ECONOMIC ANALYSIS OF THE VIABILITY OF SMALL HOLDER DAIRY FARMING IN ZAMBIA

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DECLARATION

I, **Chisoni Mumba** do hereby declare that the contents of the dissertation being submitted herein are my original work and they have not been previously submitted to any University for the award of a degree or any other qualification.

Signature…….Date……

CERTIFICATE OF APPROVAL

This dissertation submitted by, **Chisoni Mumba** is approved as fulfilling the requirements for the award of the degree of Master of Science in Livestock Economics at the University of Zambia.

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ABSTRACT

A cross sectional study was carried out with specific objectives of assessing the relative profitability of smallholder dairy farming and determining the socio-economic factors affecting it, in six of the then nine provinces of Zambia. Data used to achieve these objectives were obtained from 157 smallholder dairy households, which were randomly selected using a multi-stage sampling design and analyzed using descriptive statistics, gross margin analysis and regression analysis. The study was driven by the lack of research-based information in this area despite the involvement of an overwhelming number of donor funded projects and the Government in promoting smallholder dairy farming.

The results indicate an estimated average milk sale price of ZMK 2002.05 per litre, while the estimated average cost of production was ZMK 828.20 per litre. Thus, the estimated gross margin per litre was at ZMK 1173.85, representing 57.9 percent of the average sale price of milk. Findings on econometric analysis of the socio-economic factors indicated that dairy cow herd size and distance travelled to deliver milk to milk collection centers had a statistically significant effect on the profitability of smallholder dairy farming, other factors being held constant.

These results suggest that the Zambian smallholder dairy enterprise is a viable venture and could play an important role in rural poverty reduction, employment and wealth creation, as well as in enhancing household nutrition and food security**.** However, long distances to the milk collection centers (market), lack of resources and a scarcity of high milk yielding dairy breeds to increase dairy herd sizes are some of the major hindrances to the viability of smallholder dairying in Zambia.

From the above study findings, it is recommended that the Government, donors and other service providers need to allocate more resources towards smallholder dairy development particularly in the areas of animal breeding, marketing, value addition, infrastructure development, water harvesting mechanisms and knowledge transfer. Further projects should also consider constructing more milk collection centers near smallholder dairy farmers in order to reduce the distance travelled to deliver milk to the market.

DEDICATION

This work is especially dedicated to my dearest wife Abigail Banda and my children Rukaya, Rashida and Aadam, my father and mother who, for their love, shared with me the challenges and hardships during my studies at the University of Zambia. I thank them all immeasurably for their moral support and understanding when I could not avail myself as much as I should have done during the period of my studies. To you all, this is the reward of your endurance.

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LIST OF ABBREVIATIONS

AAEA	American Agricultural Economics Association
ANOVA	Analysis of Variance
CAR	Cost and Returns
CBA	Cost Benefit Analysis
CEA	Cost Effective Analysis
CUA	Cost Utility Analysis
CSO	Central Statistical Office
EU	European Union
FDI	Foreign Direct Investment
GART	Golden Valley Agricultural Research Trust
GMA	Gross Margin Analysis
HI	Heifer International
MCC	Milk Collection Center
NGO	Non Governmental Organisation
PBA	Partial Budget Analysis
SPSS	Statistical Package for the Social Sciences
UHT	Ultra-High-Temperature
UNZA	University of Zambia
ZMK	Zambian Kwacha
ZATAC	Zambia Agribusiness Technical Advisory Center

CHAPTER ONE

BACKGROUND TO THE STUDY

1.1 Introduction

Smallholder dairy farming is very important as it produces the much needed commodity for the life of animals and humans. Milk has been described as nature's most perfect food, as it is the sole source of nourishment for newborn mammals (Schmidt *et al*., 1988). It is very important in the human diet because of two important ingredients namely protein and calcium. Protein provides many of the amino acids often deficient in the cereal food grains. Dairy products provide the most important amino acids required for body building as well as tissue repairs in human beings (Osotimehin *et al*., 2006). Calcium is the nutrient most likely to be lacking in diets of persons who do not consume milk or milk products hence adequate calcium intake is difficult to attain in the human diet if milk or milk products are excluded (Schmidt *et al*., 1988). Milk also contains essential vitamins and minerals. Vitamins have many roles in the body, including metabolism co-factors, oxygen transport and antioxidants (Fox and McSweeney, 1998). They help the body use carbohydrate, protein and fat. Minerals also have many roles including enzyme functions, bone formation, water balance maintenance and oxygen transport (Fox and McSweeney, 1998). There is some evidence that milk and milk products exhibit a cholesterol lowering effect thus preventing incidences of atherosclerosis and coronary heart disease (Schmidt *et al*., 1988).

1.2 Global Perspective on Milk Production

It is estimated that almost 150 million farm households, i.e. more than 750 million people, are engaged in milk production worldwide, the majority of whom are in developing countries (FAO, 2010). Annual milk consumption growth rates in these countries averaged 3.5 to 4.0 percent over the decade 1995-2005, at least double the growth rates of 1.4 to 2.0 percent for major staple foods over the same period (FAO, 2010). The dairy sector provides income and employment to many, often poor, people. It is estimated that 12 to 14 percent of the world population, or 750-900 million people, live on dairy farms or within dairy farming households and the production of one million litres of milk per year on smallholder dairy farms creates approximately 200 on-farm jobs (FAO, 2010). Smallholder dairy farming promotes regular monetary earnings to people who access cash once a season after they sell their harvested crops. The regular monthly monetary earnings from the sale of milk and milk products have favorable effects on the cash flow charts of rural households and assist in improving the lifestyles of the rural people. Smallholder dairying also helps people to get involved in the mainstream cash economy and poverty alleviation ventures of their countries. It increases the milk production base of the country, improves household nutrition, empowers women and youths in income generation ventures and overall agricultural development. It assists farmers to diversify, spread farming risks and creates opportunity for some idling resources like crop residues to enter the human food chain hence utilizing marginal form of resources (Ngongoni *et al*., 2006).

1.2.1 Global Perspective on Milk Consumption

Based on milk equivalents (ME), average per capita global milk consumption amounts to about 100 kg of milk per year, with very significant differences between countries or regions (FAO, 2010). Per capita consumption in Western Europe is in excess of 300 litres of milk per year compared with less than 30 litres (and sometimes even as little as 10 litres) in some African and Asian countries (FAO, 2010). In the past, increases in global milk demand were mainly driven by population growth, whereas currently they are also increasingly fuelled by rising per capita milk consumption in some highly populated developing countries. Increasing income levels are expected to raise the demand for milk and dairy products by more than 1.8 percent per annum (FAO, 2010). Should increases in milk production not follow suit, dairy prices will rise significantly over past levels. South Asia and European Union (EU) countries are the most important dairy regions, accounting for 44 percent of global milk production. In the period 2002 to 2007, world milk production grew by 13 percent, or by an average of 15 million tons of energy corrected milk (ECM) per year – mainly through production increases in China, India and Pakistan (Saha *et al*., 2004; EU, 2009). Overall, therefore, developing countries, which rely predominantly on smallholder dairy production systems, have increased their share in world milk production.

1.3 Zambian Perspective on Milk Production

1.3.1 Dairy Subsector

Zambia has three main types of dairy producers, namely: (1) traditional farmers; (2) smallholder dairy farmers; and (3) large scale commercial dairy farmers (Phiri, 1995; Neven *et al*., 2006). Traditional small scale producers hold the largest number of cattle, but given that their cattle consist mostly of local breeds (zebu), they represent only an estimated 45 percent of milk production and an estimated 25 percent of marketed raw milk in Zambia (Kaluba, 1992; Neven *et al*., 2006). Most of the milk produced is either consumed by the household or sold in informal rural markets and consumed as raw milk. Some traditional small scale producers sell their milk to milk collection centers who in turn sell either to processors or directly to consumers.

Smallholder dairy farmers originate either from the ranks of the traditional small scale farmers or represent new entrants into the sub-sector (e.g., retirees who invested their pension in a dairy farm). Most of them are organized in cooperative societies around milk collection centers from where processors collect the raw milk. These smallholder dairy farmers use mostly mixed-breed cows and unlike traditional small scale producers, they sell the bulk of their output to processors in the formal market or consumers in the informal market. These are the farmers that this study targeted.

Large scale commercial dairy farmers are capital-intensive and have larger herds of purebred dairy cows. This set-up gives them greater control over production and hence they are able to concentrate production in the dry season when prices are at peak. Large

scale commercial dairy farmers sell in both informal and formal markets and supply about 80 percent of the milk into the formal dairy channels (Neven *et al*., 2006).

1.3.2 Milk Production and Consumption in Zambia

Zambia has a population of over 13 million of which 61 percent resides in rural areas with agriculture as their main source of livelihood (CSO, 2010). Smallholder dairying in Zambia is practiced in a production system that integrates crop and dairy farming. Smallholder dairying can play an important role in poverty reduction, creation of employment opportunities and wealth as well as in enhancing household nutrition/food security of the rural population, the majority of which live below the poverty datum line. Milk production in Zambia is estimated at over 215 million litres per year and about 115 million litres is the share from smallholder dairy farmers (Pandey, 2010). The Zambian per capita milk consumption is estimated at 24 litres against the level recommended by FAO, which is about 200 litres per person per year (Pandey, 2010). The average per capita consumption in sub-Saharan Africa is at 36 litres with Kenya being the highest at about 100 litres per person per year (Thorpe *et al*., 2000; Muriuki *et al*., 2001; Pandey, 2010).

