THE ROLE OF IN - KIND CREDIT ON MILK PRODUCTIVITY AMONG SMALLHOLDER DAIRY FARMERS IN MALAWI - A CASE STUDY OF LILONGWE AND MZUZU MILKSHED AREAS

BY

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DECLARATION

I hereby declare that this thesis is a product of my own work and efforts and that it has not been submitted anywhere for any academic award. Where other sources of information have been used, they have been acknowledged.

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CERTIFICATE OF APPROVAL

We hereby certify that this thesis is from the student's own effort and that it has been submitted with our approval.

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DEDICATION

This work is dedicated to my late mother, Catherine Chindime, who left the world 10 years ago and never witnessed the success of her only daughter. Rest in Peace Mum. My siblings Felix, Brian, Jones and Noel for the comfort you gave me throughout my life. My sister in-law, Clara whose love is better than life itself.

To God my creator who is my light in the dark, my good in a world of evil, my hope in a hopeless universe.

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ABSTRACT

A study on the role of credit on milk productivity among credit participant and non credit participant dairy farmers in Malawi was conducted in Lilongwe milk shed area, Central Malawi and Mzuzu milk shed area, Northern Malawi. The milk-shed areas were chosen because of a high concentration of smallholder dairy farmers some of whom receive credit support for livestock production from two major NGOs, namely Land O' Lakes and Small Scale Livestock Promotion Programme.

The study was conducted in two phases namely, cross-sectional survey and observational study. The cross-sectional survey involved the use of a structured questionnaire which was administered to 305 randomly selected dairy farmers. Data were collected on household characteristics, milk yield estimates, numbers of animals, breed types, calving intervals, numbers of services per conception, calf survival, resource endowments, milk disposal and marketing, credit participation status, management levels, indications of input use and costs for the purpose of selecting those to be included in monitoring survey. SPSS programme version 12 was used to generate descriptive statistics such as frequencies, means, and graphs and cross tabulations of the socio-economic variables, while General linear model of SAS was used to determine any significant differences in average milk, calving interval, number of services per conception among credit participants and non credit participants. Observational study involved 60 farmers for a period of six months, and the data included feed intake by cows, water, labour and amount of concentrates fed. Cobb

Douglas production function was used to analyze the extent of effect of the physical factors of production that form part of in-kind credit and finally gross margins were obtained for credit participants and non credit participants to verify the economic returns of in-kind credit.

Results revealed that milk production of the credit participants were significantly higher per day per animal compared to non credit participants probably due to regular availability of dairy technologies through in kind credit. Furthermore, productive parameters (technologies used) were all significantly influenced by borrowing status ($P<0.05$). These included breed of cow used, method of breeding, feeds (supplementation and improved forage), method of grazing, housing and drug availability. On the other hand, reproductive parameters and their associated problems such as number of services per conception (3.1 vs 1.6) and calving interval (15.0 vs 13.9 months) were higher in credit participating than in non credit participating group and the differences were significantly different ($P<0.05$). However the production function indicated that forage, concentrates and water which forms part of the in-kind credit had a statistically significant positive relationship to milk output ($P<0.05$).

Finally economic analysis recorded higher gross margins for the credit participants irrespective of breed than to the non credit participants. This gives evidence that credit had an important role to play in improving milk yield hence increased returns. Therefore, it is recommended that in-kind credit should be continued by government and other NGOs as a way of increasing productivity of dairy cattle.

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LIST OF ACRONYMS

ADD	Agricultural Development Division
AI	Artificial Insemination
C-D	Cobb Douglas
CI	Calving Interval
CREMPA	Central Region Milk Producers Association
FAO	Food Agriculture Organisation
LOL	Land O' Lakes
MBGs	Milk Bulking Groups
MMPA	Mpoto Milk Producers Association
MZADD	Mzuzu Agricultural Development Division
NGO	Non Governmental Organisation
NDIFA	Northern Dairy Farmers Association
NSO	Number of services per conception
SSLPP	Small Scale Livestock Promotion Programme

LIST OF TERMS AND DEFINITIONS

In the study the following terms are defined as follows

CREDIT PARTICIPANT: is defined as an individual who has been continuously using credit (in Cash or in Kind) from non governmental organisations as per operations of Land O Lakes for the past 12 months

CREDIT NON PARTICIPANT: is defined as an individual who has never used credit from any of the providers, and uses own money for purchasing inputs and technologies for the effective operations of the dairy enterprise for the past 12 months

NOTE: Both groups use, acquire or purchase inputs and technologies using either credit or own money. (Hence in the both groups, there is increased use of inputs and technologies in order to produce and market milk according to the demand of dairy industry.

CHAPTER 1

1.0 INTRODUCTION

1.1 The Contribution of Dairy in Malawi

Dairying has become very attractive among smallholder farmers in Malawi as it provides regular income due to high demand for fresh milk especially in urban centres. It is also an investment for many farmers; it provides employment to about 5700 farmers (Malawi Government, 1999) and also meat to the population through culled animals that are fattened and sales of male calves. Other than that dairy cattle also provide dung as a fertilizer for soil conditioning and provision of additional nutrients to the soil.

FAOSTAT (2005) reported that Malawi's milk consumption rate is invariably lower than that of her neighboring countries. The national average is 4.7 kg per capita, while Africa's average is estimated at 15kg per capita (Mwenifumbo and Banda, 1998). This is partly due to low milk production as a result of poor feeding methods of dairy cattle by local farmers as well as a very small dairy cattle population. The need for improving milk production and the consequent milk consumption in Malawi is heavily pronounced. Malawi still imports about 13-15,000 (FAOSTAT, 2005) metric tones of milk equivalents, representing about 38% of the annual milk consumption.

1.2 Governments Initiatives in Dairy Development

Malawi's first national livestock policy was formulated in 1952 and sought to improve environmental conditions for livestock and to develop the animal industry through better animal breeding, research, training and departmental organization (Chagunda *et al.*, 2001). Nzima (1991) observed that government efforts date back to the late 1950s with the initiative of launching a breeding program of Friesian X Malawi Zebu crosses with the view of obtaining heifers for distribution to smallholder farmers.

The Ministry of Agriculture's, Department of Animal Health and Livestock Development put in place different efforts and initiatives in development and dissemination of technologies to improve milk production. The efforts were not fruitful as milk productivity was still low due to scarcity of resources and capacity to provide the producers and processors with material, technical and training support to develop the dairy sector. Recently Government has privatized some of the companies like Malawi Dairy Industry, Choma Farm, Katete Farm and others with a view to involve private sector in improving the dairy industry. According to Chagunda *et al.* (2001) the government has also encouraged the involvement of NGOs in the same sector to boost production of livestock and related products as a mode of poverty reduction.

1.3 Non Governmental Organization Initiatives in the Dairy Industry

During the last nine years (since 1999) attempts have been made in Malawi by Non Governmental Organizations like Small Scale Livestock Promotion Programme

(SSLPP) and Land O' Lakes (LOL) in dairy development to encourage the dissemination of improved technologies on credit. This was done specifically to address the critical shortfalls the government was facing, hence stimulating the development of a commercially viable smallholder dairy sector that will result in significant increases in rural incomes, provide employment opportunities, and improve overall performance of dairy business that contributes to Malawi's GNP.

The developed technologies were aimed at improving the reproduction and production performances of dairy cattle as most of these are negatively affected by poor management which includes insufficient feeding, lack of artificial insemination and lack of veterinary facilities. These technologies were packaged in a form of credit-in-kind by Land O' Lakes Inc. / Malawi.

