. The project also focused on improving production of selected DAHLD farms involved in multiplication of breeding and fattening stock for issue to beef, dairy and poultry smallholder farmers. However, progress of the Government efforts were affected by the structural adjustment programmes of the 80's and 90's that restricted government support in service delivery.

Apart from Government efforts, Non Governmental Organizations such as Land O' Lakes, Small Scale Livestock Development Partnership (SSLP) and recently the Agricultural Research and Development Programme (ARDEP) have supported dairy development through promotion of improved breed and dairy management practices (Chindime, 2007; Banda, 2009).

Land O' Lakes implemented the Malawi Dairy Business Development Programme from 1999 to 2006. The main aim of the project was to increase access to high grade dairy cows, supplemental feed stations and vitamin supplements and veterinary pharmaceuticals (Phiri, 2007). SSLP and ARDEP funded projects have similar objectives and adopted the heifer scheme model. The model involves distribution of livestock to initial beneficiaries who in turn pass on a female calf to secondary beneficiaries.

The smallholder dairy sector has benefited from a number of improved technologies through various dairy development project activities such as; provision of extension messages on supplementary feeding and homemade dairy mash; pasture establishment and fodder conservation for stall-feeding; importation of improved dairy cattle breeds for dissemination to farmers on a heifer loan scheme; importation of dairy semen to improve milk production per cow; artificial insemination (AI); construction of appropriate housing and structures for dairy animals; improved veterinary services; promotion of zero grazing systems for dairy cattle and provision of training to dairy farmers. Hence progress in the dairy sector depends on delivery of these key improved technologies to smallholder dairy farmers (Phiri, 2007; Banda, 2008).

2.5 Economic Analysis of Smallholder Dairy Production

Economic analysis is necessary in assessing the profitability and viability of agricultural enterprises. There are different methods such as cost benefit analysis and gross margin that can be used to assess profitability of dairy enterprises (Ndambi *et al.*, 2008).

2.5.1 Cost - benefit analysis (CBA)

Cost-benefit analysis is a financial appraisal of an activity that compares all cost and benefits that go into the production process. Measuring the cost and benefits of production is important if a farmer wants to know whether he is making profit. While one can tell the price of milk right away, it is often difficult to measure production costs and profits (Bailey, 2001). Estimation of economic returns plays a very important role in influencing farmers' choice to adopt a new technology and consequently influences their resource management decisions (Bamire *et al.*, 2003). The understanding of costs and benefits is also an important pre-requisite for policy formulations aimed at improving productivity levels.

Mburu *et al.* (2007) used cost-benefit analysis to compare the profitability of smallholder dairy production in different agro-ecological zones in Kenya highlands. The results showed that farmers in the upper midlands were making much more profit from milk than those in the lower highlands. Furthermore, the study revealed that use of commercial dairy supplement was common but appeared unrelated to the level of milk production. The quantity of supplements fed varied across the zones. However, utilization and cost of the feed affected cost of milk production.

Mdoe *et al.* (1997) conducted a benefit- cost analysis to estimate returns to smallholder dairying in the Kilimanjaro region of Tanzania. Results showed that the returns to dairying were around 20%. There was no difference in returns between large scale farmers and small-scale farmers with potential lower stock. The cost benefit calculation was also used to generate summary measure of Internal Rate of Return, and Net Present Values. The benefit cost ratios were almost identical across scale groups, despite the marked differences in the intensity of spending on feed.

Van Shaik *et al.* (1996) derived benefit-cost ratios from a simulation model called TIES. The model was used to assess the performance of smallholder dairy farming among 18 case farms in Murang'a District, Kenya. The results showed that smallholder dairy farms differ in performance with milk production level and calving interval as the main indicators of performance. The study concluded that the impact of technical interventions on dairy performance can be evaluated on the basis of milk production and calving intervals which are in turn influenced by amount of concentrates fed. Consequently, the study suggested that concentrate is an indicator of high dairy farm performance.

Although cost-benefit analysis is an effective tool for analysis of profitability of an enterprise, the tool has a number of weaknesses. The major weakness is that the tool focuses on financial costs and benefits. When intangible cost and benefits are included in the analysis, the estimated values are bound to be subjective (Chamdimba, 2007).

2.5.2 Gross margin analysis

Johnson (1982) defines gross margin as the difference between the value of an enterprise's gross output and variable cost of production. Gross margins are used to evaluate economic viability of an enterprise. They are used in agriculture for farm planning and comparing different farms with similar characteristics or different enterprises on the same farm (Chamdimba, 2007).

Somda *et al*. (2005) analyzed the economic viability of milk production in smallholder farming systems in Gambia. In a study involving 90 smallholder dairy farms, the gross margin analysis was used to assess the profitability and viability of smallholder dairy production. The results showed that smallholder dairy farming in Gambia was indeed viable. The study also established that profitability varies across groups based on the scale i.e. medium-resource group and resource poor farmers. Viability was higher in resource medium group than in resource poor group. This implies that smallholder dairy farmers have different resource endowments which affect profitability. Overall a dairy technology that requires more resources is likely to be less preferred by resource-poor farmers.

Bayemi *et al.* (2009) used partial budgeting to analyze the impact of management interventions such as artificial insemination, feed supplementation, and farmer training in milk processing and veterinary services on smallholder dairy farms of western highlands of Cameroon. The study, which involved 24 peri-urban farmers, found that the interventions decreased feed, transport and veterinary costs. An overall return of 200% was realized from the management interventions. Furthermore, the study concluded that milk collection system, price of fresh milk, genotype of cattle and management were the most important factors influencing profitability and economic viability of smallholder dairying.

Mwale *et al*. (1999) assessed economic feasibility of smallholder dairy farmers using Malawi Zebu and its crosses for dairy in Mzuzu Milk Shed Area. The results suggested interlinkages between genotype and management level under the prevailing smallholder conditions in Malawi. In addition, when no labor costs were included, gross margin analysis showed that the Malawi Zebu was the most efficient genotype in a low-input low-output system. This therefore implies that the genotype of the dairy cow, management practice and labour costs (family and hired labour) have a significant influence on smallholder dairy returns.

Chindime (2007) applied the gross margin analysis to estimate returns from smallholder dairy among borrowers and non borrowers of in kind credit in central and northern milk shed areas of Malawi. The results revealed that smallholder dairy farming was profitable for both borrowers and non borrowers with borrowers reporting higher gross margins than non borrowers.

2.6 Approaches to Study Efficiency

A number of approaches are used to measure production efficiency. The original approaches are based on what are called frontiers, as proposed by Farrell (1957). A frontier defines the maximum feasible output in an environment characterized by a given set of random factors. The ratio of the observed output to the frontier is taken as a conventional measure of its relative efficiency. Two types of frontiers have been used in empirical estimations: parametric and non-parametric frontiers. The former use econometric approaches to make assumptions about the error terms in the data generation process and impose functional forms on the production functions, while the latter neither imposes any functional form nor makes assumptions about the error terms (Tchale, 2009).

The parametric approach essentially implies that structural restrictions are imposed and the effects of misspecification of the functional form might be confounded with the inefficiency. The non-parametric approaches (e.g. data envelopment analysis – DEA) are free from misspecification but they do not account for the effect of other factors that are normally not under the control of the farmer and thus are not good for studying efficiency at the smallholder farmer level where conditions are highly heterogeneous (Greene, 2003). Parametric approaches are preferred because of the many variation that underlie smallholder production in developing countries.

2.7 Measuring Economic /Profit Efficiency

Efficiency has three components: technical, allocative and economic. Technical efficiency refers to input-output relationship. A firm is said to be efficient if it is operating on the production frontier. On the other hand, a firm is said to be technically inefficient when it fails to achieve the maximum output from the given inputs, or fails to operate on the production frontier.

An efficient farm utilizes fewer resources than other farms to generate a given quantity of output. Allocative efficiency has to do with the profit maximizing principle. Under competitive conditions, a firm is said to be allocatively efficient if it equates the marginal returns of factor inputs to the market price of output (Okoruwa *et al*., 2009). Adesina and Djato (1996) defined allocative efficiency as the extent to which farmers make efficient decisions by using inputs up to the level at which their marginal contribution to production value is equal to factor costs.

Economic efficiency is distinct from the other two even though it is the product of technical and allocative efficiency. A firm that is economically efficient should by definition be both technically and allocatively efficient. However, it is possible for a firm to have either technical or allocative efficiency without having economic efficiency (Akinwumi and Djato, 1997). The reason may be that the farmer, in this case, is unable to make efficient decisions as far as the use of inputs is concerned.

Analysis of economic efficiency therefore gives a wider view of competitiveness and performance of a dairy farm. In a profit maximization framework, a dairy farm can also be inefficient if it is not equating the marginal revenue to marginal cost (Kumbhakar *et al*., 1989). Profit efficiency is therefore the ability of a farm to achieve highest possible profit given the prices and levels of fixed factors of that farm. Profit inefficiency in this context is defined as the loss of profit for not operating on the frontier (Ali and Flinn, 1989).

2.8 Conceptual Framework

A rational dairy farmer allocates a given set of inputs to maximize profits from his/her enterprise. In order for the farmer to maximize profits he/she has to produce on a Production Possibility Frontier (PPF). At this level, the dairy farmer's objective is to produce a maximum output given the available inputs. When this is achieved a farmer is said to be technically efficient (Kakhobwe, 2007). Furthermore, given a set of input prices, a farmer would want to optimally produce his output using the minimum cost of input mix. Achievement of the minimum cost of production means the farmer is allocatively efficient.

The dairy farmer becomes economically efficient when both above conditions have been achieved. The dairy farmer seeks to explore ways to measure his/her efficiency level as he/she does not want to produce below the optimal output levels and beyond the minimum input cost. This is accomplished by using a stochastic profit frontier which gives levels of economic efficiency and inefficiency, and factors responsible for the efficiency or inefficiency. When the dairy farmer is economically inefficient he/she moves to the frontier by addressing the technical and allocative inefficiencies.

A combination of economic factors, institutional factors, available inputs and farmer characteristics influence dairy production decisions. Economic factors include dairy input and output market prices which limit the scale of the dairy enterprise. Institutional factors such as access to credit and extension enhances the capacity of the dairy farmer to use improved technologies on the farm. The level of inputs such as labour, feed and veterinary drugs and services determines the production mix that a farmer chooses to achieve his objectives.

Furthermore, farmer characteristics including level of education, dairying experience, gender of household head and membership to MBG plays a key role in influencing decisions on the farm. Attainment of technical and allocative efficiency depends on these decisions which may also lead to achieving economic/profit efficiency (Nganga, 2010; Delgado, 2003).The stochastic profit frontier can be estimated using these factors. Figure 2.1 shows factors influencing decisions and economic/profit efficiency.