1.3.3 Milk Marketing in Zambia

Market development is very important for dairy or any other agricultural production to thrive (Mullins, 1995). Since 1991 the Government of Zambia has liberalized its markets leading to fundamental structural changes in the agri-food sector (Saasa, 1996). Parastatal companies were privatized, commodity markets were deregulated and foreign

direct investment (FDI) was both encouraged and facilitated. This resulted in new investments by international firms in some sectors of the country's agri-food system, most notably in retail distribution and food processing. These companies introduced modern procurement strategies that have started to change the institutional, organizational and technological characteristics of the supply chain. Currently, the smallholder dairy farmers supply their milk to milk collection centers on a daily basis. Membership to these milk collection centers is through payment of a fee and a farmer automatically becomes a shareholder. It is the duty of milk collection centers to store milk in refrigerated cooler tanks and market it. Parmalat, Zambeef, Dairy King and other dairy processing companies enter into contracts with these milk collection centers. The farmers are paid at the end of the month by the appropriate centers upon receiving payments from the processors. However, the Zambian milk market is currently under threat from cheaper low quality milk imported from the Common Market for East and Southern Africa (COMESA) Region (Kamayoyo, 2010). Prices are currently regulated by processors who have established a new quality-based raw milk pricing schedule, similar to that applied in industrialized countries. Price is calculated using complex formulas based on bacterial count and butterfat content of milk amongst others.

1.4 Statement of the Problem

Zambia has about 2,500 smallholder dairy farmers affiliated to dairy cooperatives whose capacities in smallholder dairy farming are being strengthened by resource persons, including materials & financial support mainly from Golden Valley Agricultural Research Trust (GART), Heifer International, Land 'O' Lakes International and many

other Non Governmental Organisation (NGOs) in collaboration with the Government of Zambia (Pandey and Muliokela, 2006). Despite the involvement of these donor funded projects and Government in promoting smallholder dairy farming, there is lack of the much needed solid empirical evidence on the viability of smallholder dairy farming in Zambia. However, so many studies have been carried out in different countries in Africa and other continents (Baltenweck *et al*., 1998; Mburu *et al*., 2007; Otieno *et al*., 2009; Kavoi *et al*., 2010). Similar studies are also being carried out annually in European countries (EU, 2009). This study therefore seeks to reduce the existing knowledge gap in Zambia and to contribute to the general body of knowledge in terms of study design, approach and analysis of results.

1.4.1 Rationale of the Study

The rationale for economic analysis in smallholder dairy farming arises from the fact that resources in a dairy enterprise namely human resource, facilities, equipment, raw materials and others, are all scarce commodities. This means that choices have to be made about where to deploy these scarce resources. Economic evaluation/analysis provides a scientific and systematic method for making these choices (Zweifel *et al*., 2009). Research based information on economic analysis of the relative profitability of smallholder dairy farming is lacking in Zambia. The findings from this study will therefore provide baseline data for policy makers, donors, development planners and farmers when making decisions related to the profitability of smallholder dairy enterprises in Zambia. It is also important in issues relating to farm-level decision making, policy and government program evaluation, performance analysis, and resource

allocation to smallholder dairy farming. The importance of this study to this field can therefore not be over-emphasized.

1.5 Objectives of the Study

1.5.1 General Objective

The general objective of the study was to determine the relative profitability of smallholder dairy farming in Zambia.

1.5.2 Specific Objectives

The specific objectives of the study were as follows;

i) To assess the provincial variations in relative profitability of smallholder dairy enterprise in Zambia.

ii) To determine the socio-economic factors and their effects on the profitability of smallholder dairy farming in Zambia.

iii) To assess the socio-economic contribution of smallholder dairy farming to rural development.

1.6 Operational Definitions

Smallholder dairy farmer: according to FAO (2007), smallholder dairy farmer refers to a farmer with one to four dairy cows. The smallholder dairy farmers use mostly mixed-breed cows and sell the bulk of their output to processors in the formal market through cooperatives or consumers in the informal market.

Formal markets: refer to the dairy companies that operate the processing facilities in a dairy zone (i.e. collecting centers set up at community level) that usually buy the milk either directly from the farmers or via some agent (FAO, 2007).

Informal markets: refer to milk sellers and buyers in a neighborhood or village. It includes smallholder dairy farmers who sell some of the farm produce to the local market (FAO, 2007).

Dairy value chain: refers to the various stages through which milk and milk products pass from farm to the final consumer (FAO, 2007).

Enterprise: is any coherent portion of the general input-output structure of the business that can be separated and analyzed as a distinct entity (AAEA, 1998).

Fixed costs: These are costs which cannot easily be allocated to the different enterprises on the farm and do not change if the size of the enterprise is altered (Gordijn and Whitehead, 2005).

Variable costs: these are costs that satisfy two criteria; they must be specific to a single enterprise, and they must vary approximately in proportion to the size of the enterprise output. Therefore they only occur if production takes place (Gordijn and Whitehead, 2005).

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The literature reviewed in this chapter highlights what others have written about profitability of smallholder dairy farming and the factors affecting it, under the subheadings:- profitability of smallholder dairy farming; measures of profitability; uses of gross margin analysis and its limitations.

2.2 Profitability of Smallholder Dairy Production

Many studies have been carried out to assess the viability or relative profitability of smallholder dairy farming and the critical factors affecting it. There is a rich history of researchers using gross margin analysis as a tool to determine efficiency and profitability of dairy systems, and regression analysis to determine factors affecting these systems (Cain *et al*., 2007). Mburu *et al*. (2007) carried out similar works to assess the profitability in different agro ecological zones in the Kenya highlands, but his study had limitations of valuation of manure and sale of calves as there was lack of accurate market prices for these secondary outputs. A study by Osotimehin *et al*. (2006) examined the profitability as well as operational efficiency of milk processing enterprise in Kogi state, Nigeria using budgetary analysis. This resulted in the calculation of net farm income for processors hence omitting the profitability for dairy farmers. A study on the measurement of economic efficiency for smallholder dairy cattle in the marginal zones of Kenya by Kavoi *et al*. (2010) preferred to use the cost function approach over

the profit function approach to avoid problems of estimation that may arise in situations where farm households realize zero or negative profits at the prevailing market prices. However, this study dwelt more on the socio-economic factors affecting the economic efficiency for smallholder dairy cattle, using multiple regression analysis. Otieno *et al*. (2009) carried out some work on economic evaluation of relative profitability in small holder dairy farms in western Kenya. He used farmers' profit levels generated by gross margin analysis in comparing their relative efficiency in dairy farming using regression analysis. This empirical literature on profitability of smallholder dairy enterprise formed the basis for carrying out an economic analysis of the viability of smallholder dairy farming in Zambia. However, unlike the previous ones, the current study took into account the socio-economic factors affecting smallholder dairy farmers using multiple regression analysis.

2.3 Measures of Profitability

There are five basic methods of economic analysis or measures of profitability namely gross margin analysis (GMA), partial budgeting analysis (PBA), cost effective analysis (CEA), cost utility analysis (CUA) and cost-benefit analysis (CBA) (Dijkhuizen and Huirne, 1997; Zweifel *et al*., 2009). The current study used gross margin analysis to calculate profits of dairying at an individual farm level due to the fact that it is the simplest and most practical method of assessing enterprise profitability and it is widely used in farm management economics (Dijkhuizen and Huirne, 1997). In complete enterprise costing (PBA and CBA) the fixed costs are also allocated, unlike for gross margin analysis where only the outputs and variable costs are allocated to individual

enterprises. This result in a net profit per enterprise with all costs allocated, and enables the calculation of costs per tonne of grain or per litre of milk produced on the farm and break-even budgets. The strength of such techniques is that they help to identify all costs involved in a particular enterprise. Despite its apparent simplicity, however, the full cost approach is fraught with difficulties as awkward and sometimes arbitrary decisions have to be made concerning the allocation of overhead expenses between enterprises (Firth, 2002). Net profit figures per enterprise tend to ignore the interrelated nature of enterprises and are thus less useful for most farm enterprise systems (Firth and Lennartsson, 1999). However, despite being the best measure of relative enterprise profitability, gross margin analysis has its own limitations as well, as explained in section 2.3.2.

2.3.1. Uses of Gross Margin Analysis

The many purposes for which gross margin estimates are developed broadly include farm-level decision making, policy and government program analysis, performance analysis and the study of resource allocation issues (AAEA, 1998). Farm-level decision analysis examines options for a given farm in the coming year, and for longer-range periods using projected information. Policy analysis often uses historical cost information for a group of farms producing the same commodity, to analyze the likely impacts of a proposed policy change. The study of efficiency of resource allocation usually involves details on the components of cost and returns for a composite of farms. Economic or financial performance of a particular enterprise can involve both historical and projected cost information for a single farm and/or a group of farms. To address

these various information requirements, gross margin estimates are prepared to provide measures of the costs of producing a unit of a commodity for a specific farm, for a representative farm in a region, or for a representative farm in a nation as a whole (AAEA, 1998).