The developed credit system by Land O' Lakes is based on the revolving fund principle, with four components.

- Heifer in-kind loan for passing on the first pregnant heifer to another eligible farmer.
- Dead cow fund (for replacing a dead project cow),
- Veterinary drug fund (for increasing farmers access to priority veterinary drugs for disease control) and
- Supplemental feeds fund for increasing farmers access to supplemental feeds as dairy mash, concentrates, cane molasses, and mineral supplements, in order to increase milk yield.

1.4 Role of credit in Malawi.

The majority of farms have low or negative profits and often experience lack of liquidity. When farm's performance is limited by liquidity, it may be expected that additional finance through credit may expand farm operations. Credit is, therefore one instrument which can encourage adoption of improved livestock technologies by alleviating cash constraints, thus rendering necessary inputs accessible to poor farmers. Many developing countries including Malawi have successfully established some means of advancing loans for dairy farming operations to increase and improve milk yields, yet dairy farmers seem to be relatively slow in adopting the technologies (Jabbar, Ehui & Von Kaufmann, 2002).

1.5 Problem Statement and Justification of the Study

The national dairy herd provide low milk yield, approximately 17% of total milk required (Chagunda *et al.*, 2001). This has led to low milk supply to processors such that the processing plants operate below capacity by 35% (Land O' Lakes, 2005). In order to meet the gap, most processors either import raw milk from neighbouring countries or powdered milk that is reconstituted at the dairy plant (Chagunda *et al.*, 2001). It is apparent that for some time government's objective of making Malawi self-reliant has not been fulfilled as Malawi continues to import considerable amounts of livestock products including milk and milk products.

In an effort to complement government's effort in seeking Malawi's self-sufficiency in milk and milk products, other Non governmental stakeholders such as Land O' Lakes

(LOL), Small Scale Livestock Promotion Programme (SSLPP) developed dairy technologies to improve milk yield. These technologies include the use of genetics, improved feeding and health interventions as well as other livestock management interventions such as housing. The technologies were implemented on credit basis to promote their use since poor adoption by some farmers was due to lack of capital to acquire and apply most of them. Without external sources of funding, the majority of smallholder dairy producers would not be able to generate adequate funds from their own sources to reap the full benefits of available dairy technologies. However, there is still a number of dairy farmers using own funds/ money and resources as dairy input. Hence, its important to assess the role of in-kind credit assuming that the other farmers use own resources and that dairy cattle can not produce without use of improved technologies irrespective of liquidity constraints.

The study singled out in kind credit as a factor worthy examination to help in understanding its role on milk productivity and dairy performance since the impact of in kind credit use on productivity of dairy farming operations in Malawi has not been studied with the same intensity as its impact on crop based farming operations. It was worthwhile to undertake such a study considering the importance of dairy animals as source of milk, meat, manure, transport, cash income and employment. This would help policy makers and financial institutions to accurately assess the magnitude of the expected gains in productivity resulting from the allocation of credit on a dairy enterprise. If the marginal contribution of credit to farm productivity is zero or

relatively small then re - allocation of credit to other activities or sectors with higher marginal productivity may actually lead to an improvement in the welfare of society.

1.6 Objectives of the Study

1.6.1 General Objective

The study was conducted to analyse the role of in-kind credit on milk productivity of dairy cattle among credit participating and non credit participating smallholder farmers in Malawi and to assess the effects of major physical factors considered as improved technologies on milk output among the farmers participating in credit.

1.6.2 Specific objectives

1. To compare milk production of dairy cattle among credit participating and non credit participating smallholder farmers
2. To compare productive (technology use) and reproductive parameters of dairy cows among smallholder credit participant and non participant farms.
3. To determine the extent of the effect of major physical factors that influence productivity of dairy enterprise among smallholder farmers.
4. To estimate the economic returns of the dairy cows for credit participating and non credit participating farmers.

1.6.3 Hypothesis

The hypothesis tested was

H_o: In kind credit has no significant influence on milk productivity of dairy cattle among credit participants and non credit participants.

H_1: In kind credit has a significant influence on milk productivity of dairy cattle among credit participants and non credit participants.

This hypothesis is made on an assumption that all the dairy farmers are liquidity - constrained and that the non - credit participating farmers use own money and resources to obtain inputs and employ improved technologies, the extent of which should be determined.

CHAPTER 2

2.0 LITERATURE REVIEW

2.0 Introduction

This chapter gives a review of the role of credit in kind in increasing access to factors of production which are responsible for improving dairy productivity in Malawi. It also reviews similar studies done else where (In Africa) to analyze the role of credit in dairy operations and some of the approaches that are used to analyze the milk production.

2.1 Background to Credit Investment

Investment in livestock has been prominent among the many tools used by rural people in the developing world to reduce risk and alleviate poverty. Investments in livestock area are also used to hedge against rapid inflation, as well as against unexpected natural disasters such as drought and floods. This investment tool is commonly used in poor rural areas and vested in traditional hedging and safety net systems. The provision of livestock through inheritance and gifts has been a mainstay of most rural societies. As such livestock owners use their animals either as a means of production (meat, milk, wool, eggs), capital (storage of wealth), or both (World Bank, 2001).

In the absence of rural banking, dual-purpose use of livestock (production and wealth accumulation), increases rural security. Some development networks are helping the rural poor obtain livestock to increase the financial security of their households and

help enterprising rural poor emerge form poverty (World Bank, 2001). This strategy also provides appropriate safeguards against overstocking and prevention and mitigation of environmental risks.

2.2 Credit and Livestock Improvement

The provision of livestock has been a common part of development projects since colonial times (World Bank, 2001). The initial aim was to improve genetic stock and productivity. Such projects often emphasized large-scale cattle distribution to modern production facilities, and required sophisticated inputs and veterinary care and were often supported by public sector funding. In most cases they were not suitable and failed, especially when managed through public sector. Moreover, they appeared to concentrate on herd expansion rather than increasing efficiency and productivity of livestock. Occasionally, as a by - product of these delivery schemes, smallholders or smallholder groups were provided with male animals or heifer to improve local breeds (Revesai, 2003).

2.3 Cash Loans for Livestock in Malawi

Although the farmers flock or herd may be considered a saving tool, producers borrow cash to either expand their capital or improve production. Despite the recognized importance of cash loans, experience in Malawi has shown that rural farmers frequently do not have access to appropriate financial services. The limited access to financial services by rural poor tends to have two interrelated causes (Afifi-Affat,

1998) namely: impendiment to financial institutions and resource limitations of the rural households.

2.3.1 Impediment to Financial Institutions

Large interest rates charged by financial institutions, coupled with the lengthy and cumbersome formalities and procedures required to access credit, are usually important constraints. Consequently, credit from formal financial institutions has mainly been of benefit to medium and large scale farmers, who are more likely to have the capacity to meet the requirements of formal institutions. This makes commercial credit access by smallholder farmers, especially livestock and dairy farmers, extremely difficult in Malawi (Afifi-Affat, 1998).

2.3.2 Resource Limitations of the Rural Households

The lack of the physical collateral that is a pre-requisite for the granting of loans by financial institutions, together with the low savings and the high transaction and administrative costs incurred during the delivery and recovery of loans, makes lending to the farmers financially unsound and costly. The costs and risk implications associated with the provision of financial services to the rural poor have been a strong disincentive to financial institutions (Afifi-Affat, 1998).