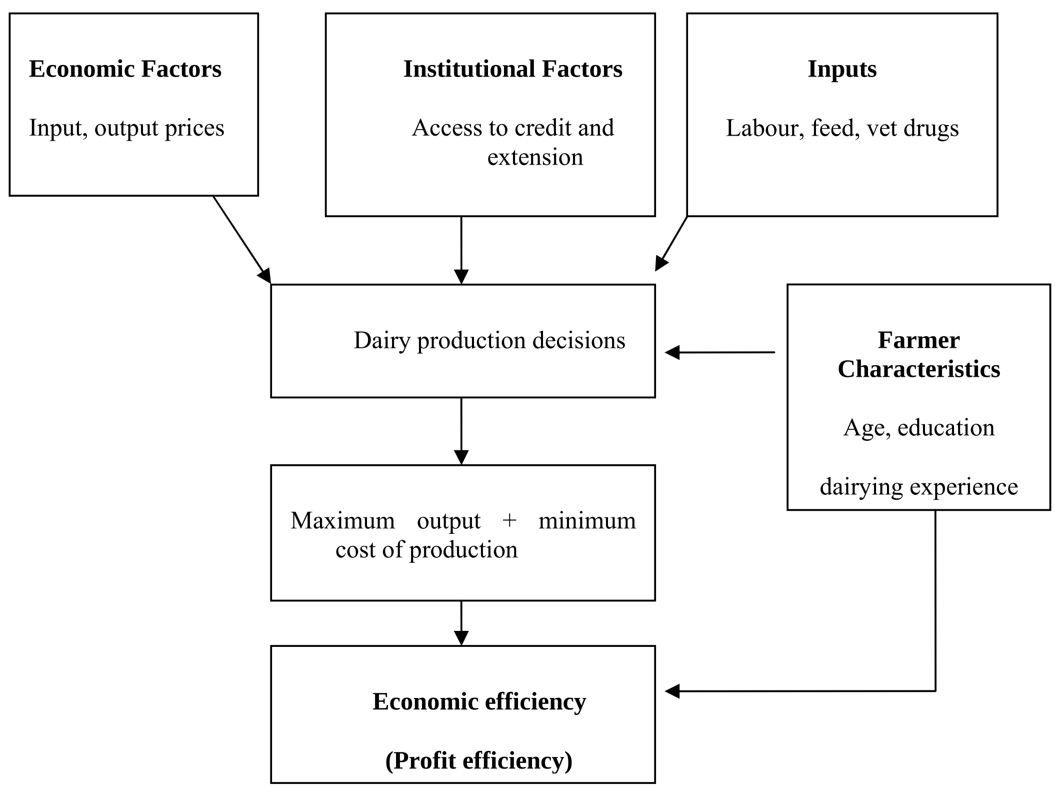

Figure 2.2: Framework for profitability and efficiency of smallholder dairying

2.9 Stochastic Profit Frontier Model Application

The popular approach for measuring efficiency component is the use of stochastic production frontier. Kakhobwe *et al*. (2010) used a stochastic production frontier to measure the technical efficiency of mixed cropping and relay cropping technologies in Zomba District, Malawi. Tchale (2009) also applied a stochastic production frontier in estimating the efficiency of smallholder agriculture in Malawi. However, use of a production function approach to measure efficiency may not be appropriate when farmers face different prices and have different factor endowments (Ali and Flinn, 1989). Similarly, Adesina and Djato (1997) reported that use of production function to analyze efficiency suffers from simultaneous equation bias because the input levels are endogenous. The profit function methods avoid these problems. A stochastic profit frontier model is therefore appropriate for direct estimation of farm-specific efficiency. Furthermore, the profit function approach combines technical and allocative efficiency in a profit relationship and any errors in the production decisions are assumed to be translated into lower profits or revenue for the producer (Rhaman, 2003). A number of studies have used the profit stochastic frontier to estimate efficiency and identified factors influencing it.

Delgado *et al.* (2003) applied a stochastic profit frontier to study profitability and efficiency of dairy farms in India. The study revealed that profit efficiency varied across farm sizes. It was concluded that if efficiency varies across farms, relatively more efficient farms would be more profitable. Furthermore, price of concentrate feed and milk yield were the major factors affecting profit efficiency. The study validated the application of the profit frontier on farms of different dairy farm types and sizes.

Rahman (2003) used the stochastic profit frontier model to analyze efficiency of Bangladesh modern rice farmers. Using cross-sectional survey data from 380 modern rice farms, the study showed that profit efficiency varied widely among farmers. The mean level of efficiency for modern rice farming was 0.77. The mean level of efficiency indicated that there was room to increase profits by improving technical and allocative efficiencies. Farmers experienced in growing modern varieties, with better access to input markets, and who do less farm work tend to be more efficient. The study justified the use of cross sectional data when estimating frontiers and provided a guide on interpretation of the estimated efficiency levels.

Oguniyi *et al*. (2008) employed a translog stochastic profit frontier to examine profit efficiency of cocoyam production in Osun State, Nigeria. Using farm level data from 120 cocoyam farmers, the results showed an average profit efficiency of 12%. The study also noted that type of soil, family size, farm size, credit and farming experience contributed to the levels of profit efficiency. The study recommended that efficiency in cocoyam production can be improved by increasing farm size, using of mulch and having better access to credit. The translog specification was justified in the study due to its inherent advantages over other specifications such as the Cobb Douglas function

Abu and Kirsten (2009) applied the translog stochastic frontier to measure profit efficiency of small-and medium scale maize milling enterprises in South Africa. The results showed an average profit efficiency of 80.6% for the small-scale mills and 87.4% for medium scale mills which revealed an unexploited potential in the two categories of mills. The study also assessed levels of competitiveness of the small-scale- and medium scale maize milling in South Africa. A key observation from this study was the separation of model estimation when dealing with different farm types.

Nganga *et al*. (2010) used a stochastic profit frontier model to analyze efficiency of sampled milk producing farmers in the Meru south district of Central Kenya. Using cross-sectional survey data obtained from 27 milk producing farms, the study showed that profit inefficiency varied moderately among the sampled farmers. It ranged from 26 to 73% with a mean of 60%. The farm specific variables used to explain inefficiency showed that farmers who had a higher level of education, more experience and larger farm sizes tend to be more efficient. The study further warranted the application of profit frontiers in studying efficiency of smallhoder dairying in developing countries.

2.10 Summary

The literature review has highlighted different smallhoder dairy production systems in Malawi which consists of improved and local dairy farming practices which should be considered when researching on smallholder dairy in Malawi. The review has provided empirical approaches to measuring farm-level profitability i.e. cost benefit and gross margin analyses. Similarly, approaches to measuring efficiency and studies that have applied the stochastic profit frontier in measuring efficiency have been reviewed. The review has also showed that socioeconomic factors affecting inefficiency among farmers including age, gender, level of education, experience among others.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

The purpose of this chapter is to highlight the methodology used in the study. First, the chapter presents a description of the study area, sampling procedure, data collection tools and training of enumerators. Thereafter, model description is presented including theoretical and analytical tools.

3.2 Smallholder Dairy Farm Survey

3.2.1 Description of the study area

The study was conducted in selected milk bulking groups (MBGs) from Lilongwe MSA which covers Lilongwe and Kasungu Agricultural Development Divisions (ADD) in Central Region of Malawi. Lilongwe MSA has a total of 18 MBGs registered under Central Region Milk Producers Association (CREMPA). The association is active in 8 districts of Dedza, Dowa, Kasungu, Lilongwe, Mchinji, Ntcheu, Ntchisi and Salima with a total membership of 2,255 dairy farmers (Chitika, 2008; Land O' Lakes, 2006).

Lilongwe MSA was chosen because it has a high concentration of smallholder dairy farmers who supply milk to the processing plants and urban dwellers in the Lilongwe City. In addition, dairy farmers in the area have received support from dairy development projects such as Land O' Lakes (LO'L), Small Scale Livestock Promotion Partnership (SSLP) and LAPE-TAPP- DAHLD partnership project supported by ARDEP. Chitsanzo and Dzaonewekha MBGs are in Dedza District.

Lumbadzi MBG is located at Chigonthi Trading Center near Kamuzu International Airport, a distance of 30 km from Lilongwe. Majiga MBG is located in Dowa District which is about 25 km from Lilongwe while Mpalo MBG is located in Ntchisi District and is 68 km from Lilongwe District (Chitika 2008).

Lilongwe lies at an attitude of 1,000-1,400m above sea level. The district occupies 542, 550 hectares excluding Dzalanyama Range. It has a warm tropical climate with mean annual temperatures of about 20^{o} C to 22.5^{o} C. Lowest temperatures of 3.5^{o} C to 12.5^{o}C are experienced in July. Highest temperatures reaching 39^{o}C are experienced in October and November. The mean annual rainfall ranges from 800mm to 1000mm. There are 350,663 farm families in the district. The main livestock kept in the district are cattle, goats, pigs, rabbits, turkey and ducks (Lilongwe City Assembly, 2006).

3.2.2 Sampling procedure and sample size

Sample size and the sample selection process should assure the representativeness of the population. Sample size determination has its own scientific approach. In this study, to determine sample size, different factors such as research cost, time, human resource, accessibility and availability of transport facilities were taken into consideration.

The study used a two stage procedure. The first stage involved purposive selection of MBGs which were targeted by dairy development projects by LOL, SSLP, FIDP and ARDEP. In addition, the MBGs were purposefully selected due to the large number of improved and local dairy farmers who produce milk for the urban and peri urban population in Lilongwe city. In the second stage, from a list of dairy farmers who owned improved dairy and local dairy cattle, simple random sampling method was used to select 161 farmers (118 improved and 43 local dairy farmers) who had their cows in milk for the previous 12 months.

3.2.3 Data collection

The survey collected cross sectional data and made use of both primary and secondary data. Primary data was collected through a structured questionnaire, a checklist and a monitoring survey. Structured questionnaires were administered to 161 farmers in the 5 MBGs. The information collected included quantities and costs of all variable inputs, dairy cattle production levels, herd size and socio economic characteristics of dairy farmers. A checklist was used to collect qualitative information from MBGs and key informants i.e. Government Assistant Veterinary Officers and MBG Executive members.

A monitoring (observational) survey recorded farm activities on daily basis in order to validate the information collected during the household interviews. This involved purposively selecting a total of 24 dairy farmers including 18 IDFs and 6 LDFs. The monitoring survey involved weighing and measuring inputs such as feed (concentrates) and labour time, and milk produced. Secondary data was collected from Land O Lakes Malawi, SSLPP, ARDEP, Department of Animal Health and Livestock Development, and MBG records.

3.2.4 Training of enumerators

Data was collected with the help of enumerators. The enumerators were trained in order to help them master the data collection tools and to avoid interviewer errors. The questionnaire was pre-tested to remove ambiguities.

3.3 Methods of Analysis

3.3.1 Descriptive statistics

The study used descriptive statistics such as frequencies and means to analyze the socioeconomic characteristics of dairy farmers in the study area. Cost benefit analysis and gross margins were used to assess farm-level profitability of smallholder dairying.

3.3.2 Gross margin analysis

Gross margin is defined as the difference between the value of an enterprise's gross output and variable costs (Ergano and Nurfeta, 2006). Gross margins were calculated for dairy farms practicing improved dairy production and those farms using local dairy production practices. A t-test was used to test differences in gross margins.