2.3.2 Limitations of Gross Margin Analysis as an Indicator of Enterprise Profitability

Gross margins should only be compared with figures from farms with similar characteristics and production systems. With this reservation in mind, the comparisons can give a useful indication of the production and economic efficiency of an enterprise. Comparison of gross margins between enterprises with different fixed cost structures can be misleading (Firth, 2002). In the current study, smallholder dairy farmers had similar characteristics and production systems. The gross margin does not measure net profit of an enterprise as it only takes variable costs into account. Therefore, it should be clearly stated that the results obtained in the current study are gross margins and not net profits, even though the former is a good measure of enterprise profitability. Labour can be difficult to allocate as most businesses have permanent labour and casual labour. In a gross margin analysis of a dairy enterprise, the tendency is to focus on the casual labour associated with that particular activity such as cattle herding or milking (Firth, 2002). Therefore casual (hired) labour took care of this aspect of fixed cost in this study.

CHAPTER THREE

DATA SOURCES AND METHODOLOGY

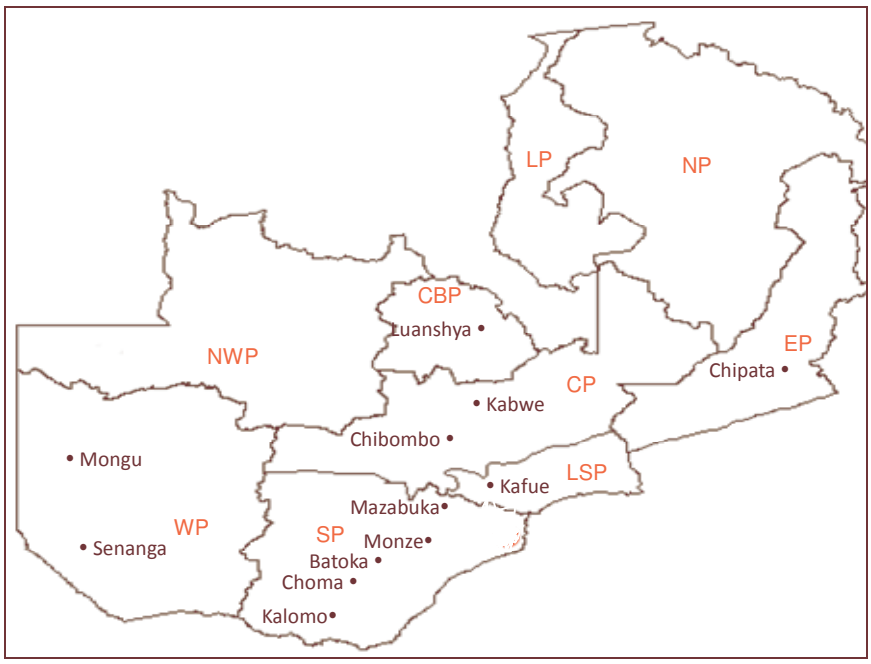
3.1 Introduction

This chapter presents the research design and description of study sites, study sample and sampling technique, data collection instruments and data analysis. It ends with the discussion on the conceptual framework for multiple regression analysis on socio-economic factors affecting the profitability of smallholder dairy farming in Zambia.

3.2 Research Design and Description of Study Sites

A cross-sectional survey design employing quantitative data collection techniques was used. The study sites included 12 districts from 6 provinces; namely Central Province (Kabwe and Chibombo districts), Southern Province (Mazabuka, Monze, Choma and Kalomo districts), Eastern Province (Chipata district), Copperbelt Province (Luanshya district), Lusaka Province (Kafue district) and Western Province (Mongu and Senanga districts). The choice of these provinces was driven by the presence of substantial numbers of dairy cooperative societies which assisted in terms of milk marketing and whose capacities in smallholder dairying are being strengthened through the provision of resource persons, materials and financial support mainly by the Golden Valley Agricultural Research Trust (GART) and non-governmental organizations (NGOs) in collaboration with the Government of Zambia (Pandey and Muliokela, 2006). The study sites are shown in Figure 1.

Figure 1: Map of Zambia showing study sites (districts).



KEY

LP=Luapula Province

LSP=Lusaka Province

NP=Northern Province

EP=Eastern Province

CP=Central Province

WP=Western Province

SP=Southern Province

CBP=Copper belt Province

NWP=North-western Province

Source: http://mapsof.net/zambia/static-maps/png/zambia-map

3.3 Study Sample and Sampling Technique

Multi-stage sampling which included both purposive and random sampling was employed in this study. Patton (1990) claims that: "The logic and power of purposive sampling lies in selecting information-rich cases for an in-depth study. Information-rich cases are those from which one can learn a great deal about issues of central importance to the research. In this study, information rich cases were those farmers regularly delivering milk to milk collection centers (MCCs) over a period of one year (August 2009 to July 2010). In the first stage, the country was divided into nine (now ten) provinces on the basis of administrative demarcations; in the second stage, six out of the then nine provinces were purposively selected based on the presence of smallholder dairy activities; in the third stage, twelve districts were also purposively selected from

the six provinces based on the same criterion as in stage two; in the fourth stage, a list of smallholder dairy farmers was developed by first going through the records of respective milk collection centers (MCCs) in the selected districts and then coming up with a sampling frame. In the final stage, sample sizes were calculated proportionate to the number of farmers on the compiled list and random sampling was used to obtain a sub-sample for each of the districts following the methods described by Osotimehin *et al*. (2006), as well as Nimoh *et al*. (2012) who carried out studies using similar methodology. A total of 157 smallholder dairy households were involved in the study and primary data were collected through personal interviews using a structured questionnaire as described by Thrusfield (1986). Secondary data were collected from milk collection centers using document reviews as described by Weiss (1998).

3.4 Data Collection Instruments

The study used triangulation in data collection through the use of **interviews** and **reviewing of documents**. Silverman (2000) points out that triangulation in data collection involves the use of two or more methods and can help to explain the richness and complexity of data. This avoids a situation where research results are generated exclusively on one method (Patton, 1990; Freebody, 2003). The assumption is that some of the methods have weaknesses and exclusive reliance on one could bias or even distort the researcher's work.

3.4.1 Structured Questionnaire

Interview-based structured questionnaires were administered to 157 smallholder dairy farmers. The information collected included socioeconomic characteristics, quantities and costs of all variable inputs and prices of milk. The questionnaire development procedure followed the method described by Thrusfield (1986) and Osotimehin *et al*. (2006) and included open-ended and closed types of questions. The structured questionnaire was prepared in English and translated in local languages during interviews. The questionnaire was administered by the researcher in all the study sites.

3.4.2 Document Review

Documents were reviewed to determine the quantities of milk delivered to the milk collection centers and the total amounts paid to the farmers over a period of one year (August 2009 to July 2010). Records of accounts were sourced from milk collection centers and reviewed. Weiss (1998) holds the view that documents are "a good place to search for answers as they provide a useful check on information gathered in an interview." She further states that when "other techniques fail to resolve a question, documentary evidence can provide a convincing answer."

3.5 Pre-testing of the Data Collection Tools

Pre-testing of the data collection tools was carried out at Mapepe Dairy Cooperative Society in Kafue District. The Cooperative Society was chosen because it had similar characteristics with the dairy cooperative societies under study. Fifteen smallholder dairy farmers were interviewed in order to determine the effectiveness of the research

tools primarily with regard to the clarity, strengths and weakness of some of the items in the tools as well as to test whether the instruments would get the intended responses.

3.6 Data Analysis

The data collected were coded and entered into Microsoft excel for calculation of gross margins and Statistical Package for the Social Sciences (SPSS) for descriptive statistics and multiple regression analysis.

3.6.1 Socio-economic Characteristics

Descriptive statistics were used to describe the socio-economic characteristics of the respondents using SPSS. The one way analysis of variance (ANOVA) was used to compare the arithmetic means of the cost of production and annual gross margin in each district.

3.6.2 Calculation of Gross Margins

Gross margins were calculated for each respondent using Microsoft Excel spread sheets to estimate costs and returns of the smallholder dairy enterprise. In this study, gross margin analysis was used to calculate gross margins of dairying at an individual farm level. Gross margins were calculated as mean revenues less mean variable costs using a formula described by Mburu *et al*. (2007), as shown in equation 1.

Gross Margin= [Milk price (ZMK/litre) x Milk volume (litres)–(Variable costs)]……..Equation 1

Variable costs consisted of the costs of feeds including roughage (hay and silage) and concentrates (molasses, bran, cakes etc). The cost of labour included cost of hired labour for feeding animals, milking and delivering milk to milk collection centers. The cost of de-worming was calculated by computing the frequency of de-worming multiplied by the number of cows and the cost of de-wormers that were used per year. The cost of vaccinations included the cost of veterinary labour and vaccinations per animal multiplied by the frequency in a year. The cost of dipping was calculated by computing the number of dairy animals, frequency of dipping during rainy and dry seasons, method of dipping (spraying or plunging) and the price of dip on the market in a year. The cost of treatment was calculated by computing the estimated number of veterinary visits for animal treatment and cost of medicines for mastitis and other diseases, cost of tuberculosis and brucellosis testing in a year. The cost of artificial insemination was calculated by computing the number of cows and costs per cow/visits by an artificial insemination extension officer**.** Other costs included the cost of milking cream, teat dips, detergents, etc.