2.4. In – kind Credit Provision

In order to save the poorest of the poor and landless farmers, who under prevailing banking standards are not eligible to receive loans, other methods have been explored

(World Bank, 2001). The provision of livestock in-kind is an alternative means of credit.

In kind credit is a non monetized economy, whereby credit is granted through direct provision of livestock and livestock inputs (feed, drugs, etc.) to improve the productivity of livestock. The repayment often takes the form of outputs (offspring and products). In kind credit schemes have traditionally been part of the private welfare transfer in most parts of the world, either as (pre-) inheritance, assistance after calamities such as drought or epidemic diseases, of informal risk- avoidance and /or insurance schemes (Afifi-Affat, 1998).

In many parts of the developing world this is still the case (World Bank, 2001). Most of the donor financed livestock in – kind credit schemes in development projects are built on these traditions, and on the associated societal oversight of such schemes. As part of the fiduciary, responsibility for the loan repayment and other aspects is shifted to community control. In addition, some organizations use credit for livestock to smallholders as a tool for community development, improved food security, environmental improvement, and poverty alleviation (World Bank, 2001).

2.4.1 Credit in Kind in Africa

Studies conducted in Kenya, Ethiopia and Uganda (Freeman *et al.*, 1998; Kosura, 1999; Mbuza, 2004), indicated that the uptake of improved dairy technologies was dependent on both the borrowing and liquidity statuses which provide useful insights

under which credit may have its greatest impact. The studies also documented on the linkage between credit, technology and productivity of dairy animals. It was hypothesized that when investible funds are raised either from own sources or through borrowing from formal and informal sources, the producer will be able acquire the technology (pay the initial investment cost) and have access to and readily purchase inputs and services associated with a new technology. The use of such technologies per animal (yield) leads to high net return to the producer. Hence return thus generated could be used to build up own funds for future re - investment and or servicing of the loan and facilitate continued use of the technology, higher dairy productivity and consequently improved welfare (Kosura *et al*., 2004).

In Ethiopia and Kenya, a unit of credit given to a credit-constrained farmer had twice as much effect on agricultural productivity as a unit of credit given to a farmer with adequate access to financial resources. The study also found that giving farmers agricultural training can significantly increase farm productivity, but only if the farm is not facing a credit constraint.

Three broad technologies categories were identified that are pertinent to improved dairy production: genetics, animal health and nutrition. The genetic component includes artificial insemination, cross breeding or purchase of pure animals. The health aspect involves use of veterinary drugs and services while nutrition component include

use of improved fodder and other livestock feeds such as concentrates. Adoption of one or more technological components constitutes an effort to raise milk yield.

It was also recognized that technology adoption was a continuous phenomenon and households might be at different levels in the adoption spectrum and intensity (low, medium and high) of adoption of the given technology. Similarly, there is bound to be interactive effects of the use of particular aspects of the technology components on productivity (Jabbar *et al*., 1998). Given the nature of data obtained from the studies and for the purpose of clarity, a dichotomous classification of technology was adopted. Farmers were considered to be using either traditional or improved (modern) technology. The study specific activities associated with either of the technology categories adopted for the study are shown.

Activities associated with Improved Technology

- Rearing Cross-bred or exotic cow;
- Artificial Insemination;
- Feeding, dairy meal, mineral salt, local salt;

Activities associated with traditional technology

- Rearing only indigenous cow;
- Open grazing with no fodder conversation;
- No artificial insemination and no improved housing.

Using the two categories of traditional and modern technologies, it was found that about 62% of farmers in the entire sample were using modern dairy technologies while 38% were still using traditional technologies. Almost all farmers kept either exotic or crossbred cows and were using concentrates and improved forages as supplementary feed. About 67% of farmers practiced zero grazing. Other practiced mainly open grazing while a few practiced tethering.

Furthermore, the studies in Kenya, Ethiopia and Uganda (Freeman, 1998, Kosura, 2004, and Mbuza, 2004) noted that providing credit to farmers to fund operations could encourage higher variable input use and substantially increase smallholder dairy productivity.

2.5. Credit in- Kind in Malawi

In Malawi there are some organizations assisting farmers in the improvement of productivity of dairy cattle through in kind credit. NGOs like Land O' Lakes (LOL) and later Small Scale Livestock Promotion Programme (SSLPP) and Malawi Social Auction Fund (MASAF) were established with the view to encourage dissemination and use of improved livestock production technologies through credit in kind. Provision of credit to encourage adoption of these technologies has been promoted through development projects run by these NGOs in collaboration with other initiatives by Government. In Malawi, credit in kind is provided as a package with support systems (improved technologies).

The packaged loan is aimed at increasing farmers' access to high grade dairy animals, high quality dairy supplemental feed rations and mineral-vitamin supplements, and availability of affordable high quality veterinary pharmaceuticals.

The farmers who do not have own access to money or funds for application of improved technologies are identified by the NGOs and provided with the In-Kind-Credit (IKC) to compete favourably with those having access to own resources.

2.6. Credit in Kind and its Support Services (Technologies) for Improving Dairy Productivity in Malawi

Mgomezulu (2002) observed that dairy farming in Malawi has been constrained with several factors among which include late age at first calving of heifers, long calving intervals, alleged repeat breeding, low productivity due to inadequate availability and poor quality feed, expensive commercially available feeds, heavy tick infestation accompanied by high incidence of tick borne diseases, excessive calf mortalities and inadequate knowledge on appropriate livestock management practices. Therefore, there is an obvious justification for promoting potentially effective technologies and management practices that would alleviate the mentioned problems. These technologies are part of support services that NGOs are providing to farmers to improve the productivity of dairy animals and they include:

2.6.1 Dairy extension

Land O' lakes and SSLPP employed dairy technicians and trained them to assist in transferring new technologies to farmers through linkage mechanisms like annual meetings, field days and open days. The critical areas that these extension workers address are calf rearing, ration formulation, animal feed requirements, dairy business records, and participatory development tools, among others. Therefore, any credit system should be included dairy extension in the whole package.

2.6.2 Animal health

Among the factors influencing the productivity and profitability of livestock, animal diseases deserve special attention because they diminish the capacity of the animal to achieve its inherent potential level of production, for any given feeding and management regime. A disease sharply reduces the productivity of livestock. Msiska (2003) reported that health related problems seem to be one of the greatest problems faced by Malawian dairy farmers. Disease control activities slacken due to high drug prices compared to milk producer prices (Mwenifumbo and Banda, 1998). In view of this, drug revolving funds were established in the milk bulking groups to increase farmer's access to improved veterinary services. Farmers are aware of simple disease diagnosis techniques (symptoms and prevention, simple treatments and prevention i.e. dewormers and deworming, arcaricides and tick control, antibiotics use, and mastitis prevention. Hence it is important that animal health should form an important component of credit systems.

2.6.3. Artificial insemination (A.I)

In Malawi, the National Insemination Centre at Mikolongwe in the southern region provides and distributes semen for improving dairy genetics and liquid nitrogen for preserving semen. However, the dairy bulls used for propagation of semen at Mikolongwe are seemingly not proven bulls (do not have pedigree information) as required for such purposes (Land O' Lakes, 2005). LOL through its partner, World Wide Sires, have been importing Holstein and Jersey frozen semen from California, USA, for commercial distribution. Through this a total of 3,696 improved dairy off-springs were born by the end of 2004 (Land O' Lakes, 2005). This implies that AI should be packaged in dairy credit system in order to improve the genetics and productivity. Some credit systems include provision of improved heifers or cows to achieve the same goal.