The following formula was used to calculate the gross margins:

$$GM = GR - VC \qquad (3)$$

where, GM is gross margin per cow in Malawi Kwacha,

GR is gross revenue calculated as the product of price per unit output and the amount of milk produced in Malawi Kwacha,

VC is variable costs associated with milk production in Malawi Kwacha.

Gross income included the value of milk sales, the value of milk consumed by the household and milk given to the calf. Enterprise variable costs including feed (concentrates), veterinary, breeding and labour (hired) costs were calculated based on financial prices.

3.3.3 Econometric analysis

The study employed the stochastic profit frontier model to evaluate economic efficiency of smallholder dairy production and identify determinants of economic efficiency of the dairy farmers. This followed Battese and Coelli (1995) who extended the stochastic production frontier model by suggesting that inefficiency effects can be expressed as a linear function of explanatory variables, reflecting farm-specific characteristics. The advantage of the model is that it allows the estimation of farm specific efficiency scores and the factors explaining the efficiency differentials among farmers in a single stage estimation procedure.

Following Rahman (2003) and Nganga *et al.* (2010), the study used the Battese and Coelli (1995) model by postulating a profit function, which is assumed to behave in a manner consistent with the stochastic frontier concept. The stochastic profit function is defined as:

$$\pi_i = f(P_{ij}, Z_{ik}).\exp(\varepsilon_i) \qquad (6)$$

where,

π_i is normalized profit of the ith farm defined as gross revenue less variable cost, divided by farm-specific output price P;

P_{ij} is a vector of variable input prices faced by the ith farm divided by output price;

Z_{ik} is a vector of fixed factors of the ith farm;

ε_i is an error term; and

i =1,., n, is the number of dairy farms in the sample.

The error term ε_i is assumed to behave in a manner consistent with the frontier concept (Ali and Flinn, 1989), i.e.

$$\varepsilon_i = v_i - u_i \qquad (7)$$

where $v_i's$ are assumed to be independently and identically distributed $N(0,\sigma_\upsilon^2)$ two sided random errors representing the random effects, measurement errors, omitted explanatory variables independent of the u_i's. The statistical noise u_i's are non-negative random variables representing inefficiency of a dairy farm. Hence u_i's represent the profit shortfall from the maximum possible value that will be given by the stochastic profit frontier. They are assumed to be independently distributed such that efficiency measures are obtained by truncation at 0 of the normal distribution with mean, $\mu_i = \delta_0 + \sum_d \delta_d W_{di}$ and variance $\delta_u^2(N(\mu_i, \sigma_u^2)$ where W_{di} is the d^{th} explanatory variable associated with inefficiencies on farm i and δ_0 and δ_d are unknown parameters.

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

$$PE_i = E\left[\frac{\exp(-u_i)}{\varepsilon_i}\right] \qquad = E\left[\exp\left\{\frac{(-\delta_0 - \sum_{d=1}^{D} \delta_d W_{di})}{\varepsilon_i}\right\}\right] \qquad (8)$$

where PE is profit efficiency and E is the expectation operator. This is achieved by obtaining expressions for the conditional expectation u_i upon the observed value of ε_i.

The method of maximum likelihood is used to estimate the unknown parameters, with the stochastic frontier and the inefficiency effects functions estimated simultaneously. According to Battese and Coelli (1995), the likelihood is expressed in terms of the variance parameters:

$$\sigma^2 = \sigma_\upsilon^2 + \sigma_u^2 \quad \text{and} \quad \gamma = \left(\frac{\sigma_u^2}{\sigma_u^2 + \sigma_\upsilon^2} \right) \qquad (9)$$

where, σ^2 is the total variance for the combined error term ε_i

σ_υ^2 is the constant variance for the symmetric error term v_i

σ_u^2 is variance for the non negative error term $u_{i,}$ and

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

The study used both translog and Cobb-Douglas functional forms. The translog specification was favored due to its inherent advantages over other functional forms like Cobb Douglass function (Matanmi *et al*., 2008; Rahman, 2003). The fitted models were analyzed using frontier software based on STATA statistical computer software. Frontier fits the stochastic profit frontier models and is compatible with cross-sectional data that was used in the study (Wubeneh and Ehui, 2004; Kakhobwe *et al*., 2010; Tchale, 2009).

3.3.3.1 Definition of variables and *a priori* expectations

In the stochastic profit frontier, the dependent variable was gross margin as a proxy for profit. The independent variables were defined as follows:

Price of feed

The price of feed (concentrate) or fodder affects profitability. In Kenya, a study by Omiti *et al*. (2006) found that quantity of concentrates used per litre of milk and the weighted price of concentrate feed had negative effects on profitability. This showed the importance of concentrates in milk production. The price of concentrates was therefore expected to negatively affect smallholder dairy farm profits. The variable was captured by estimating the total expenditures and quantities for each respective concentrate.

Labour wage

Dairy production is labour intensive, as such labor as an input plays a significant role in profitability and efficiency of the enterprise. In the smallholder set up in Malawi, family labour and hired labour are usually involved. The study only considered hired labour as it is more accurate to measure in a smallholder dairy setup. The price of labor in terms of labour hours was computed by calculating the annual expenditure on hired labour.

Otieno *et al.* (2009) noted that labour significantly explained the variation in profits in smallholder dairy farms in western Kenya. Wilson (2010) observed that low expenditures on labour resulted in higher dairy profitability in dairy farming. It was therefore hypothesized that labour wage has a negative influence on profits.

Health cost

Kavoi (2010) examined the relationship between animal health related costs and profitability of smallholder dairy in the marginal zones of Kenya where increased health related costs reduced dairy farm profits. In this study, health costs included dipping and vaccine costs incurred per animal in the previous year in Malawi Kwacha. A negative relationship was hypothesized between health cost and profit.

Herd size

In the study herd size was the number of dairy cows available on a farm. Lapar *et al.* (2005) observed that smaller herd sizes increase efficiency due to the reduction in costs associated with a larger herd size in a smallholder set up. Therefore farm size was hypothesized to have a negative relationship with profit.

3.3.4 The Inefficiency Model

Age of household head

Age of household head was a continuous variable measured in years. Age was considered in the study because the head is responsible for household farm decisions. Delgado *et al.* (2003) noted that older farmers tended to have lower levels of efficiency in dairying on Indian dairy farms. Therefore a positive relationship was hypothesized between age of household head and inefficiency.

Education of household head

Education level Influences efficiency. This is because efficiency in agriculture production, in terms of quality and quantity, speed of new technology adoption and rationalizing of input, may boost the output. In addition, schooling has been shown to provide substantial externality benefits by increasing farm output and shifting the production frontier outwards (Weir and Knight, 2005). Edrisinghe *et al*. (2010) reported that education represents human capital in reducing inefficiency in dairy holdings. It was hypothesized that education has a positive impact on efficiency. The education of the variable was measured by number of years in formal education.

Gender of household head

Gender of household head is also an important factor in estimating efficiency of agricultural production. In Malawian agricultural sector, women provide at least 70% of the labor force. However, it is generally hypothesized that male-headed households are more likely to get information about new technologies and hence be efficient than female-headed households. This was a dummy variable taking a value of one if the household head is female and zero otherwise.

Years of dairying experience

Experience in dairying is an important factor as it exposes the farmer to various dairy production techniques. Nwanchukwu *et al.* (2007) showed that smallholder farmers with more years of experience achieved higher levels of economic efficiency than less experienced farmers. Therefore it was expected that dairy farmers with more dairy experience will be more efficient. Hence years of dairying experience was expected to reduce inefficiency.

Household size

In all farming activities, human physical energy is required. The level of active involvement by individuals in their farms to a large extent determines their production output levels. A household is defined as a person or a group of persons, related or unrelated, who live together in the same dwelling unit, who make common provisions for food and regularly take their food from the same pot or share the same grain store, or who pool their income for the purpose of purchasing food (National Statistics Office, 2006). Household size was measured as the number of family members living in the particular household at the time of the survey. A negative relationship was hypothesized between household size and inefficiency.

Institutional factors

Institutional factors were used to assess the influence of transactions on smallholder dairy efficiency. Delgado (2003) found that transaction costs were responsible for variation in profit efficiency of dairy farms. Access to credit and extension were the key institutional factors used in the study.

Access to credit contributes to farmer adoption of new technologies and practices by easing farmers' liquidity constraints. As credit is likely to facilitate investment in crossbred dairy cows it will have substantial impacts on smallholder dairy farms especially if it is targeted to credit constrained farms. In Malawi, studies on credit in smallholder dairy (Chindime, 2007; Phiri, 2007) showed that credit played a significant role in adoption of improved dairy technologies such as protein supplements. Therefore, access to credit is expected to positively affect efficiency.

This was measured as a dummy variable, one if any of the households accessed dairy credit and 0 otherwise.

Access to extension services and information about technical aspects of dairy technologies plays an important role in increasing farm-level efficiency (Tchale, 2009). Therefore access to dairy extension is expected to reduce inefficiency in smallholder dairying. The variable was measured as a dichotomous variable, 1 if the household accessed dairy extension and 0 otherwise.

3.4 Summary

This chapter has highlighted the methodology used in the study. The study area has been described including the location of the MBGs and dairy farmers that were sampled. The methods of analysis used in the study have been discussed. The chapter also presented the Stochastic Profit Frontier Model and the a *priori* expectation on the variables in the model.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents results and discussions of the study. Firstly socioeconomic characteristics of Improved Dairy Farmers (IDFs) and Local Dairy Farmers (LDFs) in the study area are presented. The socioeconomic characteristics were intended to assist in understanding the differences that may exist between IDFs and LDFs. Thereafter, an analysis of farm-level profitability of IDFs and LDFs using cost benefit and gross margins is presented. Finally, an analysis of economic efficiency and factors influencing inefficiency for IDFs and LDFs using a stochastic profit frontier model is also presented in the chapter.

4.2 Socioeconomic Characteristics of Households

4.2.1 Age of household head

The overall mean age of household head for the sample was 45.1 years (Table 4.1). The mean age was 45.7 years for IDFs and 43.6 years for LDFs. The differences in the average ages of IDFs and LDFs were not significant ($P>0.05$). The average age is consistent with Chitika (2008) who observed that the mean age in Lilongwe MSA was 43.95 years.

Table 4.1: Socio-economic characteristics of sampled households

Characteristic	IDFs (n=118)	LDFs (n=43)	All (n=161)	P value
Mean age of household head (Years)	45.7(1.1756)	43.6(2.0050)	45.1(1.0138)	0.379
Mean household size	6.4 (0.2281)	7.6 (0.4576)	6.7 (0.2105)	0.110
Mean years of dairying experience	5.7 (0.4574)	15.6(1.3077)	8.3 (0.5899)	0.000
Mean farm size* (No. of milk cows)	1.9 (0.8761)	2.3 (0.2755)	2.0 (0.0981)	0.074

Note: Figures in parenthesis are standard errors
*Farm size was measured by head count of milk cows (See Kavoi, 2010)

4.2.2 Household size

The overall mean household size was 6.7 persons (Table 4.1). The average household size was 7.6 and 6.4 for LDF and IDF, respectively. However, t-test showed that the difference in average household sizes for the two farmer categories was not significant (P>0.05). Household size indicates the availability of labour (Osotimehin *et al*., 2006; Edriss, 2003). The larger the household size the more labour is available for agricultural activities. Staal *et al*. (1998b) indicated that labour for dairy production activities was provided mainly by the family but 60% of the households used hired labour, with 20% retaining permanent labour throughout the year.