Fixed costs [land, permanent labour and capital] were ignored since they were unrelated to higher levels of milk production and do not affect the optimal combination of the variable inputs. For example, land could not be valuated because the respondents were on communal land so they were not paying any rentals or land rates. These farmers do not have title to this land as communal land belongs to the chiefs. Capital could not be valuated because the farmers did not need any capital to start their smallholder dairy enterprise as they were given the dairy cows as a grant by Golden Valley Agricultural

Research Trust, Heifer International, Africa Development Bank, Land "O" Lakes under a "Pass-on Project" and many other non-governmental organizations (NGOs). Land "O" Lakes International was implementing a smallholder dairy project called "Pass-on-the-gift" under which farmers were given a pregnant dairy heifer, and then they would 'pass-on' the calf if it is female to another farmer.

Permanent labour was not computed because the respondents did not employ workers on a permanent basis. Other studies like that conducted by Mburu *et al*. (2007), included opportunity cost on family labour as permanent labour, but in our scenario this was difficult due to lack of accurate methods of valuating opportunity costs of family labour which was used by many farmers..

Revenue (outputs) included sale of milk as a primary produce. Manure is a non-market benefit of the smallholder dairy enterprise and it is very difficult to evaluate (Staal *et al*., 2003; Ouma *et al*., 2004). However, due to lack of reliable data on the market value of manure and calves as stated by Ouma *et al*. (2004), no attempts were made to quantify these non-marketed benefits (manure) to the smallholder dairy enterprise. A similar study in Kenya by Mburu *et al*. (2007) did not include manure due to the same reason. The female calves were not sold because of the "Pass-on-the-gift" project basis by Land "O" Lakes International- a USAID donor-funded project. Male calves were kept and used for payments of dowry in most of the surveyed areas. The value of milk consumed by households and calves was included under revenues since it is a product of the farm. Revenues included the total value of milk produced on the farm i.e. sales of milk and the

value of milk consumed on the farm and by the calves. After computing the gross margins for all the farmers in the six provinces, a one-way analysis of variance was used to determine the provincial variations in the costs of production and profits at 0.05 level of confidence**.** This was done at a farm level.

The milk price was a market price. Farm gate prices were not captured by the study as no farmer was allowed to sell milk at the farm or informal market by the smallholder dairy project implementers who had given the dairy animals to these farmers. As a result the farmers could not reveal the farm gate prices for fear of reprisals by their cooperative societies. Milk produced was delivered to the respective milk collection centers (co-operatives) on a daily basis. It is the responsibility of the cooperative to market the milk.

The gross margins estimated in this study were not net profits. This is because some fixed costs such as capital and land were not included due to lack of reliable data as earlier stated. Firth (2002) states that, an enterprise budgetary analysis (Full cost accounting and net margins) provides a better reflection on the smallholder dairy enterprise, but the difficulties of using net margins are that; firstly there are few (if any) published 'standards' with which to compare, secondly costs of field operations are not accurately recorded on all farms thereby relying on estimates that may vary from farm to farm and which can cause problems when farm comparison is made and, finally net margins and net profit per enterprise are less appropriate for farm planning since the fixed cost elements are unlikely to vary directly in proportion to the size of the enterprise.

3.6.3 Econometric Specification and Estimation of the Empirical Model

The empirical literature on dairy economics reflects the investigation into the relationship between socioeconomic variables and profitability by means of multiple regression methods (Olubiyo *et al*., 2009). Studies conducted by Nchinda and Mendi (2008); Otieno *et al*. (2009); Chagunda *et al*. (2006) have demonstrated the effects of age, gender, marital status, education level, household size and distance on relative profitability of smallholder dairy enterprise by use of multiple regression models. This formed the basis of inclusion of the socio-economic explanatory variables in our study. Annual gross margin was used as a dependent variable (Y) and seven socioeconomic characteristics of the respondents as explanatory variables (X) namely age, sex, marital status, education level, household size and distance to milk collection centers. Categorical variables (gender, marital status and level of education) were converted to dummy variables so that they could be included into the linear regression model. The implicit model of the regression was as indicated in the equation 2 below:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + e \text{.....Equation 2}$$

Where;

Y = Annual Gross Margin (ZMK)

β_0 = Intercept

β_1 to β_7 = Constants

X_1 = Age of the farmer (Years)

X_2 = Gender of farmer (0=female, 1=male), converted to dummy variable with 1= female and anything else=0.

X_3 = Marital Status (1=single, 2= married, 3=widowed), converted to dummy variable with 1= single and anything else=0.

X_4 = Household Size (No of Persons)

X_5 = Educational Level (0=no formal, 1=primary, 2=secondary, 3=tertiary) converted to dummy variable 1=no formal education, anything else=0.

X_6 = Herd Size (Number of Dairy Cows)

X_7 = Distance travelled to deliver milk to MCCs (Km)

e = Error Term; where the error term is assumed to be ***independent*** and ***normally*** distributed with mean zero and constant variance.

The null hypothesis was that each independent variable (age of the farmer, gender, marital status, household size, level of education, dairy cow herd size and distance to MCCs) was having absolutely no effect (has a coefficient of 0) and we were looking for a reason to reject this theory. The F-ratio was used to test the joint hypothesis to show whether the included variables collectively exerted any significant influence, on the dependent variable, the value of annual gross margin. It tested the null hypothesis that all the estimated coefficients are zero. The hypotheses are explicitly represented as follows:

$$Ho: \beta_1 \text{ to } \beta_7 = 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{Equation 3}$$

The alternative hypothesis states that profit is a function of age of the farmer, gender, marital status, household size, level of education, dairy cow herd size and distance to MCCs). Therefore, at least one of the coefficients is not zero.

$$H_A: \beta_1 \text{ to } \beta_7 \neq 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{Equation 4}$$

3.6.4 Model Estimation (Specification Analysis)

Choice of functional form: the factors affecting profitability of smallholder dairy enterprise were subjected to regression analysis in three functional forms (linear, quadratic and cubic forms). The dependent variable (annual gross margin) was plotted against each independent variable using curve estimation in order to determine the functional form of the relationship. Gujarati (2004) states that, in determining model adequacy, some broad features of the results, such as the R^2 value, the estimated *t* ratios and the positive and negative signs of the estimated coefficients in relation to their prior expectations are considered. Therefore, if these diagnostics are reasonably good, it can be concluded that the chosen model is a fair representation of reality

Heteroskedasticity Test: According to Gujarati (2004), examination of the residuals is a good visual diagnostic to detect autocorrelation or heteroskedasticity. A plot of the residuals will exhibit distinct patterns. Technically normality is necessary only for the t-tests to be valid; estimation of the coefficients only requires that the errors be identically and independently distributed. Normality of residuals can be visually inspected from the histogram with the superimposed normal curve which shows skewness for symmetry and the kurtosis for peakedness.

Multicollinearity Test: Multicollinearity exists when a predictor is a perfect linear combination of one or more of the remaining predictors (Maddala, 1992), i.e. when a predictor is highly correlated with others. A high level of correlation between predictors

X_1 and X_2 limits the ability to determine the proper relationship between X_1 and Y while controlling for X_2 and vice versa, because X_1 does not vary independently of X_2.

3.6.5 Summary Model Estimation (Specification Analysis

Multiple Linear Regression analysis was carried out using Statistical SPSS version 16 after carrying out the preliminary tests on the data. It was indicated that the empirical model did not violate the rules of regression analysis as the following assumptions were met:

Linearity: the relationships between the predictors and the outcome variables were linear.

Normality: the errors were normally distributed.

Homogeneity of variance (heteroskedasticity): the error variance was found to be constant.

Independence: the errors associated with one observation were not correlated with the errors of any other observation.

Multicollinearity: there was no collinearity between and within the predictors. SPSS recommends caution if the VIF > 10, or equivalently if the Tolerance is < 0.1.

CHAPTER FOUR

RESULTS

4.1 Introduction

This chapter presents the results in a following way: socio-economic characteristics of the respondents, descriptive statistics for milk production, profitability of smallholder dairying and its provincial variations, and contribution of smallholder dairy farming to rural development. It ends with a model estimation and description of the socio-economic factors affecting smallholder dairy farming in Zambia through the use of multiple regression analysis.