2.6.4. Use of supplementary feeds

The ingredients, which make up the concentrate portion of the ration, are maize, maize bran, soybeans, minerals and vitamin supplement. For ruminants the concentrate ingredients are fed just to supplement the nutrients supplied by the forage to meet the requirement of the animal. A credit package should also contain a component on provision of improved feeds to improve milk yield since it has been noted that milk yield differences among animals are 60% due to feeds (Land O' Lakes, 2005).

2.6.5 Use of improved forages

A number of improved forages, grasses and legumes were introduced in Malawi in the late sixties (Msiska, 2003). Farmers at the moment are conserving silage and hay. They are using legumes in stall feeding as they can and do increase milk production. Legumes increase protein content of the diet hence can cut costs of concentrates.

At every milk bulking group, farmers have established communal nurseries of Rhodes grass pasture, Napier grass, and other improved grasses so that seeds from the nurseries are acquired by farmers. Hence access of such improved forages through credit for liquidity constrained farmers would have greater impact on dairy production.

2.7 Approaches Used to Analyze Extent of Major Physical factors on Milk production

A number of studies have been conducted all over the world in an attempt to analyze factor product relationship in milk production. The majority of the studies have used Cobb Douglas Production Function. In a study conducted by Sandilands (1999) on the analysis of the input-output relationship, productivity of inputs and resource use efficiency of milk production for local and crossbred cows, a Cobb Douglas Production Function was used under rural conditions in Villupuram District of Tamil Nadu (India) The input data such as quantities of green fodder, dry fodder, concentrates, human labour (both family and hired) in man hours per day, veterinary expenses and other miscellaneous expenses and inventory comprising milk animals, cattle shed, stores, dairy and watering equipments, etc. and the output data such as

milk and dung were collected from selected households. The estimated Cobb-Douglas function explained about 72 and 70 per cent of variation in returns from milk yield of local and crossbred cows respectively. In the case of local cows, expenditures on dry fodder, concentrates and labour had significant impact on returns from milk production. In the case of crossbred cows, expenditures on dry fodder and concentrates had positive and significant impact on returns from milk production. One thing that appears to be surprising is that green fodder, an important dairy input, turned out to be non-significant in milk production for both local and crossbred cows. In case of local cows, the Marginal Value Product (MVPs) of dry fodder and concentrates were significantly less than unity, signifying over utilization of these inputs; while that of labour was observed to be significantly more than unity indicating it's under utilization. Conversely, for crossbred cows, MVPs of dry fodder and concentrates were significantly greater than unity, indicating their under utilization in the milk production process. However, the MVPs of green fodder and labour turned out to be statistically not different from unity, signifying optimal use of these inputs.

Using Cobb Douglas Production Function Choosaksakunwiboon (1998) estimated production function and returns to scale of raw milk production, and analysed the technical and economic efficiency of factors of production used in the production of raw milk. The production function of raw milk was estimated to be a function of four inputs, i.e. Average use of concentrated feed per day, average use of roughage per day, man hour per day, and farmer's number of years experience in raw milk production. It was found that the variations of four inputs explained the production by 90.4 percent.

Among four inputs, concentrated feed, roughage and man-hour were found to be statistically significant ranging form the highest to lowest, respectively. Farmer's number of years of experience in the production was found to be not statistically significant. The study on the returns to scale showed that most farmers' production was in the stage of decreasing returns to scale with input elasticity of production of 0.89.

In another study by Tung and Rasmussen (2005), a Cobb Douglas Production Function was applied to analyze and compare semi-subsistence and semi- commercial smallholder poultry systems in three regions. The general assumption was that poultry production output at farm level depends on the number of birds, feed amount, labour amount, garden size, income level and veterinary costs. The results from the analysis of production showed that the coefficients of flock size, feed amount per bird, labour amount per bird, household income level and veterinary cost were highly significant in different models.

In all the studies Cobb Douglas was used to find the returns to scale of output (only to factors which farmers have no control over), and it gives all the three returns to scale, these are the increasing returns to scale, decreasing returns to scale and constant returns to scale hence is preferred by most authors. Also Cobb Douglas Production Function is linear in its logarithmic form, and therefore easy to estimate using ordinary least squares estimation technique (OLS). At the same time, this functional type has been widely used for production function analysis by many authors as discussed above

(Choosaksakunwiboon, 1998; Mutavdzic *et al.*, 2003; Mwebaze, 2004; Tung and Rasmussen, 2005).

CHAPTER 3

METHODOLOGY

3.0 Introduction

This chapter describes the methodology used from data collection to analysis. It indicates the data collection techniques used in the study, instruments used, sample size calculation and sampling techniques. It outlines the approaches used in the study in order to achieve the objectives.

3.1. Location of the study

The study was conducted in Lilongwe and Mzuzu milk shed areas covering Lilongwe Agricultural Development Division (ADD) and Mzuzu Agricultural Development Division (MZADD), respectively. Lilongwe milk shed area is in the Central Region of Malawi and falls under the Central Region Milk Producers Association (CREMPA). There are a total of 18 milk bulking groups (MBGs) in this milk shed area. Mzuzu milkshed area is in the Northern Region of Malawi and falls under Mpoto Milk Producers Association (MMPA). The milk-shed area has about six milk bulking groups, each with a cooling tank located at the centre of bulking group. Mzuzu milk shed area is the smallest of the three milk shed areas (Lilongwe and Shire highlands) in Malawi.

The milk-shed areas were chosen because of a high concentration of smallholder dairy farmers some of whom receive credit support for livestock from Land O' Lakes and

Small Scale Livestock Promotion Programme. The study involved mainly the peri urban smallholder dairy farmers who have a long history of dairy production, and are more commercially oriented because of their proximity to the cities, which offer marketing opportunities. The data for the initial phase of the study was collected from the following bulking groups: Chitsanzo, Nathenje, Mpalo, Lumbadzi in Lilongwe Milkshed Area and, Kapacha, Lusangazi, Kawindula and Doroba in Mzuzu Milkshed Area.

3.2 Design of the Study, Study Instruments and Data Collection tools

The study was conducted in two phases namely, the cross sectional survey and the monitoring study.

3.2.1 Cross Sectional Survey

The cross-sectional survey involved the use of a structured questionnaire administered to 305 randomly selected dairy farmers. Two categories of farmers were used: those who participated in credit (obtained in-kind credit), and those who did not participate (who did not obtain in-kind credit) to use certain livestock technologies. Only smallholder farmers were considered. Data was collected on household characteristics, milk yield estimates, numbers of animals, breed types, calving intervals, numbers of services per conception, resource endowments, milk disposal and marketing, credit participation status, management levels, indications of input use and costs for the purpose of selecting those to be included in monitoring survey.

3.3.2 Observational/ Monitoring Survey

The monitoring (Observational) study involved actual recording of farm activities on daily basis. In the study only sixty farmers were involved in the exercise due to financial constraints. Credit participation farmers were involved in the exercise because most of them kept their animals confined and it was easy to weigh and measure the inputs unlike the non credit participants who kept the animals under free range. The farmers were chosen purposively based on the following criteria:

1. Willingness to participate in the research project for a period of approximately five months.
2. Presence of early lactation or late pregnancy animals for specific observational studies in order to measure and record on regular basis and accurately performance of dairy farms. This was done to enhance the understanding of productivity of dairy enterprise.
3. Easy accessibility of the farms.
4. Possession of at least one of the exotic animal

Farmers were trained in recording of farm activities to assist each other in the exercise. Equipment was provided to facilitate accurate recording of data. For example weighing scales for measuring quantities of feed, and calibrated jugs for measuring volume of milk. The recording was done on daily basis for a period of five months. Data was recorded by farmers. However, to ensure quantity and consistent data collection, researcher and enumerators had frequent visits to the selected farms. Recording sheets were provided written in local language (Chichewa) and a two day

training session on recording was done before commencement of the study. The type of data that was captured in the observational study included input use such as labour, feed, water and yield / milk levels. Input use was recorded on per animal basis.