4.2.3 Years of dairying experience

The overall mean number of years of dairying was 8.4 years (Table 4.1). The mean for improved dairy farmers was 5.7 years and 15.6 years for local dairy farmers. The average number of years of dairying of improved dairy farmers was significantly different from that of local dairy farmers (P<0.01). The results imply that local dairy farmers have more experience in dairying than improved dairy farmers. However, this is contrary to expectation that farmers with more experience are likely to adopt improved technologies. Households with past experience in dairy are able to diagnose and control diseases, and give the right kind of feeds to animals (Makokha *et al*., 2007).

4.2.4 Herd size

Herd size in the study was number of dairy animals per farm. The overall mean number of dairy animals was 2 cows (Table 4.1). The mean herd size for improved dairy farmers was 1.9 which was below the overall mean of 2. The average herd size for local dairy farmers was 2.3 cows, which was above the overall mean. The results from t-test showed that the average dairy herd sizes for the two dairy production systems were significantly different ($P<0.10$). A typical smallholder dairy farmer in Malawi owns between 2 to 3 dairy animals (Mgomezulu, 2002).

4.2.5 Education of household head

Table 4.2 shows that the overall mean number of years of education for the sample households was 6. IDFs had higher mean years of education (6.2) than LDFs (5.6). T-test showed that the differences in mean years of education between IDFs and LDFs was significant ($P<0.05$). The proportion of LDFs' household heads that did not attain formal education was higher than IDFs household heads and was also significant ($P<0.05$). Thus improved smallholder dairy production in Lilongwe MSA is largely practiced by farmers who have attained basic formal education. Education plays a critical role in adoption of new farming methods.

Table 4.2: Education level of household head

Education Level	IDFs (n=118)	LDFs (n=43)	All (n=161)	P value
None (%)	2.5	9.3	4.3	0.0621
Primary School (%)	70.3	79.1	72.7	0.2694
J.C.E (%)	15.3	9.3	13.7	0.3287
M.S.C.E (%)	7.6	2.3	6.2	0.2186
Tertiary (%)	3.4	0	2.5	0.2226
Adult literacy (%)	0.8	0	0.6	0.5572
Total	100	100	100	
Mean years of Education	6.2	5.6	6.0	0.0325

4.2.6 Gender of household head

Table 4.3 shows that more dairy farmers were from male headed households (72.0%) than from female headed households (28%). Furthermore, p-value showed that the proportion of female headed dairy farmers was higher among IDFs than LDFs ($P<0.01$). This could be the case because the dairy development programmes in Malawi are encouraging higher women participation in improved dairy activities. Tangka *et al.* (1999) also observed an increased women participation in intensified dairying in Kenya.

Table 4.3: Gender of household head

Characteristic	IDFs (n=118)	LDFs (n=43)	All (n=161)	P value
Male headed households (%)	69.5	79.1	72.0	0.2315
Female headed households (%)	30.5	20.9	28.0	0.0013
Total	100	100	100	

4.2.7 Non dairy income

Non dairy income is income obtained from non dairy enterprises including crop sales, off farm employment and remittances. The overall mean non dairy annual income was MK89 091(Table 4.4). This shows that dairy farmers in the study area live above the expenditure threshold of MK16, 165 ($117) per year (NSO, 2004). The mean annual non-dairy income for the IDFs was higher (MK99,900.56) than that of LDFs (MK58,723.80) and was significant ($P<0.05$). This means that improved dairy farmers have bigger income base than local dairy farmers. In addition, it also implies that most farmers who are targeted with improved dairy farming technologies are those who are relatively wealthier. During the focused group discussions it was reported that the selection of beneficiaries for the pass on programme takes into account and individuals capacity in terms of resources to manage the dairy cow feed and health requirements.

Van Shaik *et al.* (1996) in an economic study of smallholder dairy farms in Murang'a District, Kenya found that non-dairy income influenced overall farm performance. Non-dairy income increases the capacity of dairy farmers to purchase dairy inputs such as feed and livestock drugs. This therefore means that improved dairy farmers have better financial capacity to meet input costs than local dairy farmers.

Table 4.4: Non dairy income among improved and local dairy farmers

Characteristic	IDF (n=118)	LDFs (n=43)	All (n=161)	P value
Mean annual non dairy income (MK)	99,900.56	58,723.80	89, 091.00	0.020

4.2.8 Institutional Factors

4.2.8.1 Access to credit

Table 4.5 shows that IDFs had a higher (92.1%) access to input credit than LDFs (33.3%).

Table 4.5: Farmer access to credit and extension

Characteristic	IDFs (n=118)	LDFs (n=43)	All (n=161)	P value
Access to inputs credit: Yes (%)	95.5	57.1	92.6	0.000
Access to extension: Yes (%)	98.9	70	87	0.000

The p-value showed that the difference in proportion of dairy farmers with access to input credit was highly significant (P<0.00). The results imply that adoption of improved smallholder dairy production largely depends on access to input credit. The results are consistent with findings by Phiri (2007) who observed that adoption of improved dairy technologies is influenced by credit. The dairy farmers mainly access credit for inputs through a drug revolving fund available in the MBGs. The credit includes dairy farming inputs such as commercial dairy mash, vitamin supplements, drugs and improved breed semen. The credit is automatically recovered through deductions from monthly milk sales.

4.2.8.2 Access to extension

The results in Table 4.5 show that 97.7 % of the dairy farmers had access to extension services. Access to extension was however higher for IDFs (99.1%) than LDFs (88.9%). The p- value showed that extension contact between the farmer categories was highly significant (P<0.00).

This therefore means that improved dairy farmers in general receive more attention from extension service providers. NSO (2007) found that only between 0.3% to 1.6 % of the households keeping livestock and poultry were provided with extension and veterinary services. The dairy farmers mainly accessed the extension messages from the MBGs through Government Assistant Veterinary Officers (AVOs) who were also the key providers of veterinary services including disease treatment, dipping, vaccination and de-worming. Extension messages enable farmers to understand and use information. Specific knowledge on dairy is quite crucial in adoption of improved dairy technologies and performance of the dairy enterprise (Makokha, 2007).

4.2.9 Sources of dairy stock

The results in Table 4.6 show that the majority of the dairy farmers in the sample accessed the improved dairy stock through support from NGOs. Most of the local dairy farmers accessed the dairy stock through local purchase. Land O' Lakes was the major source of improved dairy stock (73.7%).

Table 4.6: Sources of dairy stock

Source of Dairy Cows	IDFs (n=118)	LDFs (n=43)	All (n=161)	P value
Local Purchase	0.8	58.1	16.1	0.0000
Inherited	5.1	39.5	14.3	0.0000
FIDP	9.3	0	6.8	0.0399
Land O' Lakes	73.7	0	54	0.0000
LAPE-TAPP-DAHLD Project	5.9	0	4.3	0.1054
SSLP	3.9	0	2.5	0.1908
Ergmont Trust	0	2.3	0.6	0.1004
MASAF	0.8	0	0.6	0.5572
Government Programme	0.8	0	0.6	0.6651
TOTAL	**100**	**100**	**100**	

4.2.10 Major sources of income

Overall 79.25 percent of the dairy farmers ranked crop farming as the major source of income (Figure 4.1). This means that dairying in the study area operates under a mixed crop- livestock system. IDFs ranked crop farming (67.5 %) first, followed by dairy farming (25%) and off-farm employment (0.8%) as major sources of income. Crop farming (91%) and off-farm employment (3.5%) were ranked first and second, respectively as major sources of income among LDFs. However, Swai *et al.* (2005) noted that dairying makes immense contribution to income in rural areas. Regular flows of cash, milk for household consumption and for collateral or security were the most cited reasons.

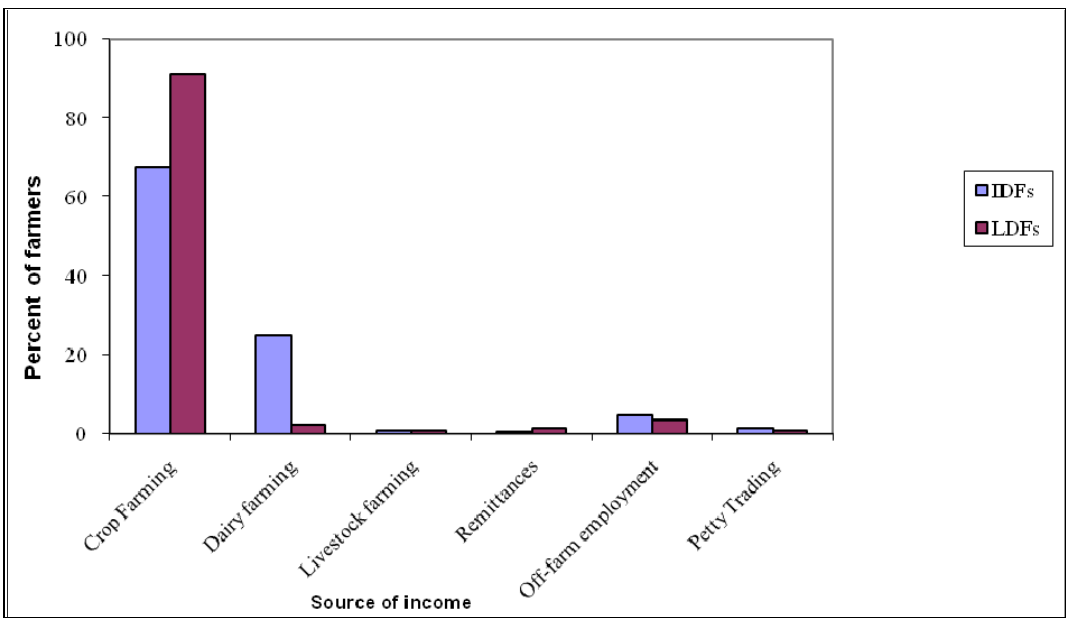

Figure 4.1: Major sources of household income

4.2.11 Farm constraints

High cost of feed, milk marketing problems including breakdown of cooling facilities and blackouts, diseases and breeding costs were ranked most important farm constraints in both categories of farms (Table 4.7). Overall high cost of feed was ranked first among IDFs and was significant (P<0.01). Similar observations were made by Imani (2004) and Lockie *et al*. (2008) who reported recurrent blackouts as a major constraint to smallholder dairy business. Due to frequent electricity blackouts, farmers incur heavy losses from non sale or souring of milk. The breakdown of cooling facilities also means that farmers have to travel long distances to sell their milk at the next MBG which results in high transaction costs (Chitika, 2008).