4.2 Socioeconomic Characteristics of Respondents

The findings in Table 1 indicated that 14.6 percent of the respondents were aged between 31-40 years, 45.9 percent between 41-50 years, 23.6 percent between 51-60 years and 15.9 percent between 61-70 years, respectively. The mean age of the respondents was 48.8 years. The majority of the respondents were male (63.1 percent), while 36.9 percent were female. Marital status of the respondents was distributed as follows; 82.8 percent were married, 5.1 percent were single and 12.1 percent were widowed. It was also observed that 9.6 percent of the respondents had household sizes of 1-5 persons, 42.7 percent had 6-10 persons, 22.3 percent had 11-15 persons, 10.2 percent had 16-20 persons and 15.2 percent had 21-25 persons, respectively. The average household size was 10 persons. The majority of the respondents (56.7 percent) had primary education, 29.9 percent had secondary education, 8.3 percent had no formal

education and 5.1 percent had tertiary education. Distance to milk collection centers seemed to be a very important factor on the viability of the smallholder dairy enterprise. About 17.2 percent of the respondents lived at distances less than 1 km from the respective milk collection centers, 43.9 percent at 1-5 km, 25.5 percent at 5-10 km, 12.1 percent at 10-20 km and 1.3 percent at over 20 km i.e. the longer the distance from the MCC the lower the number of smallholder dairy farmers delivering the milk.

Table 1: Socioeconomic characteristics of respondents

Parameter	Number	Percentage
Age (years)		
31-40	23	14.6
41-50	72	45.9
51-60	37	23.6
61-70	25	15.9
Gender		
Female	58	36.9
Male	99	63.1
Marital status		
Married	130	82.8
Single	8	5.1
Widowed	19	12.1
Household size (number of persons)		
1-5	15	9.6
6-10	67	42.7
11-15	35	22.3
16-20	16	10.2
21-25	24	15.2
Level of education		
No formal education	13	8.3
Primary	89	56.7
Secondary	47	29.9
Tertiary	8	5.1
Distance travelled to MCCs (km)		
Less than 1	27	17.2
1-5	69	43.9
6-10	40	25.5
11-20	19	12.1
Over 20 km	2	1.3
Total for each section	**157**	**100**

Average age= 48.8 years, average household size=10 persons

4.3 Descriptive Statistics for Milk Production

The dairy cow herd size ranged from 1 to 40 with an average of about 4 cows. The animals were fed an average of 3.23 kg of concentrates as supplementary feed per cow per day during and after milking as none of the farmers practiced complete zero grazing. The farmers were delivering from 1 to 145 litres of milk per day to the milk collection centers in the dry season with an average of 15.37 litres and up to 170 litres with an average of 27.69 litres per day in the rainy season. Home milk consumption ranged from 1 to 5 litres per day with an average of 2.2 litres per household. This resulted in dairy households having a per capita consumption of about 80 litres. An average of 3.96 litres of milk was being fed to calves in the first three months of life. The farmers were making profits ranging from ZMK 132,000 to ZMK 57,862,000 with an average of ZMK 5,508,620 per year. Table 2 depicts milk production descriptive statistics.

Table 2: Descriptive Statistics

Parameter	N	Min	Max	Mean	Std. Deviation
Dairy cow herd size	155	1	40	4.37	6.53
Litres per day in dry season	157	1.00	145.00	15.37	16.82
Litres per day in rain season	157	0.00	170.00	27.69	25.17
Litres consumed at home/day	157	1.00	5.00	2.20	1.16
Litres per calf/day for 3 months	157	0.00	5	3.96	1.39
Concentrates feed supplemented /cow/day	157	0.00	16.00	3.23	3.36
Annual profit (ZMK)	157	132,000	57,862,000	5,508,620	7,311,694

4.4 Profitability (Gross Margins) of Smallholder Dairy Farming

The estimated average sale price of milk by the farmers was ZMK 2002.05 per litre. The estimated average cost of production was ZMK 828.20 per litre, representing 42.1 percent of the sale price. The estimated returns per litre were at ZMK 1173.85, representing 57.9 percent of the average sale price of milk. Table 3 and 4 depicts the average sale price of milk, costs of production and returns with their respective percentages.

Table 3: Average price received and cost of production milk in ZMK/L

Province	District	Price (ZMK/L)	Cost (ZMK/L)	Cost %
	Mazabuka (N=25)	1976	980	49.6
	Monze (N=22)	1754	816	46.5
	Batoka (N=12)	1817	642	35.3
	Choma (N=12)	1883	717	38.1
Southern	Kalomo (N=6)	1583	776	49
	Chibombo (N=18)	1828	734	40.2
Central	Kabwe (N=4)	2000	994	49.7
Lusaka	Kafue (N=15)	2000	1069	53.4
Eastern	Chipata (N=15)	2073	860	41.5
Copperbelt	Luanshya (N=10)	2110	1015	48.1
	Mongu (N=8)	2500	828	33.1
Western	Senanga (N=10)	2500	506	20.2
Averages		**2002.05**	**828.20**	**42.1**

Table 4: Average price received and gross margin in ZMK/L

Province	District	Price (ZMK/L)	Gross margin (ZMK/L)	Gross margin%
	Mazabuka (N=25)	1976	996	50.4
	Monze (N=22)	1754	938	53.5
	Batoka (N=12)	1817	1175	64.7
	Choma (N=12)	1883	1166	61.9
Southern	Kalomo (N=6)	1583	807	51
	Chibombo (N=18)	1828	1094	59.8
Central	Kabwe (N=4)	2000	1006	50.3
Lusaka	Kafue (N=15)	2000	931	46.6
Eastern	Chipata (N=15)	2073	1213	58.5
Copperbelt	Luanshya (N=10)	2110	1095	51.9
	Mongu (N=8)	2500	1672	66.9
Western	Senanga (N=10)	2500	1994	79.8
Averages		**2002.05**	**1174.85**	**57.9**

4.4.1 Cost of Production and Gross Margins from each Province Expressed as a Percentage

Western Province recorded the highest gross margin per litre, followed by Eastern, Southern, Central, Copperbelt and Lusaka in that order as shown on the graph below (Figure 2).

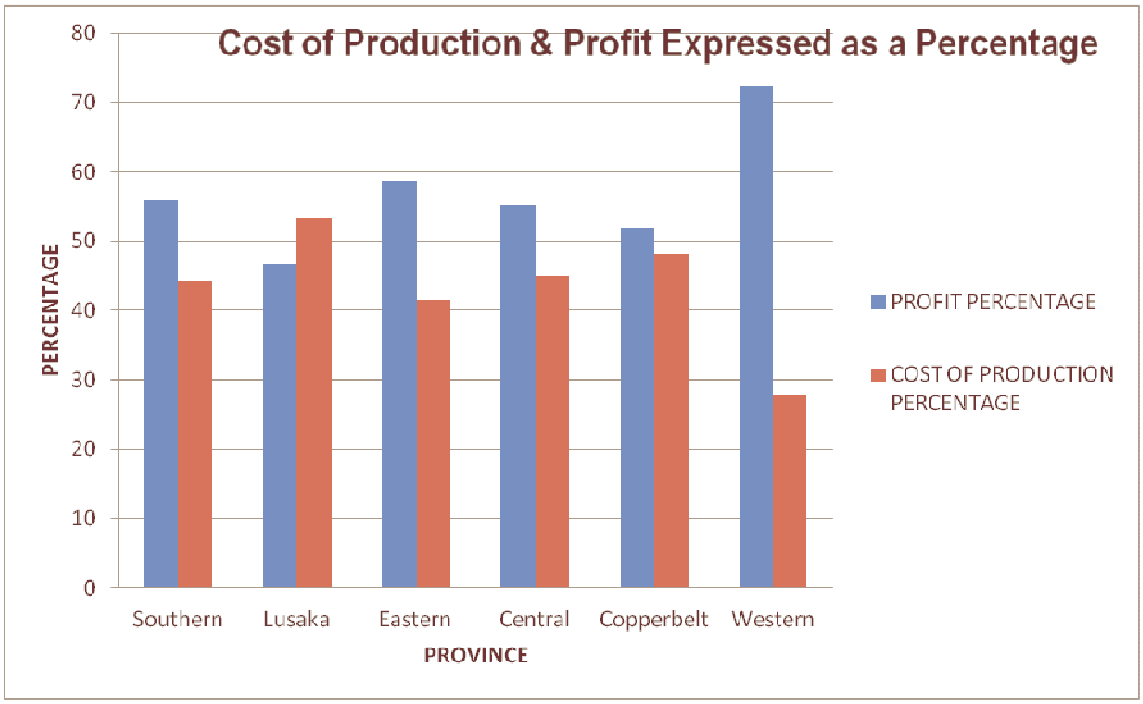


Figure 2: Graph of cost of production versus profit expressed as a percentage

4.4.2 Provincial Variations in the Cost of Production and Profitability

A one-way Analysis of Variance was used to find out whether the costs of production and the gross margins were significantly different at ($P<0.05$) for the six provinces. Post Hoc tests were carried out using the Benferonni statistic. There was a significant difference in cost of production between Lusaka and Western Provinces (Table 5). There was no significant difference in annual profits in all the provinces studied (Table 6).