All required information were first recorded in well-organised notebooks on daily basis, and then entered into questionnaires by the enumerators on a weekly basis. All properly filled questionnaires were returned to the researcher. During the process, meetings were held comprising the researcher, collaborators, field extension staff and representatives of credit institutions to review the progress of data collection, identify constraints and the solutions.

3.4 Sample sizes

For 95% (Z = 1.96, 2- tailed test) level of confidence, within ± 5% (e= 0.05) margin of error with the (0.75) proportions of farmers in the two milk-shed areas, the sample size was determined using the formula below (Edriss, 2003).

$$\mathbf{N = [Z^2 (1\text{-}p) p] / e^2 = [1.96^2 (1\text{-}0.75) 0.25]/0.05^2 = 288}$$

Adding 10% non- respondents the sample size was 302.

3.5 Sampling Techniques

Stratified sampling procedure was used with bulking groups as a stratum which was used to draw the sample. This involved a combination of purposeful and random sampling procedure. Proportional Probability Sampling (PPS) was used to determine

the number of farmers to be interviewed in each stratum (the milk bulking group) in order to obtain sample size proportional to the size of milk bulking group.

The milk bulking groups were purposively selected basing on credit access or support that they get from Land O' Lakes and SSLPP. Probability Proportional Sampling was applied such that a number was assigned to each bulking group and a list of population size of each bulking group was obtained and finally cumulative population of each bulking group to select the villages in the sections. From the list of bulking groups, a sampling interval was obtained and finally a random number was picked which was equal or less than the sampling interval and the two were added indicating the bulking group that has been selected.

Finally the farmers were selected randomly from each bulking group. Names of listed farmers were given numbers, and using a table of random number of farmers was selected. Using similar procedures, non-credit participants were selected from the Mzuzu and Lilongwe milk shed areas, the total size was 302.

3.6 Data analysis

3.6.1 The Cross sectional study

3.6.1.1 Descriptive statistics

Descriptive statistics were used in the data analysis. These included; percentages, frequencies, mean and cross tabulations. These mainly explained some of the socio-economic characteristics of the credit participants and non borrower. The variables

were tested for significant differences between credit participants and non credit participants using chi-square and analysis of variance (ANOVA) using General Linear Model Procedure of SAS (GLM of SAS) (SAS, 1989) to determine any significant differences in average milk, calving interval and number of services per conception. Significance of the results was tested at 5% probability.

3.6.2 Monitoring study

3.6.2.1. Description of variables used in the study

a) Forage

Forage was measured as a continuous variable in kilograms per day. The most commonly used forages were Napier, Rhodes grass, and star grass there were no variations across farms in the use of these forages. This can be attributed to the fact that farmers were given start-up seeds for the forages.

b) Concentrate

This was captured as a continuous variable, and measured in kilograms per day. The concentrate constituted of home made and manufactured dairy mash

c) Labour

This is essential in any type of production including milk production. It was measured as a continuous variable in persons-hours. Dairy cows require additional labour inputs for cleaning cattle housing, cutting fodder when animals are kept in a confinement system, spraying or dipping the animals to control parasites, milking and transporting

milk to market, and such activities are mostly performed by a worker or family members.

d) Water

Water is very important in livestock nutrition. Restricting access to water depresses milk yield, therefore water must be available throughout in the kraal. This was measured as a continuous variable. Water was mostly provided three to four times a day, and some farmers invested in well, others are near bole holes less than a kilometre from the khola. In the study water was measured in litres per cow per day

3.6.2.2 Production function

Cobb Douglas production function was normally used because it is linear in its logarithmic form, and therefore easy to estimate using ordinary least squares estimation (OLS). At the same time C-D is widely used for production function analysis (Choosasakunwiboon, 1998, Mutavdzic *et al*., 2003; Mwebaze, 2004; Xuan and Rasmussen, 2005).

The function in its stochastic form may be expressed as

$$y = e^{\beta_1} \prod_{K=2}^{K} X_K^{\beta_K} e^{\varepsilon}$$

Where:

Y is milk output per farm (litres) per day

X_2 level of concentrate (Kilograms) per day

X_3 is level of fodder feed (Kilograms) per day

X_4 is labour amount (labour hours per day) per day

X_5 level of water (litres) per day

e is error term.

From the above expression, it is clear that the relationship between output and the inputs is not linear. However if we log- transform this model, we obtain

$InY= In\beta_1+ \beta_2 InX_{2i}+\beta_3 InX_{3i}+\beta_4 X_{4i}+u_i$

$=\beta_0 + \beta_2 InX_{2i}+\beta_3 InX_{3i}+\beta_4 X_{4i}+u_i$ where $\beta_o=In\beta_1$

The model is linear in the parameters β_0, β_2, β_3, and β4 and is therefore, a linear regression model (Gujarati, 1995).

3.7 Profitability analysis

In order to assess the economic returns of dairy cows of the credit participants and non credit participants, Gross margin (GM) was computed. Gross margin is the difference between total revenue (TR) and Total variable cost (VC) and it was estimated form the formulae below (Johnson, 1982)

Mathematically this is presented as follows:

GM=TR-TVC…… (i)

Where:

GM= Gross margin (MK)

TR= Total revenue (MK)

TVC=Total Variable Cost (MK)

Total revenue refers to the value of product which is the product quantity produced multiplied by the product price. In this particular analysis the revenues include the sales of milk

Mathematically total revenue can be expressed as:

TR=Q*P…… (ii)

Where:

Q= Quantity of milk sold

P=Price of milk

Total variable costs in the analysis include: Cost of supplementary feeds, labour, veterinary costs, and artificial insemination.

3.8 Study limitations

In the study credit participants and non credit participants were supposed to be divided into two groups namely liquidity and non liquidity constraints. However this was not done due to small sample size observed from the two categories. In similar studies conducted in Ethiopia, Kenya, Uganda (Freeman *et al.*, 1998; Kosura, 1999; Mbuza, 2004). There were no significant differences in these categories, this entails that both groups are the same.

CHAPTER 4

RESULTS AND DISCUSSION

4.0 Introduction

The chapter describes and discusses the broad categories of technology components that are related to improved dairy production: genetics, health, nutrition and management, but preceded by demographic characteristics of farmers. The genetic component comprised artificial insemination (AI) or the availability of crossbred animals (heifers). The health components identified diseases that are prevalent in borrower and non borrower farms and treatment costs. Nutritional components included the use of improved fodder and other livestock feeds such as concentrates. Management component included improved housing, marketing and accessibility to training that improves farmer's competence in decision making related to improved dairy technologies.

4.1 Demographic Characteristics

4.1.1 Participation to credit by sex of the farmer

Table 1 indicates the level of credit access in dairy industry in the study area by sex of the farmers. Sex is an important factor that influences adoption of technologies (Mapila, 2002).