Table 4.7: Major farm constraints by type of farm

Farm Constraint	Improved dairy (n=118)		Local dairy (43)		All (n=161) %	P value
	%	Rank	%	Rank		
High cost of feed	50.8	1	30	2	40.4	0.0043
Milk marketing	35.2	2	20.5	1	27.9	0.7700
Diseases	6.3	3	17	3	11.7	0.0389
Breeding costs	5	4	10.1	4	6.5	0.2425

4.2.12 Dairy performance recording

The results in Table 4.8 show that over 55 % of the farmers keep records for milk production and other financial transactions. Improved dairy farmers (88%) consistently kept dairy records than local dairy farmers (22%). The p-value showed that the difference in proportion of dairy record keeping was significant (P<0.01). Revenue from milk sold through the MBG is collected monthly as such most improved dairy farmers are compelled to keep record of daily sales volume in order to verify if the correct value is given at the end of the month (Imani, 2004). In modern dairy farming, successful management relies on good record keeping and on information that can be derived from it (Chagunda, *et al.,* 2006).

Table 4.8: Dairy performance record keeping

Characteristic	IDFs (n=118)	LDFs (n=43)	All (n=161)	P value
Keep records on dairy enterprise: (Yes %)	88	22	55	0.000

4.3 Farm - Level Profitability of Smallholder Dairy Production

4.3.1 Cost benefit analysis

The Cost benefit analysis involved an analysis of the production costs incurred in smallholder dairy production and the benefits derived from the enterprise.

4.3.1.1 Dairy production costs

Table 4.9 shows the estimated production costs based on the dairy enterprise only. Fixed costs were ignored in the study because they are unrelated to higher levels of milk production and they do not affect optimal combination of variable inputs in smallholder dairy production (Mburu *et al*., 2007; Mumba *et al*., 2011).

Results show that concentrates were the major cost in both improved and local dairy enterprises and had higher contribution to total variable costs in improved dairy enterprises (61%) than in local dairy enterprises (42%). Similar findings were reported by Mburu *et al.* (2007) in a study on economic analysis of smallholder dairy cattle in different agro ecological zones of Kenya highlands. Ergano and Nurfeta (2006) also reported that feed expenses accounted for 80% of the total expenses in smallholder dairy in Southern Ethiopia.

Table 4.9: Smallholder dairy production costs

Costs	IDF	LDF	Overall
Casual labour, (MK)	22373 (23)	7228 (40)	18327 (24)
Veterinary services,(MK)	11277 (12)	1636 (9)	8702 (11)
AI and Bull Services,(MK)	3947 (4)	1657(9)	3338 (4)
Concentrates,(MK)	59078 (61)	7576(42)	45323 (60)
Miscellaneous Costs,(MK)	14293 (15)	6284(35)	12154 (16)
Total Costs (MK)	**110968**	**23481**	**87844**

Note: Figures in parentheses are percentage contribution to variable costs

The high cost of concentrates in improved dairy enterprises was attributed to the intensive use of commercial dairy marsh among improved dairy farmers for higher milk yields. This underscores the importance of concentrates in improved smallholder dairy farming. The costs of veterinary services were higher in improved dairying than local dairying as improved breeds require more routine health checks as compared to local breeds which are usually more resilient to pest and disease attacks.

Only casual labour was captured in the study due to difficulties in measuring the exact family labour involved in smallholder dairying. The cost of casual labour was higher among IDFs than LDFs. Costs of mineral supplements including powdered premixes, blocks and milking jelly were included in the miscellaneous costs. The miscellaneous costs were higher in improved dairy because of the higher mineral supplement demand in improved dairy breeds. The cost of AI, bull services and veterinary services were also higher in improved dairy than in local dairy.

4.3.1.2 Gross margin analysis

The benefits of smallholder dairy included milk sold, milk consumed on the farm, milk given to calf and sales of heifer. Table 5.2 shows the outputs from smallholder dairying per year per cow.

Table 4.10: Estimated milk yield and market price

Outputs	IDFs	LDFs	Overall
Milk yield per year (liters)	2685	742	2814
Maximum milk yield per day, (liters)	15.1	5.6	10.4
Lowest milk yield per day (liters)	2.6	1.3	1.9
Milk consumption per day (liters)	1.2	0.8	1.0
Annual consumption (liters)	253	103	213
Milk given to calf up to weaning age (liters)	108	119	113.5
Milk price per litre (MK)	59	66.5	64.5
Milk sold (liters)	2324	520	1842

Improved dairy enterprises had high annual milk yield as compared to the local dairy enterprises due to better productive performance such as shorter calving interval and higher milk yields per lactation period.

Non marketable benefits such as manure were not quantifiable in the study. The price of milk received by LDFs was higher than that of IDFs. LDFs receive higher prices because most of them sold significant amounts of milk to the informal sector where prices are higher than in the formal sector (Chitika, 2008). There was significant difference in milk prices between the two farmer categories ($P<0.01$). Gelan and Muriithi (2010) noted that selling of milk to individual consumers and organizations contributes to dairy efficiency than other marketing outlets such as traders of chilling plants. Gross margin calculation was based on the estimated production costs and revenues from milk and heifer sales. The analysis did not include the value of animals at the beginning and end of the year as this data was not readily available. Although some farms had negative gross margins, on average revenues exceeded costs (Table 4.11).

Table 4.11: Annual cost, gross income and margins

Items	IDFs	LDFs	Overall
Income			
Milk Sales (MK)	158468	36023	126407
Heifer sales (MK)	56800	22660	39730
Home consumption (MK)	14927	6849	10888
Gross Income (MK)	**230195**	**65532**	**177025**
Variable Costs			
Casual labour, (MK)	22373	7228	18327
Veterinary services,(MK)	11277	1636	8702
AI and Bull Services,(MK)	3947	1657	3338
Concentrates,(MK)	59078	7576	45323
Miscellaneous ,(MK)	14293	6284	12154
Total Variable Costs (MK)	**110968**	**23481**	**87844**
GM/Cow/ Year (MK)* **	**119227 (16453)**	**42051(3452)**	**89181(5356)**

Figures in parenthesis are standard errors
*** Significant at 99% level ;

The gross incomes were estimated from the total annual milk sales and heifer sales. The gross income averaged MK230, 195 and MK 65,532 for IDFs and LDFs, respectively. The gross margin for IDFs was higher than that of LDFs. The difference in gross margin was significant at 99% level. The results revealed that milk production is generating income to smallholder dairy farmers in the study area. Milk revenues were, however, affected by frequent electricity black outs and breakdown of facilities which contributed to significant losses due to souring of milk. Similar observation was made by Lockie *et al*. (2008) in a study of milk marketing in Southern MSA in Malawi.

4.3.2 Profitability Analysis by Milk Bulking Groups

Assessment of profitability levels in the five MBGs involved comparison of the mean gross margin per cow per year, mean costs of production per cow per year and the mean price of milk per liter. This was done to show the differences in profitability of smallholder dairy in the five milk bulking groups. Chitsanzo MBG had the highest mean gross margin while Mpalo had the lowest gross margin (Table 4.12).

Table 4.12: Mean gross margin, cost of production and price by MBG

Milk Bulking Group	**Mean Gross Margin/Cow/year (MK)**	**Mean Cost of production/Cow/year (MK)**	**Mean Milk Price (MK/liter)**
Majiga	89718 (18915)[ab]	80501.75(8728.4) [a]	71.3 (4.18) [abg]
Lumbadzi	103146.01(16760) [c]	94341.59(6848.0) [c]	63.1 (1.59) [ad]
Chitsanzo	147562.15 (14248.31) [bd]	102463 (5538.84) [ce]	66.23 (2.34) [e]
Dzaonewekha	68626.1 (19073)de	83501.36 (7199.78) [d]	64.03(1.21) [b]
Mpalo	37391.02 (6872.23) [acef]	78412.9(4728) [acde]	58.00 (1.01) [deg]

Note: figures in parenthesis are standard errors; c,d, e, f significant at 99% level
a , b significant at 95% level

On the other hand, the mean cost of production was very high in Chitsanzo MBG while in was the lowest Mpalo MBG. The high cost of production at Chitsanzo MBG could be attributed to the relatively regular supply of dairy marsh as compared to other MBGs in Lilongwe MSA. Furthermore, Majiga MBG had the highest mean milk price while Mpalo had the lowest price. The differences in the milk prices could be attributed to differences in the distance to the market and the fact that some MBG members at times sell significant quantities of milk to the informal sector (Chitika, 2008). For instance, Majiga and Dzaonewekha MBGs cooling facilities were not operational for the previous 10 months at the time of the survey. Consequently, more members were forced to sell to individuals although other travelled long distance to sell to other MBGs.

4.4 Analysis of Economic Efficiency of Smallholder Dairy Production

4.4.1 Stochastic profit frontier model results

The analysis involved two separate estimations of IDF and LDF stochastic profit frontier functions with half normal distribution assumption. The stochastic profit frontier model allows for simultaneous estimation of profit efficiency and inefficiency components of the individual farms. Rhaman (2003), Delgado (2003), and Nganga *et al*. (2010) used using the same stochastic profit frontier model to estimate profit efficiency of rice farmers in Bangladesh, Indian dairy farms and smallholder milk producers in Meru-South District in Kenya, respectively,.

Maximum log likelihood estimates (MLE) of the parameters for the stochastic frontier models for both IDF and LDF were generated using STATA computer software. The estimation of the profit frontier is adapted from the frontier command for production functions in STATA (Coelli, 1996; Delgado, 2003). Gross Margin was the dependent variable. The data was transformed to take care of heteroskedasticity, high correlation and to ensure orthogonality condition. In addition, some variables were dropped due to high collinearity. Tables 4.13 and 4.14 show results of the stochastic frontier estimates for the two dairy farm categories. In each category, both Cobb Douglas and translog functional forms were estimated to identify a better statistically significant functional form that fitted the data well. Furthermore the selection of functional form also considered number of observations in each farm category.

4.4.1.1 Profit efficiency of improved dairy farmers

The values of the Likelihood ratio tests show that the translog specification was significant (P<0.000) for the improved dairy farmers data. Table 4.13 shows the parameter estimates, standard errors and variance parameters of the specified translog stochastic frontier model. The presence of profit inefficiency effects in improved dairy production was tested by the significance of the variance parameters. The null hypothesis was that there are no profit efficiencies in the model, and all deviations from the profit frontier are due to statistical noise if $\lambda=0$ (Coelli *et al*., 2005).

Table 4.13 shows that λ is large and significantly different from zero (2.3007). Therefore the null hypothesis of no profit inefficiency in IDF was rejected at the 5 percent significance level. This indicates that IDFs operated below the profit frontier and did not attain maximum possible profits. The sigma squared (σ^2) was also significantly different from zero (7.7741) indicating that the inefficiency effects were random and stochastic. The ratio of the farmer-specific profit efficiency effects to the total output variance, gamma (γ) was 0.8414. This means that about 84 percent of the variation in gross margins among IDFs was due to differences in profit efficiency (PE).