Table 5: One way analysis of variance of arithmetic means of cost of production

		Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
(I) Province	**(J) Province**				**Lower Bound**	**Upper Bound**
Lusaka	Southern	4711845.45	1792203.590	.142	-633618.14	10057309.05
	Central	5341854.55	2126318.479	.196	-1000147.04	11683856.13
	Eastern	6203666.67	2318749.267	.124	-712282.98	13119616.31
	Western	7913188.89	2220033.404	**.007***	1291671.22	14534706.56
	Copperbelt	3692720.00	2592440.492	1.000	-4039546.77	11424986.77

*The mean difference is significant at the .05 level

Table 6: One way analysis of variance for arithmetic means of profits

		Mean Difference (I-J)	Std. Error	Sig	95% Confidence Interval	
(I) Province	**(J) Province**				**Lower Bound**	**Upper Bound**
Lusaka	Southern	3945363.64	2067889.80	.874	-2222367.36	10113094.63
	Central	3209854.55	2453400.00	1.000	-4107707.18	10527416.27
	Eastern	3807800.00	2675431.51	1.000	-4171997.50	11787597.50
	Copperbelt	3040180.00	2991223.36	1.00	-5881504.83	11961864.83
	Western	4772444.44	2561530.65	.966	-2867630.00	12412518.89

The mean difference is significant at the .05 level

4.5 Socio-economic Factors Affecting Profitability of Smallholder Dairying

4.5.1 Model Estimation: Choice of a Functional Form

The linear form was chosen as the lead function because it had the highest R^2 value (0.425) and the highest F-ratio (114.55) as show in Table 7.

Table 7: Curve estimation for annual gross margin against dairy cow herd size

Independent: HERD_SIZ Dependent Mth		Rsq	d.f.	F	Sig.	b0	b1
ANN_GM	LINEAR	.425	157	114.55	.000	2289307	734640
ANN_GM	QUAD	.267	157	56.32	.000	2517538	.0749
ANN_GM	CUBIC	.267	157	56.32	.000	4.0E-07	.9279

4.5.2 Model Estimation: Heteroskedasticity Test (Examination of Residuals)

The data were tested for heteroskedasticity (Y=ZRESID, X=ZPRED). The curve was considerably fitted centrally indicating a perfect distribution of residuals as shown in the histogram (Figure 3). This meant that the p-values for our t-tests were valid.

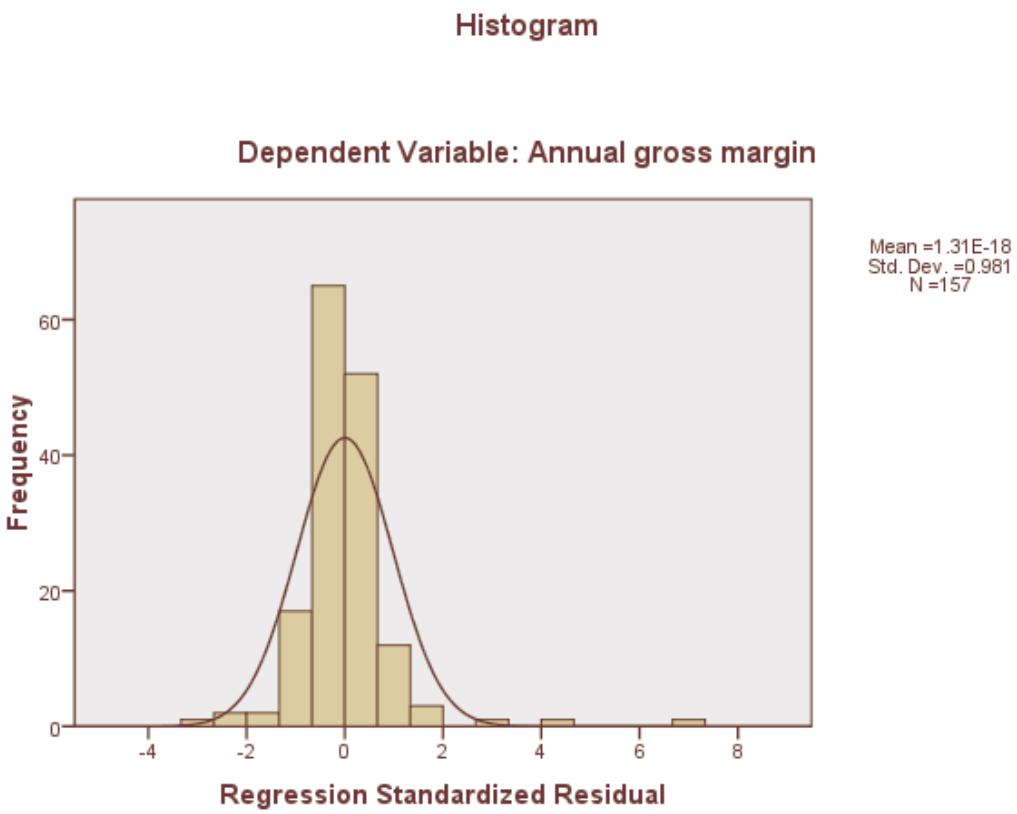


Figure 3: Histogram of Y=ZRESID, X=ZPRED

4.5.3 Model Estimation: Multicollinearity Test using Correlation Matrix and Variance Inflation factor (VIF)

Data from the current study did not show any multicollineality because none of the correlation values was significant (closer to 1.000) as shown in Table 8. Variance-inflation factor (VIF) and tolerance values indicated that there was no collinearity between and within the predictors in the regression model, as shown in Table 9.

Table 8: Multicollinearity test with the correlation matrix

Pearson Correlation	Annual gross margin	Age	Gender	Marital status	Household Size	Education level	Herd size	Distance travelled to MCC
Annual gross margin	1.000							
Age	.040	1.000						
Gender	.021	.062	1.000					
Marital Status	.078	-.103	-.414	1.000				
Household Size	.145	-.100	-.155	.077	1.000			
Education Level	.249	.135	.047	-.031	.078	1.000		
Herd size	.652	-.056	-.045	.081	.097	.130	1.000	
Distance travelled to MCC	.196	.007	.071	-.007	-.094	-.076	-.038	1.000

*Correlation is significant at 0.05 level (1-tailed)

Table 9: Collinearity test using tolerance and variance inflation factor (VIF)

Parameter	**Collinearity Statistics**	
	Tolerance	VIF
Age of the farmer	.965	1.036
Gender of the farmer	.771	1.297
Marital status	.766	1.305
Household size	.941	1.063
Level of education	.954	1.048
Dairy cow herd size	.953	1.049
Distance travelled to MCC	.979	1.021

*Collinearity when VIF is > 10. No collinearity if VIF = 1

4.5.4 Multiple Regression Estimates of the Socio-economic Factors Affecting Profitability of Smallholder Dairy Farming

Table 10 summarizes the multiple regression estimates of socio-economic factors affecting profitability of smallholder dairy enterprise. Age of the farmer was not statistically significant (p=0.076), gender of the farmer was not statistically significant (p=0.342) and marital status was also not statistically (p=0.226). Thus, profitability is not a function of age, gender and marital status of the farmer, other factors being held constant. Household size was not statistically significant (p=0.945). Level of education was equally not statistically significant (p=0.139). Dairy cow herd size was statistically significant (p=0.00). A unit increase in the herd size of milking cow results in the increase of profit of the smallholder dairy enterprise by ZMK 741, 405.57, other variables being held constant. Distance to milk collection centers was statistically significant (p=0.00). A unit decrease in distance to the MCC leads to an increase in profit by ZMK 338, 445.16, other factors being held constant.

Table 10: Multiple regression estimates of factors affecting profitability of smallholder dairy enterprise.

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
Constant	-2.806E6	2.107E6		-1.332	.185
Age	61512.01	34415.885	.105	1.787	.076
Gender (dummy)	-950878.76	995387.018	-.063	-.955	.341
Marital status (dummy)	1.547E6	1.273E6	.080	1.215	.226
Household size	5630.66	81238.355	.004	.069	.945
Education level (dummy)	-2.329E6	1.567E6	-.088	-1.486	.139
Dairy herd size	741405.57	66452.989	.658	11.157	.000
Distance to MCC	354611.58	83995.607	.250	4.222	.000
Dependent Variable: Annual Gross margin		$R^2 = 52.3$	F = 23.3	P < 0.05	

4.6 Contribution of Smallholder Dairying to Rural Socio-economic Development

Table 11 indicates that the majority of the respondents (87.3 percent) stated that they depended on smallholder dairying as their main source of income while 12.7 percent had other main sources of income. The banking sector was benefiting from smallholder dairy enterprise, with 35.7 percent of the respondents accessing their payments for the milk delivered per month through bank transfers while 64.3 percent were receiving cash directly from the milk collection centers. Most of the smallholder dairy farmers (68.2 percent) had acquired and used bicycles as the main mode of transport to deliver milk to the milk collection centre, with 27.4 percent delivering milk on foot. Some farmers used motorbikes (3.8 percent) and oxcarts (0.6 percent). Most (52.9 percent) of the respondents used part of the money from milk sales for monthly church contributions as tithe and offering in accordance with their religious teachings. Smallholder dairying seems to also play an important role towards poverty reduction and rural development. This can be seen from the number of respondents (10.2 percent) who had built iron sheet-roofed houses from income generated from smallholder dairy enterprise as shown in Figure 4. Many (43.9 percent) of the respondents indicated that they had bought some luxuries such as cell phones, televisions, radios, satellite dishes etc. from income generated from smallholder dairy farming. Of the 157 respondents, 49 percent had employed other people to work on the farms as herdsmen, milkers and in other dairy activities.