The results indicate that there are more female credit participants than the male credit participants, probably because the conditions of borrowing favour females. Table 1 indicates that 62.1% and 37.9% of farmers are female credit participants and non credit

participants, respectively. About 46.5 and 53.5 are male credit participants and non credit participating, respectively and these had access to credit for the dairy activities. This agrees with Mbuza (2004) who reported that there were relatively more credit participants among females than among males. Chi-square showed no significant relationship between the sex of the farmer and access to credit at the 5% significance level.

Table 1. Credit Participation by sex

Sex	Credit participants		Non-credit participants		Total		*P*-value
	Freq	%	Freq	%	Freq	%	
Male	72	46.5	83	53.5	155	51.7	0.2278
Female	90	62.1	55	37.9	145	48.3	0.0000
Total	162	54.0	138	46.0	300	100	

$\chi^2_{(1, 0.05)c} = 7.356 > \chi^2_{(1, 0.05)t} = 3.84$ $P > 0.05$

4.1.2 Education status

The results in Table 2 indicate that the most of farmers in both groups had attended school beyond primary and secondary, and only a few had no formal education and tertiary education. About 76.9% of farmers attained at least primary school education in credit participation and 73.9% in non credit participation group, respectively. However, only a small proportion (6.9% and 6.5% of the credit participants and non credit participants) did not do any formal education.

The literacy level of the farmer is considered an essential element in any development process (Ngulube, 2001), which could include the adoption and access to credit. This

is because adoption of any technology requires rationality and the more educated an individual is, the more rational one is in decision making (Ngulube, 2001). Mapila (2002) reported that education enables the farmers to have a better understanding of any instructions and conditions that may come with new technology. Literature on adoption also indicated that formal education is positively related to farmers' awareness of economic advantages of improved technologies (Hussain *et al.*, 1994).

Table 2. Access to credit by formal education level of the farmers

Education Status	Credit participants		Non-Credit participants		Total		*P*-value
	Freq	%	Freq	%	Freq	%	
None	11	6.9	9	6.5	20	6.7	0.8907
Primary	123	76.9	102	73.9	225	75.5	0.5486
Secondary	23	14.4	24	17.4	47	15.8	0.2326
Tertiary	3	1.9	3	2.2	6	2.0	0.85551
Total	160	100	138	100	298	100	

$\chi^2_{(3, 0.05)\,c}=0.560 < \chi^2_{(3, 0.05)t}=9.488$ $P>0.05$

It was therefore noted that, among those with primary education about 77% were credit participants and 74% were non credit participants. Those with secondary education on larger percentage were not credit participants (17.4%) compared to credit participants (14.4%). Chances of being a credit participant and a non credit participant were the same for those with tertiary education. The Chi-square analysis showed no significant relationships between the level of farmer's education and the credit status at the 5% significant level. This agrees with studies done in Kenya, Uganda and Ethiopia

that formal education was not associated with participation to credit amongst of farmers (Freeman *et al.* 1998; Kosura, 1999; Mbuza, 2004).

4.1.3 Age of the farmer

Table 3 indicates that farmers of above 50 years of age dominated in the credit participation group i.e., 54%. On the other hand farmers of 40-49 dominated in the non credit participation group with 33.6% of farmers. The chi-square test indicated that the access to credit was not associated with the age of the household head.

Table 3. Access of credit by age of the farmers

Age	Credit participants		Non-credit participants		Total		*P*-value
	Freq	%	Freq	%	Freq	%	
< 29	23	14.2	18	13.4	41	13.9	0.8429
30-39	38	23.5	29	21.6	67	22.6	0.6977
40-49	47	29.0	45	33.6	92	31.1	0.3954
50 above	54	33.3	42	31.3	96	32.4	0.7146
Total	162	100	134	100	296	100	

$\chi^2_{(3, 0.05)c} = 0.720 < \chi^2_{(3, 0.05)t} = 9.488$ $P>0.05$

4.2 Uses of Technologies among Dairy Farmers

4.2.1 Genetic technologies among credit participant and non credit participant farmers

Of the 295 farmers who accessed the genetic technologies, 68.1% kept Friesian/ Holstein crosses of pure breed dairy cattle as indicated in Table 4. However the

proportion of farmers using the crossbred cattle was higher among credit participants (80%) compared to non-credit participants (54.5%), the latter also having a substantial number of local zebu cattle (35.8%) compared to the former (about 2%). There was a strong association between the breeds of dairy animals farmers have with the credit status ($P<0.05$).

Mabett (1996) reported that milk production per cow increases as the breed improves hence more improved breeds means more milk production. The results indicate that the most common breed of cow kept by both groups is Holstein/Friesian cross, although for non credit participants, the local breed also dominates. Use of local breeds which are beef animals by non credit participants might be an indicator of inability and unavailability of dairy breeds for the purchase of suitable breeds for milk production by a number of these farmers.

Table 4. Breeds of animals owned by credit participant and non credit participant farmers

Breeds of Animals	Credit participants		Non-Credit participants	Total		*P*-value
	Freq	%	Freq	Freq	%	
Local	3	1.9	48	35.8	51	17.5	0.0000
Holstein/Friesian	128	79.5	73	54.5	201	68.1	0.0000
Jersey	30	18.6	13	9.7	43	14.6	0.0317
Total	161	100	134	100	295	100	

$\chi^2_{(2, 0.05)c} = 61.93 > \chi^2_{(2, 0.05)t} = 7.81$ $P < 0.05$

4.2.2 Mean milk production among credit participating and non credit participating farmers

Table 5 presents Analysis of Variance for daily milk yields in litres per cow. The overall mean daily yield was 8.39 ±0.80 per cow. This value was significantly affected by breed of cow (P<0.01), milkshed area (P<0.05) and credit participation status by milkshed area interaction (P<0.05).

Table 5. Analysis of variance for daily milk yield in liters per cow

Source	Mean Square	F-value	*P*-value	Significance
Breed (B)	164.35	5.71	0.01	***
Participation (C)	96.52	3.35	0.07	NS
Milkshed area(M)	157.88	5.49	0.02	**
B* C	14.06	0.49	0.69	NS
C* M	165.06	5.74	0.0173	**

*** Significant level at 1%, ** significant level at 5%, NS- not significant

The following subsections present the results on effect of breed, milk shed area and interaction effect of borrowing status by milk shed area on milk yields as significant sources of variations.

a) Effect of breed on daily milk yield

Figure 1 summarises the daily milk yields of the different breeds kept by credit participating and non credit participating farmers, irrespective of milk shed area. Figure 1 show that within each credit participating category, however there were significant differences. Within each farmer category Holstein and Friesians crosses

produced the highest (P<0.01) amounts compared to Jersey crosses which ranked second and to local which were the last.

The results agree general expectations that on average, the crossbred cows gave significantly higher milk yield per day than local cows because the cross breeds have higher genetic potential for milk production as compared to local breeds.