Table 4.13: Maximum likelihood estimates of profit frontier for IDFs

Variable label	**Parameter**	**Translog**	**Standard Error**	**P values**
Intercept	B_0	8.9107	0.0432	0.8471
LnFeedPrice	B_1	**-0.6886*** **	**0.2732**	**0.0000**
Ln HealthCost	B_2	**-0.5750*** **	**0.1121**	**0.0000**
LnWagerate	B_3	0.0408	0.0128	0.9776
LnFarmSize	B_4	-1.8350	0.8106	0.8368
$\frac{1}{2}LnFeedP^2$	B_5	-1.3465	0.5214	0.3432
$\frac{1}{2}LnHealthc^2$	B_6	0.1850*	0.0341	0.0612
$\frac{1}{2}LnWage^2$	B_7	1.0540	0.2939	0.1276
$\frac{1}{2}LnFarmsize^2$	B_8	-4.0675	1.9174	0.8927
LnFeedP*LnHealthC	B_9	-0.5805**	0.0011	0.0235
LnFeedP*LnWage	β_{10}	0.012**	0.005	0.0245
LnFeedP*LnFarmSize	β_{11}	-0.3955	0.0341	0.1222
LnHealth*LnWage	β_{12}	0.4825**	0.2610	0.0144
Ln HealthC*LnFsize	β_{13}	-0.9713	0.4649	0.3785
LnWage*LnFarmSize	β_{14}	0.1411	0.2875	0.1257
		Variance Parameters		
Lambda	λ	**2.3007** **	**0.1814**	
Sigma squared	$\sigma^2 = \sigma_u^2 + \sigma_v^2$	7.7741**	1.0121	
Sigma_u	σ_u	2.788	0.1814	
Sigma_v	σ_v	1.2107	0.0106	
Gamma	$\gamma = \sigma_u^2 / (\sigma_u^2 + \sigma_v^2)$	0.8414		
Log Likelihood		-206.64		
LR test		**86.44*** **		
Number of observations		112		

Note :* P<0.10; ** P<0.005; *** P<0.001

A number of estimated parameters in the translog frontier had expected signs. Results from Table 4.13 shows that feed cost and health costs were negative and significantly reduced profit efficiency in IDFs (P<0.000). However, the first order translog profit frontier coefficients are not conclusive as they do not provide much information on the responsiveness of the profit to the various input prices. Hence profit elasticities for the input prices were calculated based on the estimates of the profit frontier. Table 4.14 shows computed elasticities at the mean values of the inputs.

Table 4.14: Estimated profit elasticities

Prices and Inputs	Elasticity
Feed Price	-0.046
Health Cost	-0.011
Wage rate	-0.025
Farm Size	0.016

The results show that a percentage increase in feed price leads to a 4.6% reduction in profit, *ceteris paribus*. Similarly, holding all other factors constant, percentage increase in health and labour unit expenditure will reduce the profit by 1.1% and 2.5%, respectively. Finally, a percentage increase in dairy animals will increase profits by 1.6%. This agrees with Backshooden and Shahneshi (2009) who showed that number of exotics in the herd influenced efficiency. The interaction parameters had no economic meaning, which is one of the weaknesses of the translog model (Abdullai and Huffman, 2000).

4.4.1.2 Distribution of profit efficiency levels for improved dairy farmers

The level of profit efficiency (PE) was computed for each IDF. There was wide variation in PE. The minimum PE was 0% while the maximum was 67.5% with a standard deviation of 20.8%. The mean PE estimate for the improved dairy was 28.1% and this suggests that, on average, about 72% of the profit was lost due to economic inefficiency. The value of 72% represents the gap that can be achieved by the farmers if they improved their technical and allocative efficiencies. Over fifty percent of the dairy farmers had profit efficiency below the mean (28.1%) (Figure 4.2)

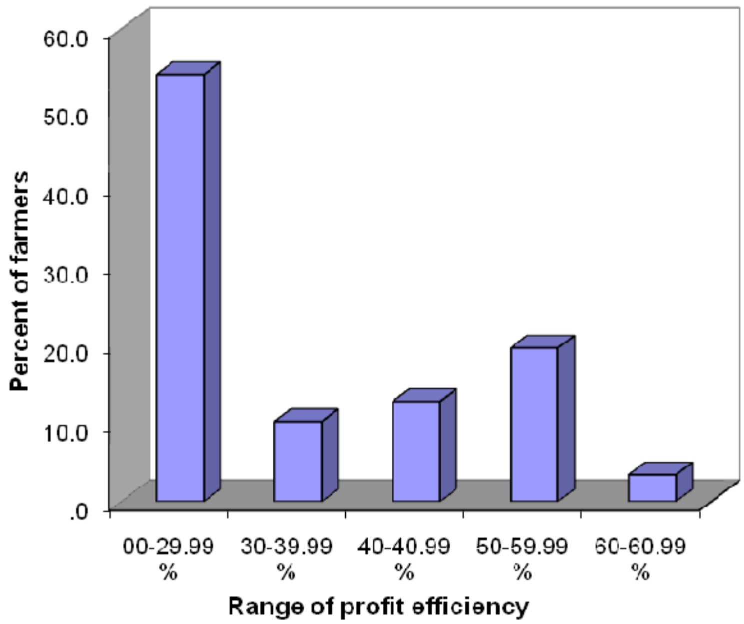

Figure 4.2: Distribution of profit efficiency among improved dairy farmers

4.4.1.3 Analysis of profit efficiency by milk bulking group

The study further assessed profit efficiency levels for IDFs in the 5 MBGs. Chitsanzo MBG had a higher percentage of farmers operating with PEs of over 50 percent (Table 4.15).

Table 4.15: Analysis of profit efficiency by MBG

PE Category	Chitsanzo (%) n=43	Majiga (%) n=20	Lumbadzi (%) n=19	Dzaonewekha (%) n=30	Mpalo (%) n=43
0.0-29.99 %	25.6	64.7	44.4	75	91.4
30-39.99 %	13.0	23.5	11.1	0	8.6
40-40.99 %	17.4	5.9	16.7	10.7	0
50-59.99 %	30.4	5.9	22.2	14.3	0
60-60.99 %	17.6	0	5.6	0	0
70- 79.99 %	0	0	0	0	0
80-89.99%	0	0	0	0	0
99-99.99%	0	0	0	0	0
Total	100	100	100	100	100

The study further investigated if there were significant differences between mean PEs across the MBGs. Table 4.16 shows that the mean profit efficiency for improved dairy in Chitsanzo, Majiga, Lumbadzi are significantly different from that of Mpalo MBG (P<0.01). Chitsanzo MBG had the highest mean PE (36.22%) followed by Lumbadzi (31.81%) while the lowest mean PE was at Mpalo MBG (4%).

Table 4.16: Mean profit efficiency for improved dairy by MBG

Milk Bulking Group	Mean profit efficiency for improved dairy	Standard Error
Majiga	0.2089^{a}	0.0575
Lumbadzi	0.3181^{b}	0.0510
Chitsanzo	0.3622^{c}	0.0236
Dzaonewekha	0.1852^{d}	0.0360
Mpalo	0.0403^{e}	0.0312

Note: a and e, b and c, c and e, a and d are significantly different at 1% level

4.4.1.5 Profit efficiency of local dairy farmers

In the LDF category, the Log likelihood ratio test showed that the profit frontier with a Cobb Douglas functional form fitted the data well as it was significant (P<0.000) (Table 4.17). The λ was large (2.0207) and significantly different from zero. Therefore the null hypothesis that there were no profit inefficiency effects in the model was rejected. The variance parameter σ^2 was significantly different from zero (1.7866) implying that the inefficiency effects were random and stochastic. The ratio of farmer-specific PE effects to the total output variance, gamma (γ) takes on the value 0.8044. This indicates that about 80% of the variation in gross margins among LDFs was due to differences in profit efficiency.

Table 4.17: Maximum likelihood estimates of profit frontier for LDFs

Variable label	Parameter	Cobb Douglas	Standard Error	P-Value
Intercept	B_0	4.7652***	0.8547	0.0000
LnFeedPrice	B_1	-0.3006	0.0405	0.1376
Ln HealthCost	$\boldsymbol{B_2}$	**-0.1747*****	**0.0499**	**0.0000**
LnWagerate	B_3	-0.1265	0.3412	0.0379
LnFarmSize	B_4	-7.864	0.2805	
		Variance Parameters		
Lambda	λ	1.527**	0.162**	
Sigma squared	$\sigma^2 = \sigma_u^2 + \sigma_v^2$	1.7866**	0.4333**	
Sigma_u	σ_u	1.3366**	0.162**	
Sigma_v	σ_v	8.7907	0.032	
Gamma	$\gamma = \sigma_u^2 / (\sigma_u^2 + \sigma_v^2)$	0.8044		
Log Likelihood		-34.54		
LR test		18.03***		
Number of observations		38		

Note :* P<0.10; ** P<0.05; *** P<0.01

The relative importance of each variable is presented in Table 4.17. The coefficients of the variables are the estimates from the profit function maximum likelihood and are interpreted as the elasticities of the variables (Burki and Khan, 2007). The coefficients were all properly signed. The elasticity estimate of the health cost was negative and significant at the 5% level. This implies an inverse relationship between heath cost and profit efficiency i.e. a 10 % increase in the expenditure on health costs will reduce the local dairy profit by 17%. The variables: feed price, wage rate and farm size had a negative but insignificant relationship with profit.

4.4.1.6 Distribution of profit efficiency for local dairy farmers

The level of profit efficiency was computed for each local dairy farm. Figure 4.3 shows the distribution of PE in LDFs.

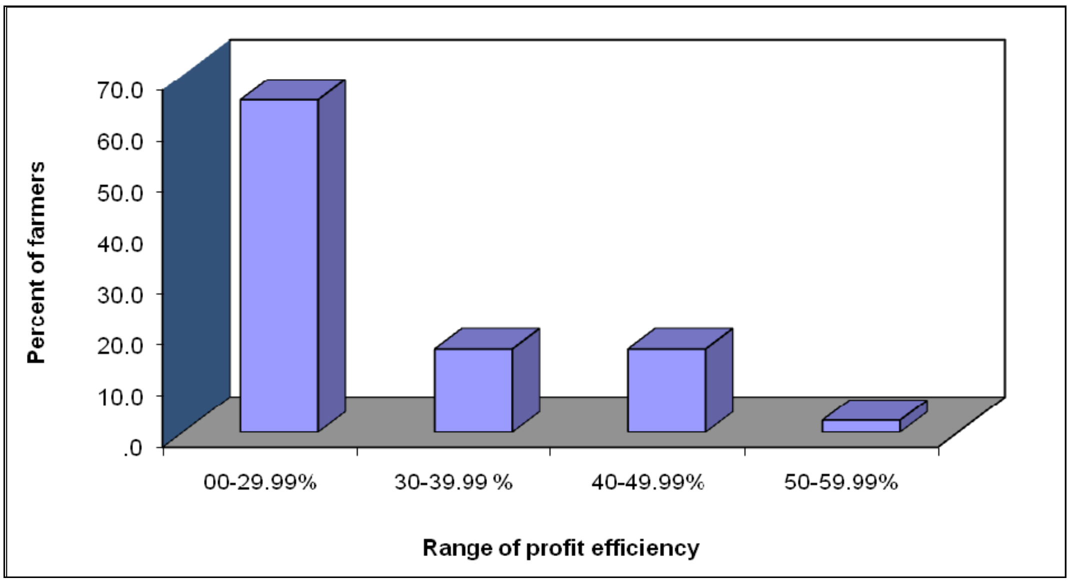

Figure 4.3: Distribution of profit efficiency in local dairy farmers

The PE ranged from 0.51% to a maximum of 56.23%. The average profit efficiency for the local dairy farm was 24.7% with a standard deviation of 15.39%. About 53% of the local dairy farmers have profit efficiencies below the 24.1% mean. The local dairy farmers profit efficiency levels, therefore, can be increased by up to 75.9%. This also implies that 75.9% of the profit was lost due to technical and allocative inefficiencies among LDFs.