Table 11: Contribution of smallholder dairying to rural socio-economic development

Parameter	Frequency	Percentage
Main source of income		
No	20	12.7
Yes	137	87.3
Total	**157**	**100**
Mode of payment		
Cash	101	64.3
Bank transfer	56	35.7
Total	**157**	**100**
Mode of transport to MCCs		
Foot	43	27.4
Bicycle	107	68.2
Ox cart	1	0.6
Motor bike	6	3.8
Total	**157**	**100**
Contribution to religion		
No	74	47.1
Yes	83	52.9
Total	**157**	**100**
Contribution to provision of human housing		
No	141	89.9
Yes	16	10.2
Total	**157**	**100**
Contribution to improving standard of living		
No	88	56.1
Yes	69	43.9
Total	**157**	**100**
Contribution to Employment		
No	80	51
Yes	77	49
Total	**157**	**100**

Figure 4: Decent house (right) built from income generated from smallholder dairy farming by a widow in Monze district. Old house (left).

CHAPTER FIVE

DISCUSION

5.1 Socio-economic Characteristics and their Effects on Profitability of Smallholder Dairy Farming (Multiple Regression Analysis)

The socioeconomic findings showed that the average age of the respondents was 48.8 years. This seems to suggest that smallholder dairy farming is mainly practiced by people in the old age bracket as these are the ones targeted by donor funded projects on the assumption that they have had experience of cattle rearing from their traditional cattle breeds. There is need for these smallholder dairy donor funded projects to also engage the youths so that there is continuity upon the demise of their parents in the old age bracket. However, age, gender and marital status had no significant effect on the profitability of smallholder dairy enterprise, other factors being held constant.

The average household size was ten persons per home. This is in agreement with the Central Statistical Office census report that indicates that the average number of persons per home in rural areas is ten (CSO, 2010). Household size has been described as the most important determinant of labour investment for family farms because in addition to being a source of labour, it also influences the need for increased milk production for home consumption as well as for the market (Ngongoni *et al*., 2006). This was not the case in this study as regression analysis showed that household size was not statistically significant (p=0.945).

The majority of the respondents (77.7 percent) had formal education. However, level of education was not statistically significant (p=0.139) in multiple regression analysis. It had been expected that level of education would have a statistically significant effect on profitability as this results in better understanding of smallholder dairy farming as a business. It is also assumed that educated farmers have proper management of dairy animals, feeding and good hygiene, thereby improving milk yield and profits.

According to FAO (2007), a smallholder dairy farmer is a farmer who has a dairy herd size of one to four dairy cows. The average number of dairy cows in this study was four; which conforms to the above definition of a smallholder dairy farmer by the Food and Agriculture Organization (FAO). Dairy cow herd size (milking cows) was statistically significant (p=0.000) and its coefficient was positive meaning that a unit increase in the herd size of milking cows, results in an increase in profit of the smallholder dairy enterprise by ZMK 741, 505.57, when other variables are held constant. This is in agreement with Cain *et al*. (2007) who stated that profitability of a dairy enterprise is highly correlated with herd size and measures should be taken to reduce calving intervals in order to increase herd sizes.

Mutukumira *et al*. (1996) stated that long distance to milk collection centers is a hindrance to a viable dairy enterprise**.** The longer the distance to the MCCs the less the number of smallholder dairy farmers delivering milk, hence the less the profit. In this study distance to MCCs was statistically significant (p=0.000). Thus, the shorter the distance to the MCCs, the higher the profit. This is because the shorter distance, the

more the likelihood of the farmer delivering milk on a daily basis hence making more profit than the one staying far who will only deliver when he has transport. Furthermore, those staying far risked their milk becoming sour leading to rejection of this milk at the MCC hence a reduction in profits.

The farmers were delivering 15.37 litres of milk per day to the milk collection centers in the dry season and an average of 27.69 litres per day in the rainy season. This shows that milk production in Zambia reduces by 44 percent during the dry season due to inadequacies in quantity and quality of food and water for animals. Most of the farmers did not conserve grass in form of hay as the fields are normally burnt or become dry and overgrazed in the dry season.

Home milk consumption had an average of 2.2 litres per household. This resulted in rural dairy households having a per capita consumption of about 80 litres against the national per capita consumption of about 24 litres. An average of 3.96 litres of milk was fed to calves in the first three months of life. The farmers were making an average gross margin of ZMK 5,508,620 per year. This corresponds to a monthly income of about ZMK 450, 000 which is almost equal to the current minimum wage for people in employment in Zambia.

5.2 Cost of Milk Production and Gross Margins

The estimated average sale price of milk by the farmers was ZMK 2002.05 per litre. The estimated average cost of production was ZMK 828.20 per litre, representing 42.1 percent of the sale price. The estimated returns per litre were at ZMK 1173.85, representing 57.9 percent of the average sale price of milk. The profit calculated was a gross margin and not net profit. This is because some fixed costs could not be added due to lack of reliable data on their market values. This is in agreement with the studies carried out by Mburu *et al*., 2007 and Ouma *et al*., 2004 who had similar challenges. However, gross margins are still useful in assessing enterprise profitability and are widely used in farm management economics (Dijkhuizen and Huirne, 1997; Firth, 2002).

5.3 Provincial Variations in the Cost and Returns of Milk Production

According to Mburu *et al*. (2007), the costs of production are expected to be highest in the most intensive systems and lowest in the most extensive systems reflecting the high amounts of concentrate feeds used. This assumption was correct in our study as a one-way analysis of variance showed that there were significant differences ($P<0.05$) between the costs of production for Lusaka and Western provinces. The cost of production was lowest in Senanga (20.2 percent) and Mongu (33.1 percent) districts in Western Province compared to 53.4 percent in Lusaka. This was because the costs of labour, feeding, vaccination and dipping animals were very minimal in these districts. The respondents indicated that the use of acaricides for dipping or spraying animals against ticks is not practiced in Western Province because the ticks are eradicated by the floods in the Zambezi flood plain every year hence very minimal or no costs towards

dipping. There were minimal costs on vaccination because most the vaccinations against major diseases in Western Province i.e. contagious bovine pleural pneumonia (CBPP), anthrax, blackleg etc, are carried out by the Government through the offices of district veterinary officers. Rice polish and maize bran are the only supplementary feeds that a few farmers give to their animals when in the uplands. The animals are kept in the Zambezi flood plain which is evergreen almost throughout the year (6 to 8 months) and are only moved to the uplands when the plain gets flooded in the rainy season. The animals usually owned by several people and kept in herds of 30–100 are herded during daytime and enclosed in kraals at night. The kraals are shifted frequently to spread the manure over wide areas that are used to grow maize and millet (Moll *et al*., 2007). Some interviewed farmers reported that they were using manure as payment for hired labour. Manure from the dairy farming was used to fertilize the fields hence contributing to conservation agriculture which the Government of the Republic of Zambia is currently promoting.

Lusaka Province recorded the highest cost of milk production per litre. This is because of the intensive systems being practiced where high amounts of concentrate feeds are used. This is in agreement with Baltenweck *et al*. (1998) whose study findings showed that the cost of production in a dairy enterprise is dependent on the level of intensification, with less-intensified districts having relatively high levels of cash flows while some highly intensified areas experience rather low levels of cash flows. Farmers in urban areas like Lusaka have smaller families as compared to rural areas; hence the cost of labour is also higher than in rural areas. Land in Lusaka Province is a limiting

factor due to the population pressure, hence the high level of intensification in dairy farming.

There was no significant difference in unit profits in all the provinces regardless of some provinces recording more profits than others. This is due to the differences in milk volumes and prices which had a buffering effect in respective provinces. Western Province had the lowest volume of milk but the price per litter was the highest at ZMK 2,500.00, while Lusaka Province had the highest volumes of milk at the price of ZMK 2,000.00, hence the price buffering effect.

5.4 Contribution of Smallholder Dairy to Rural Socio-economic Development

Smallholder dairying seems to contribute significantly to the socio-economic wellbeing of the rural poor. Most of the respondents (87.3 percent) depended on dairying as their main source of income, besides other agricultural activities such as cultivation of cash crops. This is probably due to the fact that dairying is not seasonal as compared to cash crops. Ngongoni *et al*. (2006) is of the view that smallholder dairy farming promotes regular monetary earnings to people who normally access cash once a season after they sell their harvested crops i.e. maize, groundnuts, sunflower, cotton, etc. The regular monthly monetary earnings from the sale of milk and milk products have favorable effects on the cash flow charts of rural households and assist in improving the lifestyles of the rural people.

The human right to adequate housing is the right of every woman, man, youth and child to acquire and sustain a secure home and community in which to live in peace and dignity. The right to housing is codified as a human right in the Universal Declaration of Human Rights of 1948:

> "Everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, **housing** and medical care and necessary social services, and the right to security in the event of unemployment, sickness, disability, widowhood, old age or other lack of livelihood in circumstances beyond his control." [Article 25(1)]

In this study, 10.2 percent of the smallholder dairy farmers had built decent houses with clean latrines from income generated from dairying. This development is very significant as stated in the universal declaration above.