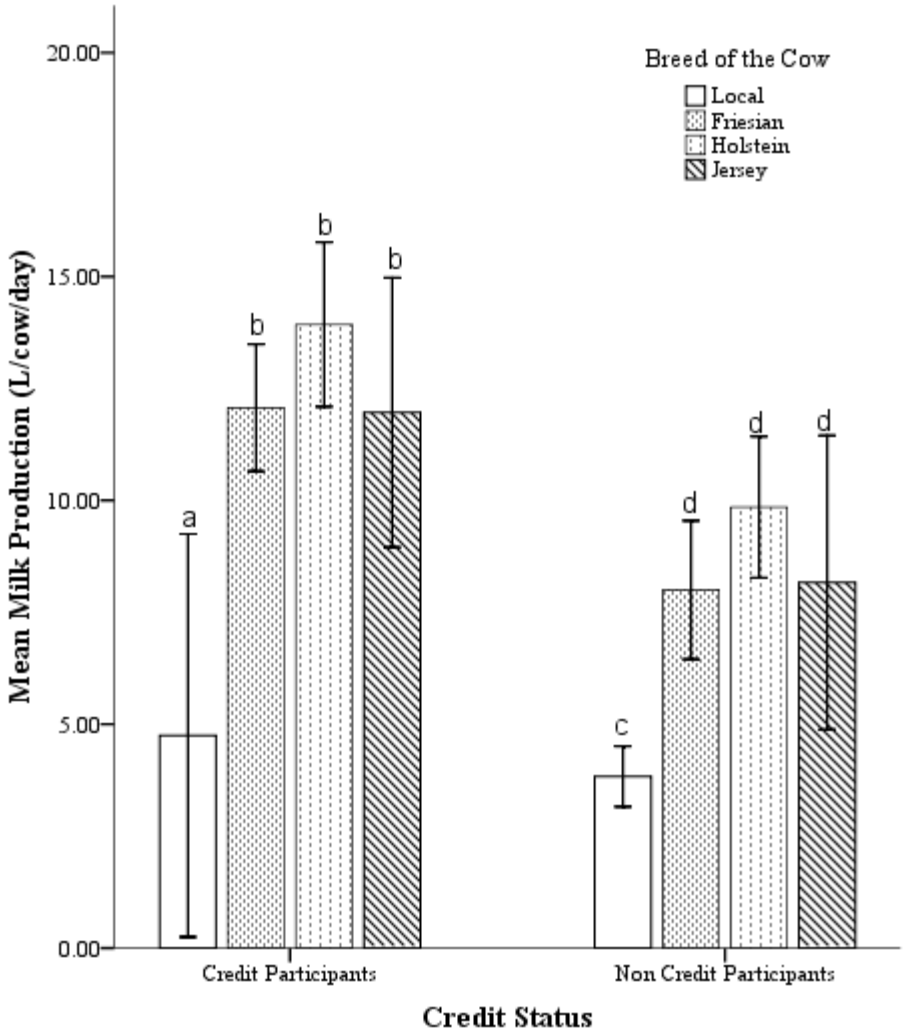

Figure 1: Mean daily milk yields per cow for credit participants and non credit participants separated by breed of cow (mean ± SE; n = 303).

b) Effect of in kind credit participation on milk yield

Results in Table 6 indicate that the average milk yield per day was slightly higher and significantly different between credit participants (10.0±1.04 litres) and the non credit participants (7.81± 0.57 litres) (P<0.05). The effect of credit participation on the milk output by farmers was not significant at 5%.

The results correspond with a study done by Mbuza *et al.* (2006) in Uganda who observed that there was no significant difference in milk yield performance between credit participating and non credit participating farmers. It is therefore, of little importance whether a farmer is a participant or non participant in the business of milk production. This agrees also with Freeman *et al.* (1998) in Ethiopia who observed that credit participation status and liquidity constraint condition did not have any significant effect on the average daily milk yield of cross bred and local cows although milk yield of credit participants were generally higher than of non credit participants.

There are probably many factors other than the credit participation status which are important in explaining the differences in the performance of the two categories of farmers, such as the complementary inputs that are given in kind, i.e., access to quality veterinary services and access to supplementation at the bulking which are accessed by credit participants only. The combinations of technologies used for milk production are therefore important.

c) Effect of Milkshed Area

Results in Table 6 below, indicate that overall mean daily milk yields in central milkshed area were 9.86±0.715 kg liters /cow, and this was about 2 kg/cow/day higher (P<0.05) than in northern milkshed area. Similar findings were observed by Banda (2002) who reported higher actual productivity coefficients for central milkshed area. This may be a result of increase in uptake of the high productivity inputs due to the efficient functioning and collaboration between upstream service providers like dairy mash suppliers, transporters and the central milkshed area who are within reach of the farmers.

Table 6. Least square means (±SE; n=303) of milk production in small holder dairy cattle

Parameter	Ls mean ±SE	*P*-value
Genotype		
Local	4.20^{a}±0.60	**0.0174**
Exotic	11.0^{b}±0.71	
Credit status		
Credit participants	9.97^{d}±1.04	**0.0682**
Non credit participants	7.81^{c}±0.57	
Milkshed area		
Northern milk shed	7.92^{e}±0.73	**0.0199**
Central milk shed	9.86^{f}±0.72	

Means in the same column designated by same superscripts are significantly different (P<0.05)
LSmean= least square mean, se=standard error.

d) Effect of Credit participation by Milkshed Area interaction

Since credit participation status by milkshed area interaction had significant effect on milk yield, Figure 2 summarizes the daily milk yields per cow of each credit participation status by milkshed area. Overall, credit participants had higher milk yield than non-credit participants. There was significant interaction between participation to credit and region ($P<0.01$). In the Northern region, non credit participants had more significantly higher milk yield than central region. The opposite was true for credit participants with lower yields in the northern region and more yields in the central region, although overall credit participants produced more milk than the non credit participants irrespective of region. The probable reason could be that northern region has high potential of fodder production in terms of land size as noted by Mgomezulu (2002).

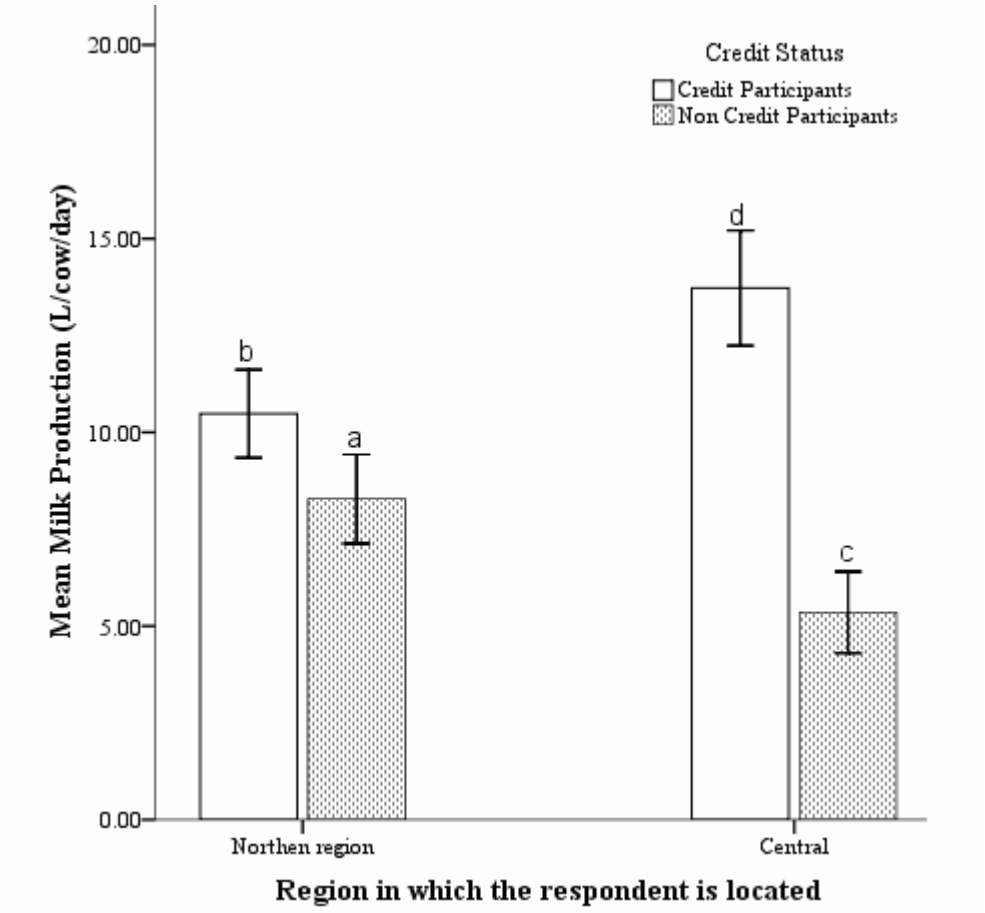

Figure 2: Interaction between credit participation and region on milk yield (mean ± SE; n = 303).