4.4.2 Factors Influencing Profit Inefficiency in Smallholder Dairying

4.4.2.1 Factors explaining inefficiency of improved dairy farmers

Given the differences in profit inefficiency levels among the improved dairy farmers, it was appropriate to determine why some dairy farmers can achieve relatively high levels of efficiency while others are economically less efficient. This was achieved by investigating the relationship between farmer characteristics and the computed profit inefficiency indices (Bravo-Ureta and Rieger, 1991). The inefficiency model results are presented in Table 4.18.

Table 4.18: Factors influencing inefficiency of IDFs

Variable label	Parameter	Coefficient	Standard Error	P-value
Intercept	α_0	0.9828	0.3031	0.1070
Gender	α_1	0.2982	0.0228	0.5011
Age	α_2	0.0988*	0.0481	0.0711
Years of education	α_3	-0.0139**	0.0018	0.0217
Household size	α_4	0.1529**	0.0281	0.0261
Dairying experience	α_5	-0.0525*	0.0281	0.0744
Access to credit	α_6	-0.0133**	0.0069	0.0309
Access to extension	α_7	- 0.6738	0.2460	0.4701

Note :* P<0.10; ** P<0.05; *** P<0.01 R^2 = 0.5616 Number of observations: 118

The results reveal that age of the household head was positive and significantly increased inefficiency in improved smallholder dairy. This implies that as the age of the household head increases, inefficiency increases as well i.e. older dairy farmers tend to exhibit profit inefficiency. Kavoi *et al.* (2010) also found similar results in marginal zones of Kenya where a stochastic frontier model was applied to measure economic efficiency of smallholder dairy cattle.

Number of years of education was negative and significant at 5% level. This means that an increase in number of school years reduces profit inefficiency. This is consistent with results from other profit efficiency studies in developing countries (Nganga *et al.,* 2010; Rhaman, 2003; Delgado, 2010) which showed that higher education improves efficiency. Bravo-Ureta and Pinheiro (1997) reported that formal education is likely to increase farm-level efficiency for two related reasons: (1) educated farmers are able to gather, understand and use information from research and extension more easily than illiterate farmers and (ii) educated farmers are very likely to be less risk-averse and therefore more willing to try out modern technologies. Tchale (2009) in a study on efficiency of smallholder agriculture in Malawi found that education level of the household head was an important determinant of farm-level efficiency.

Dairying experience was negative which implies that more experience in dairying reduces profit inefficiency. This relationship was significant at 5% level. This finding is consistent with Nganga *et al*., 2010 who observed that dairying experience reduced profit inefficiency among dairy producers in Meru south district in Kenya.

Results further showed that increase in household size increased inefficiency. This relationship was also significant at 5% level. However this is contrary to *a priori* expectation as an increase in household size is expected to increase efficiency as it increases family labour thereby reducing hired labour costs. However, large household size may not necessarily mean increased efficiency in improved smallholder dairying. Alemandor *et al.* (2010) in a study on cost, return and efficiency analysis on smallholder dairy producers in Turkey, found that farmers employing hired labor were more efficient than those employing family labour. In addition household size could constitute mainly children who would not take part in intensive activities associated with improved dairy.

The institutional factors considered in this study were access to credit and extension visits. The coefficient on credit was negative and significant at the 5% level. This indicates that credit access significantly reduces profit inefficiency. Tchale (2009) reported that smallholder farmers who are members of extension/market/credit related organizations exhibit higher levels of efficiency.

4.4.2.2 Factors explaining inefficiency in local dairy production

The relationship between farmer/farm characteristics and profit inefficiency in local smallholder dairy was estimated using the inefficiency model. The results showed that education had a negative and significant relationship with profit inefficiency (Table 4.19). This implies that as the education of the household increases profit inefficiency in local dairy decreases.

Table 4.19: Factors influencing inefficiency of LDFs

Variable label	Parameter	Coefficient	Standard Error	P- value
Intercept	δ_0	7.18***	2.5475	0.0000
Gender	δ_1	0.9801	0.2864	0.1923
Age	δ_2	0.2539**	0.1053	0.0233
Education years	δ_3	-0.4490***	0.1074	0.0000
Household size	δ_4	-0.7427*	0.0970	0.0761
Dairying experience	δ_5	-0.0369	0.0182	0.1107
Access to credit	δ_6	-2.8725	0.0715	0.7235
Access to extension	δ_7	0.4058***	0.0344	0.0041

Note :* P<0.10; ** P<0.05; *** P<0.01 ; R^2 = 0.4881 ;number of observations: 43

Age of household head was positive and significant at 1% level. This means that older farmers tend to exhibit higher levels of profit inefficiency in local smallholder dairying. Household size variable was negative which implies that the variable tends to reduce inefficiency in local dairy production. Thus, as household size increases, profit inefficiency decreases in IDFs. This could be the case because most IDFs mainly use family labour including younger members of the households because it is less labour intensive as compared to improved dairying.

Dairying experience variable was negative and significant which shows that as the local dairy farmer gains experience in years, profit inefficiency decreases. Access to credit variable was also negative and significant at 10% level. This indicates that an increase in access to credit reduces profit inefficiency.

4.5 Summary

This chapter has compared socioeconomic characteristics of improved dairy farmers with local dairy farmers. The results have shown that LDFs have higher mean household head age, household size, and herd size than IDFs. IDFs had higher mean years education than LDFs. Women participation in smallholder dairying was higher among IDFs than LDFs. There were significant differences in non-dairy income, access to extension and credit between the IDFs and LDFs.

Farm level profitability results showed that although some farms registered negative gross margins, on average, revenues exceeded costs implying that both improved and local dairy are profitable enterprises. The gross margins were higher in IDFs than LDFs implying high returns in the former category. Chitsanzo MBG and Lumbadzi MBG had higher mean gross margins while Mpalo had the lowest mean gross margin. The cost of production per cow per year was highest in Chitsanzo MBG and again lowest in Mpalo MBG.

The mean profit efficiencies (PEs) were 28.1% and 24.7% for IDFs and LDFs, respectively. The results imply that IDFs and LDFs operate below the profit frontier. Over 50% of the dairy farmers in both categories were below the mean PE scores. Feed costs and health costs significantly influenced PE in IDF while only health costs significantly affected PE in local IDF category. Analysis of PE by MBG showed that Chitsanzo MBG had the highest profit efficiency score followed by Lumbadzi MBG while Mpalo MBG had the lowest mean profit efficiency score. Socioeconomic factors such as education of household head, dairying experience, and access to credit significantly reduced profit inefficiency.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND POLICY RECOMMENDATIONS

5.1 Summary and Conclusions

The main objective of this study was to assess profitability and economic efficiency of smallholder dairy farmers in Lilongwe Milk Shed Area in Malawi. The hypotheses tested in the study were: a) improved and local smallholder farm milk production is not profitable; b) improved and local smallholder dairy farmers are not profit efficient; c) farmer characteristics such as labor, dairying experience and education do not affect profit efficiency of smallholder dairying. Economic efficiency was measured using the stochastic profit frontier framework.

Descriptive statistics were used to analyze socioeconomic characteristics of the dairy farmers. Improved dairy farmers had a higher number of years of education than local dairy farmers. This implies that improved dairy farming in Lilongwe MSA is mainly practiced by farmers who attained some basic formal education. Similarly, improved dairy farmers had higher average non dairy income, increased access to extension and credit than local dairy farmers. The higher non dairy income among improved dairy farmers is consistent with the resource demands of improved dairy technologies. On the other hand, this finding may imply that dairy development projects targeted relatively wealthy farmers leaving out poor resource farmers.

The price of milk was higher for local dairy farmers than improved dairy farmers because the former sell significant amount of milk to the informal sector. Improved dairy farmers sell their milk through the MBG where prices are controlled by dairy processors. High feed (concentrates) costs, health costs and breeding costs increased dairy production costs particularly among improved dairy farmers. The average gross margins were positive in both farmer categories implying that smallholder dairy production generates income for dairy farmers in Lilongwe MSA. Breakdown of cooling facilities and frequent electricity black outs affected milk revenues as it increased incidences of milk losses through souring and non-sale.

The estimated translog stochastic profit frontier model showed a strong linkage between profit efficiency, feed and health costs in improved dairying. The elasticities showed that a unit increase in feed and health cost would reduce profit by 4.6% and 1.1 %, respectively. This finding underscores the importance of improved dairy feed and health services in smallholder dairying.

The mean profit efficiencies for IDFs and LDFs were 28.1 % and 24.8 percent, respectively. Over 50% of the dairy farmers in both categories operated below the mean profit efficiencies. Education of household head, dairying experience, access to credit and household size significantly reduced level of profit inefficiency.

5.2 Recommendations for Policy

The study revealed that improved dairy farmers had higher non dairy income and benefitted more from dairy development projects than local dairy farmers. This calls for policy interventions in the smallholder dairy sector such as increasing credit access to resource poor farmers to ensure that they also benefit from improved dairy technologies.

Linking farmers to micro loan institutions should therefore be part of dairy development programmes.

Costs of improved feed and health services were the main costs contributing to high production costs and significantly reduced profits in smallholder dairying. Alternative improved feed sources such as home made dairy marsh could significantly reduce feed costs. Therefore there is a need for research and outreach activities to focus on development and utilization of improved cost effective feed to suit dairy farmers' budget.

The study also revealed that improved dairy farmers face lower prices than local dairy farmers because the later sell significant amount to informal sector where prices are higher. Given that most of improved dairy farmers are in the legally recognized formal sector, it can therefore be recommended that Government should protect these farmers (producers) through either milk pricing or tax policies.

Low levels of profit efficiencies reveal a huge potential to increase profits by addressing the technical and allocative inefficiencies. The inefficiencies could be addressed creation of cooperative unions to increase access to various dairy inputs and farmers bargaining power of milk prices. Furthermore, the income opportunities of smallholder dairying make a strong case for further policy attention by the Government of Malawi in promotion of market oriented dairying as an important path in achieving poverty reduction.