Banking institutions are benefiting from smallholder dairying through provision of loans and processing of payments for the dairy farmers. Many farmers (35.7 percent) were receiving their payment for milk sales through bank transfers. Banking is indeed no longer for the urban people only, as some rural smallholder dairy farmers now have access to automated teller machines (ATMs).

Most of the smallholder dairy farmers (68.2 percent) used bicycles as the main mode of transport to deliver milk to the milk collection centre. This is in agreement with the study by Mutukumira *et al*. (1996) whose findings indicated that most of the farmers use a bicycle as the main means of transport in Zimbabwe and indeed many other African countries.

Almost half of the respondents (49 percent) had employed other people to work on the farms as herdsmen, milkers and in other dairy activities. Estimates by FAO (2010) show that production of 1 million litres of milk per year on smallholder dairy farms creates approximately 200 on-farm jobs. Thus smallholder dairying in Zambia plays an important role in rural poverty reduction, employment opportunities and wealth creation as well as enhancing household nutrition and food security.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The results of the study on the cost and returns demonstrate that smallholder dairy farming is profitable in Zambia. The average price received by the farmer from milk sales was ZMK 2,002.05 per litre while the average cost of production was at ZMK 828.20 (42.1 percent) per litre resulting in the average returns of ZMK 1,173.85 (57.9 percent) per litre. Findings based on multiple regression analysis indicated that profitability of smallholder dairy farming is a function of dairy cow herd size and distance travelled to deliver milk to the market. Findings on socio-economic contribution of smallholder dairying to rural development demonstrated that smallholder dairying in Zambia plays an important role in rural poverty reduction, employment opportunities and wealth creation as well as in enhancing household nutrition and food security.

6.2. Recommendations

Smallholder dairying in Zambia is profitable and plays an important role in rural poverty reduction, creation of employment opportunities and wealth, and in enhancing household nutrition and food security which is in line with the millennium development goals. Thus the Government of the Republic of Zambia, donors and other service providers need to allocate more resources towards smallholder dairy development particularly in the areas of animal breeding, marketing, value addition, infrastructure

development and knowledge transfer. It is difficult to source dairy animals in Zambia and thus there is need to introduce dairy animal breeding centers so that farmers can easily buy and increase their dairy herd sizes when necessary.

Policy makers and stakeholders should also consider constructing more milk collection centers near the smallholder dairy farmers in order to reduce the distance travelled to deliver milk to the market (MCC). This will have a positive effect on milk production in Zambia as more than half of the milk produced is from the smallholder dairy sector. The farmers who live far from milk collection centers and walk when delivering milk were recording less profit than those living in closer proximity. For some farmers, that have to walk long distances, milk go sour by the time they arrive at milk collection centers, and such milk is rejected leading to losses by the farmer.

Loans for bicycles need to be provided by stakeholders as it seems to be the major mode of transport used to deliver milk to milk collection centers as indicated in the results. If most the farmers delivering milk can be provided with bicycles and the loan be deducted from the milk delivered over a period of time, the dairy industry can see a major growth as more farmers can be delivering milk on a daily basis.

CHAPTER SEVEN

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CHAPTER EIGHT

APPENDICES

8.1 Appendix I: Questionnaire used in Data Collection

Section 1: General Information of the Farm

Name of Farm/ Owner ……Herd Size……Dairy……..

Beef…….No. Females……No. Males……..Farm size……..

No. Milking Cows……Sex……Age…….Marital status……Household size…….

Education:……...Province……District:……Area/Village……

Section 2: Cost of Feeding

1. Besides grazing, do you supplement the animals?

   (a) Yes. [ ]

   (b) No (if no, go to section 3). [ ]

2. If the answer to question (1) is yes, what do you supplement them with?

   (a) Hay. [ ]

   (b) Silage. [ ]

   (c) Molasses / Urea. [ ]

   (d) Maize bran / wheat bran. [ ]

   (e) Cakes (soya, sunflower, e.t.c.) [ ]

   (f) Maize Stover. [ ]

   (g) DCP and salt. [ ]

   (h) We grow our own [ ]

(i) All above. [ ]

(j) Others. Specify……

3. Approximately how many kilograms of the feed in question (2) do you give each cow per day?

(a) Roughage…….

(b) Concentrates……

4. Approximately how much money do you spend on feed per month?

(Roughage and Concentrates)……

Section 3: Cost of Labour

5. Other than family members, do you have workers to herd, milk and transport milk?

(a) Yes. [ ]

(b) No (if no go to section 4). [ ]

6. If the answer to question (5) is yes, how many workers do you have?

(a) 1 worker. [ ]

(b) 2 workers. [ ]

(c) 3 workers. [ ]

(d) Over 4 workers. [ ]

(e) Others. Specify…….

7. How much do you pay each worker per month?.....

8. Approximately how much money do you spend on workers salaries per month?

……

9. Do you also pay them something in kind like maize, vegetables, milk?

(a) Yes. [ ]

(b) No [ ]

10. If the answer to question 9 is yes, how much is the value of the items (in kwacha) you give them per month?.....

Section 4: Milk Production and Sales

11. Do you keep milk production records for your farm (kindly check the records if yes).

(a) Yes. [ ]

(b) No. [ ]

12. On average, how many litters does each cow produce per day?

(a) Dry season……

(b) Wet season…….

13. What is your total milk production per day?

(a) Dry season……..

(b) Wet season…….

14. Do you sell the milk?

(a) Yes. [ ]

(b) No (if no, go to question 16). [ ]

15. If the answer to question (14) is yes, how many litters of your milk do you sell?

(a) Dry season……

(b) Wet season……

16. How many litters of your milk do you give to calves per day?.....

17. How many litters of your milk do you consume per day?.....

18. Where do you sell your milk?

(a) To the local community. [ ]

(b) To milk collection centers (MCC) cooperative. [ ]

(c) All above. [ ]

(d) Others.Specify……..

19. How much do you sell per litter?.....

20. Approximately how much money do you make from milk per month……..

Section 5: Cost of Farm Management Practices (Veterinary Costs)

Deworming

21. How often do you deworm your milking cows?

(a) Once per year. [ ]

(b) Twice per year. [ ]

(c) Thrice per year. [ ]

(d) Others. Specify……..

22. What dewormers do you use?

(a) Levamisole. [ ]

(b) Albendazole. [ ]

(c) Ivemectin. [ ]

(d) Others. Explain…….

23. Who deworms them?

(a) Myself. [ ]

(b) My workers. [ ]

(c) Veterinary assistants. [ ]

(d) GART technician [ ]

(e) Private vets. [ ]

(f) Others. Explain…….

24. Approximately how much money do you pay the veterinarians for deworming per animal?.....

25. Approximately how much money do you spend on deworming per year?

…….

Vaccination

26. How often do you vaccinate your animals?.....

27. How much money do you spend on vaccinations per animal / year?.....

Dipping

28. How often do you dip/spray your animals?

(a) Dry season……(b) Rainy season……

29. What acaricides (dips) do you use?……..

30. How much money do you spend on dipping animals per year?.....

Other expenses

31. How much money do you spend on the following per month,

(a) Detergent paste (soap),Soap for washing hands, Teat dip medicine, Teat dip cups and milking cream per month…….

(b) Medicines for mastitis and other diseases (treatment) per year……

(c) Cost of Artificial insemination if any……

Transport

32. What mode of transport do you use to transport milk to MCC?

(a) Walking [ ]

(b) Bicycle [ ]

(c) Ox cart [ ]

(d) Motor [ ]

(e) Others. Specify……..

33. How far is your place to the MCC?

(a) Less than 1 km [ ]

(b) 1-5 km [ ]

(c) 5-10 km [ ]

(d) 10-20 km [ ]

(e) Over 20 km [ ]

34. What type of a container do you use to deliver milk to MCC?

(a) Plastic [ ]

(b) Stainless steel cane [ ]

(c) Non-food plastic [ ]

(d) Others. Specify……

SECTION 6: SOCIO-ECONOMIC IMPACT

35. How do you receive payment from milk sales?

(a) Cash. [ ]

(b) Cheque. [ ]

(c) Through the bank. [ ]

(d) Others. Specify……..

36. What do you spend your money on?

(a) Buying feed for animals. [ ]

(b) Medicines for animals. [ ]

(c) Education for children. [ ]

(d) Medical bills. [ ]

(e) Salary for workers. [ ]

(f) Donation at church. [ ]

(g) Clothes for children. [ ]

(h) All above. [ ]

(i) Others. Specify…….

37. What luxuries do you buy from this money?

(a) Bicycle [ ]

(b) Radio [ ]

(c) Television [ ]

(d) Mattress [ ]

(e) Others. Specify……..

38. Have you undergone any form of training in dairy animal management?

(a) Yes. [ ]

(b) No. [ ]

39. Who provided the training?

(a) GART [ ]

(b) Land O lakes [ ]

(c) Livestock services [ ]

(d) UNZA [ ]

(e) USAID/PROFIT [ ]

(f) Government [ ]

(g) Others. Specify……

40. Did you pay for this training?

(a) Yes. [ ]

(b) No. [ ]

41. If yes to question (41), how much did you pay?.....

42. Do you have any comments or suggestions?.....

END OF QUESTIONAIRE.