5.3 Areas for Further Research

The study focused on smallholder dairy farmers in Lilongwe Milk Shed Area alone. There is need for a further study to be conducted in all regions of Malawi to capture variation in profitability and economic efficiency in different agro ecological zones or all the regions of Malawi. This will assist in prioritizing expansion of smallholder dairy development efforts.

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APPENDIX

Questionnaire

UNIVERSITY OF MALAWI

Bunda College

<u>Analysis of Profitability and Efficiency of Smallholder Dairy Production in Malawi : A Case of Lilongwe Milk Shed Area</u>

<u>Introductory Remarks</u>

Greetings. My name is ……….. from Bunda College of Agriculture. I am conducting research on profitability and efficiency of smallholder dairy in Lilongwe Milk Shed Area. You were selected to participate in this exercise voluntarily. The information that you provide is for academic purposes only and will be treated with utmost confidentiality. You will be briefed on the results of the study.

Name of respondent: ________________________________

Name of enumerator: ________________________________

Date of interview ___/ ___/ 2010

Village: ______________________________

MBG: _________________________________

District_________________________________

MODULE A: SOCIO DEMOGRAPHIC INFORMATION

Q1	Gender of H/hold head; 1= Male 0= Female	
Q2	Age of Household Head(years)	
Q3	Highest Education attained 1. Primary school 2. JCE 3. MSCE 4. TERTIARY 5. Adult Literacy 6. No Education (Indicate actual number of years in brackets)	
Q4	Household Size	
Q5	Dairy farming experience (Years)	
Q6	Member of MBG; 1= Yes 0= No	
Q7	Livestock Training; 1= Yes 0=No	

MODULE B: COW INFORMATION ON PRODUCTIVE PERFORMANCE

Q8(a). Number of dairy cattle; _____________

Q8b.Type of Cattle 1. Heifer 2. Bull 3. Bull Calf **4.** Heifer calf	**Q9. Type of Breed** 1.Local 2.Friesian 3.Holstein 4.Jersey	**Q10.Breed level** 1. Pure local 2. ½ 3. 3/4 4.7/8 5. pure exotic	**Q11. Source** 1. Local Purchase 2. Inherited 3. SSLPP 4. heifer pass- on scheme (L'OL) 5. LAPE/ TAPP/DAHLD 6. Other	**Q12. Estimated Cost of cow (MK)**	**Q13. Lactating stage** 1. Early 2. middle 3. Late 4. Dry 4. Late pregnancy
1.					
2					
3.					
4					

14.How many times per day do you milk your cow(s)? |____|____|

1) Once 2) Twice 3) Three times

Disaggregated Milk Quantities /day

Q15. How long do you milk your cow when its in milk?______________ Months

Q16c. How long is the dry period for your cow? _______________ Months

MODULE C: INFORMATION ON FEEDING (for the previous12 months)

Category	**Litres /day**		
	Morning	Evening	Total
14a.. Total Milk produced			
14b. Home Consumption			
14c. Free transfers to friends			
14d. Milk given to calf			
14e. Milk wastage (Sour)			
14f. Milk Sold			

Q17. Do you provide your animals with supplementary feeds? |____| 1) Yes 2) No

Q18. Type of Supplementary feed (Tick appropriate ones)	**Q19 No. of times fed/ day; 1. Once 2. Twice 3. > Twice**	**Q20. Quantity fed to lactating cow at one moment**	**Q21. Cost of Feed**		**Q.22 a. How much is consumed in a month by one cow**
			Unit of measure	**Price**	
1. Dairy mash (Commercial)					
2. Dairymash (Homemade)					
3. Maize bran					
4. commercial molasses					
5. cotton seed cake					
6. Sunflower seed cake					
7. Soy seed cake					
8. Other					

Q23. What feed regime do you use? |____|____|

1) Zero grazing

2) Free range

3) Zero and free range

Q24. Do you give mineral premixes to your cows? |____|____|

1. Yes 2. No

If No, Why?____

____

Q25 a. If yes, in what form ? |____|____|

1) Powder 2) Block

Q25b. If yes, what is the source of the premix?

____

Q26. What is the cost of the mineral premix |____|____|/ Block/packet

Q27 Do you face any problems with supplements feeding? |____|____

1) Yes 0) No

Q28. What are the problems with supplement feeding?

1) High Cost of feed

2) Inadequate availability

3) Inconsistent supply

4) Other specify__________________

Q29. What is the source of forage on your farm?

1) Own production

2) Buying

3) Free grazing from communal land

4) Others (Specify)________________

Q30. If own production what type of forages do you grow?

1) Napier

1) Rhodes

2) Sesbania

3) Desmodium spp

Q31.How much land has been allocated for pasture (specify the size)________________

Q32.If buying pasture, how much do you pay per unit (land)______________ (specify)

Q33. Do you face any problems with forage feeding

1) Yes 2) No

Q34.What are the major problems with forage feeding

1) inadequate land

2) labour availability

3) inerratic rainfall

4) Other specify______________________________

HOUSING AND MILKING EQUIPMENT

Q35. What type of Khola do you have? (Where possible view the Khola)

1) Grass thatched shed with mud floor

2) Grass thatched with stone/brick floor

3) Iron roof with mud floor

4) Iron roof with stone/brick floor

5) Other types (Specify)___________

Q36. How often do you clean your khola?

1) once a day

2) twice a day

3) every time when there is dung

4) Other (Specify)__________

Q37. Estimated cost of khola?

a) Estimated Total cost of Khola/(Milking Shed)

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

b) Annual repairs and maintenance for the Khola MK_________

WATER SOURCE AND CONSUMPTION

Q37. What is the source of water for your cows to drink?

1) tap water
2) bore hole
3) stream
4) river
5) Other specify ________________________________

Q38. How many times a day do you provide water to your animals in a day? (Specify number of times)___________

Q39. What quantities of water do you provide to your cows ? (specify amount in litres/ cow)______________________

Q40. What materials do you use for watering the animals?

1) bucket
2) cemented water trough
3) Other specify__________________

Q41. What materials do you use for milking the cow and their cost? (Tick appropriately cost against each material)

1) Jug
2) Bucket/Pail
3) .Other (Specify)_________________

VERTERINARY COSTS (for the previous 12 months)

Q42. How often do you dip or spray your animals (specify no of times)

1. Once a month 2. Twice a month 3. Other______________

Q43. What is the average cost per dipping service; MK _____________

Q44. Do you face major problems on disease disorders and treatments?

1. Yes 2. No

Q45. If yes, what could be the possible cause of the case? |____|____|

1) Ticks

2) Feeding (nutritional problems)

3) Worms

4) Injury

5) Calving (dystocia)

6) Other specify____________________

Q46. Number of treatments |____|

Q47. Total costs |____|____|

BREEDING AND REPLACEMENT COSTS

Q48 How do you breed your animals and why that method?

1) AI , Why?________________________________

2) bulls ,Why?________________________________

3) both AI & bulls, why?_______________________

Q49. What is the cost of AI? (Price in MK)

1)Per straw |____|____||____|____|

2) Per breeding |____|____||____|____|

Q49b. How many times did you have to use AI for the cow to concieve?________________

Q50. What was the source of AI?__________________

Q51.What was the cost of using a bull? MK______________

Q52. How did you acquire the breeding service? |____|____

1) Loan

2) Cash

3)Other (Specify)

Q53. What are the problems with breeding?

____

____

LABOR COSTS

Q54.Who is normally involved in dairy activities? |____|____

1) Family members

2) Casual worker

3) Both

Q54b. If family labour, how many people are USUALLY involved?

Individual	Age	Number of individuals
Man		
Woman		
Boys		
Girls		
Total		

Q55. If Casual :Labour; How much do you pay for casual labour/day(Or per month)? MK_________

Q55a. Estimated Annual Cost

MODULE D : INFORMATION ON MILK MARKETING (for the past 12 months)

Q56.Where do you sell your milk? |____|____|

1. MBG 2. Middle men 3. Within the village

4.Local Market 5. Other specify_________________

Q57. How far are you from the nearest market? |____|____|

1. <1km 2) 1-1.9km 3) 2-2.9km 4) 3-3.9km 5) 4-4.9km

6. >5km

Q58. How much do you pay for transporting milk to the market place? (If applicable)MK________________

Q59. What was the average price of milk for the past 12months? MK |____|____|/ Litre

Q60. What are the reasons for selling milk at this market |____|____|

1. Better prices
2. NGO encourages it
3. Direct cash payment
4. Closer to the farm

Type of Cattle	Purchased Feed/ Month	Cost of Veterinary Services (MK)				Housing (MK)
		AI	Vaccinations	Dipping	Veterinary drugs	
Heifer						

5. Other (Specify)___________________

Q61. What problems do you face with the marketing of your milk |____|____|

1. low milk prices
2. long distance
3. late payments
4. leadership at the MBG
5. Other (Specify)_______________

Q62. Which activity (ies) attract much costs on your dairy farm?

1) Feed
2) Veterinary
3) Marketing costs
4) Labour
5) Other (Specify)________________

Q63. Value of Dairy Stock for the past 12 months?

Type of Cattle	Number at beginning of the year	Value of Stock at the beginning of year (MK)	Number Sold During the year	Number bought during the year	Stock at the end of the year (By category)	Value of stock at the end of the year(MK)
Bulls						
Heifers						
Calf- Bull						
Calf- heifer						
Total						

HOUSEHOLD INCOME

Q65. What are your main sources of income?

1) Sales of crops
2) Sales of Livestock
3) Milk Sales
4) Remittances
5) Other (Specify)____________

Q 66. What was your income the previous year?

	Source	Average Income	
		Monthly Amount (MK)	**Annual mount (MK)**
1	Sales of crops		
2	Sales of Livestock		
3	Milk Sales		
4	Remittances		
5	Other (Specify		

ACCESS TO EXTENSION SERVICES

Q67. Do you have access to extension services? |____|____|

1) No 1) Yes

Q68. Who provides dairy extension services? |____|____|

1.) Government

2) NGO (Specify)_________________

3) Both

ACCESS TO CREDIT

Q69. Do you have access to credit for your dairy enterprise?

1) Yes 2) No

Q70. If yes, what type of loan?

1) heifer scheme
2) cash loan
3) Feed loan
4) other loans (specify)__________________

Q71. What is the source of that loan?

1) Land O'Lakes
2) LAPE, TAPP, DAHLD Project
3) SSLP
4) MBG
5) Other (Specify)___________________

Q72. What is the purpose of the loan you obtain (indicate all the appropriate codes)

1) Buy Drugs
2) Buy Molasses
3) Purchase of Heifer
4) Dairy mash
5) Semen
6) Other (specify)______________________________

Q73. Has /was the loan repaid in full?

1) Yes 2)No ____|____|

If No, Why____

Q74. What are the most important benefits from your improved system of dairy farming?

____

____

____

Q75. What are the key challenges in your dairy production enterprise (in order of importance)?

____

____

Q.76 Do you keep a record for your dairy animal performance? (Please verify)

1) Yes 2) No

Thank the respondent for his time and assure him/ her that they will be briefed on the results of the survey findings whenever possible.