4.2.3 Method of breeding practices used by farmers

Table 7 presents results on methods of breeding used by credit participants and non credit farmers. Overall, close to 60% of farmers use AI technologies irrespective of credit participation status. However, among credit participating and non credit participating differences were noted. About 69% of the credit participating farmers were using Artificial insemination, compared to only 32 % in the non credit participating group. The non credit participating farmers who used natural service accounted for 47% in that group. This is most probably explained by the differences in

access to semen straws at the MBG for the exotic breeds they predominantly use. This facility is only available through the semen revolving fund offered as part of credit facility. The association between breeding methods and credit participation was significant (P<0.05).

Table 7. Methods of breeding used by credit participants and non credit participant farmers.

Breeding method	Credit participants		Non-credit participants		Total		P-value
	Freq	%	Freq	%	Freq	%	
AI	110	68.8	45	32.6	175	58.7	0.0000
Bulls	3	1.9	65	47.1	48	16.1	0.0000
Both	47	29.4	28	20.3	75	25.2	0.0722
Total	160	100	138	100	298	100	

$\chi^2_{(2, 0.05)\,c} = 55.40 > \chi^2_{(2, 0.05)\,t} = 9.488$ $P<0.05$

Some reasons given by farmers for using AI were; avoidance of disease, a choice of breeds, and breed improvement for high milk yields and rapid calf growth. In agreement with reports by Morton and Miheso (2000) on the other hand, natural service is seen to promote risks of in-breeding, and mating of immature heifers.

4.2.4 Nutrition Technologies

a) Concentrate feeding

Table 8 shows the number of farmers who were using various feed sources as improved feed resource technologies. A general inverse trend was observed in supplement feeding between the two groups of farmers in the current study. Credit

participants tended to use more of refined or concentrate feeds compared to plant residues which were favoured in the non credit participation group that used less of the concentrates.

Table 8. Types of Supplementation offered by credit participant and non credit participant farmers.

Supplement feed	Credit participants		Non Credit participants		P-value
	Freq	%	Freq	%	
Dairy mash	136	86.6	21	13.4	0.0000
Maize bran	140	54.5	117	45.5	0.0024
Molasses	110	79.1	29	20.9	0.0000
Cotton seed cake	4	1.3	1	0.3	0.0789
G/haulms	113	68.9	57	31.1	0.0000
Soya haulms	68	59.1	47	40.9	0.0000
Maize Stover	83	57.2	62	42.8	0.0000
Grasses/ legumes	103	48.8	108	51.2	0.4165
Minerals	30	76.9	9	23.1	0.0000

***Multiple responses**

A particular example was observed with dairy mash, molasses and minerals which are being used by 77-87% of farmers in the credit participation group, compared to the high percentage of non credit participants who used grass/ legumes to feed their animals. Maize bran was the major concentrate in non credit participating group (46%). Concentrates are costly and are acquired through the credit scheme taken on by credit participants.

This diverts most of their reliance from garden residues to bought in concentrates, as in- kind credit is readily available for their procurement. Since concentrates are associated with high or improved milk yields, the more the farmers use these, the more high milk levels are sustained as farmers would not like to reduce the milk quantities by falling back to natural plant residues as feed for their animals.

b) Improved forage

Improved forages are more nutritious than the natural local varieties and were introduced to supplement the nutritive deficiencies of natural local forages. This coupled with their high growth and regeneration rates were taken on by farmers. In the study area, 3 types of improved forages were noticed i.e. Napier, Rhodes and star grass.

From Table 9 below, it can be observed that irrespective of the credit participation status, Napier was the most utilised forage by almost 94% of all farmers, followed to a very small extent by Rhodes grass. Isolated incidences of star grass were noted to be used by few farmers and this accounted to almost 0.4% of forages utilised. Chi square analysis indicated that the in kind credit participation status was not significantly related to the use of improved forage, and the findings agree with Mbuza *et al.* (2004). This can be explained by the fact that most farmers tend to share planting materials, a social practice by most farmers in Malawi.

The improved grass was introduced by the LOL for the farmers who were participating in the credit scheme. The farmers shared the seeds from their gardens to other village members who are involved in dairy farming, but can not have access. At the time of the current study, most of the farmers had gained access to better varieties of forages from their fellow farmers who are credit participants. This is the most probable reason for the indifference in significance of the forages adopted

Table 9. Improved Forage feeding used by credit participants and non credit participants

Improved forage	Credit participants		Non-credit participants		Total		*P*-value
	Freq	%	Freq	%	Freq	%	
Napier	145	92.9	250	94.3	105	96.3	0.2412
Rhodes	10	6.4	14	5.3	4	3.7	0.3348
Star grass	1	1.2	1	0.4	0	0	0.2521
Total	156	100	265	100	109	100	

$\chi^2_{(2\ 0.05)c} = 1.689 < \chi^2_{(2\ 0.05)t} = 9.488$ $P > 0.05$

c) Feeding legumes

Legumes are high protein plants and add to protein supplements in the dairy feed. *Leucaena*, Silver leaf and *Sesbania* were the varieties common in the study area. Table 10 shows silver leaf, *Leucaena* and *Sesbania* as the varieties mostly used with the following percentage of use 50%, 37%, and 12%, respectively among all farming groups.

Table 10. Legumes used by credit participants and non credit participants farmers.

Legumes feed	credit participants		Non-credit participants		Total		*P*-value
	Freq	%	Freq	%	Freq	%	
Leucaena spp.	55	40.7	42	33.6	97	37.3	0.2379
Sesbania	23	17.0	10	8.0	33	12.7	0.0302
Silver leaf	57	42.2	73	58.4	130	50	0.0096
Total	135	100	125	100	276	100	

$\chi^2_{(2, 0.05)c} = 8.461 > \chi^2_{(2, 0.05)t} = 5.99$ $P<0.05$

The differences observed by in kind credit participation status can probably be explained by the unavailability of the seeds used for the establishment of the legumes. Credit participants had better access to the planting materials through the credit schemes than non credit participants.

Attitude problems partly explain the observed differences between credit participants and non credit participants. This is backed by Banda *et al. (*2000) who observed that technologies for growth of legume forages like *Sesbania* and *Leucaena* are available but laziness and attitude problems of farmers and lack of practical demonstration by extension workers have lead to the farmers hardily adopting these technologies.

d). Feeding management systems used by farmers

Feeding management regimes were significantly related to credit status ($P<0.05$) as shown in Table 11. The grazing systems among dairy farmers differed; a high proportion of credit participants kept their dairy animals on zero grazing (95.6%) as compared to only 71% of non credit participants. About 16.8% of non credit participants used free grazing who also combined with zero grazing while only 3% of credit participants did so. Participation to credit encouraged farmers to keep their cows in the kholas as it was easy to provide inputs like concentrates and drugs. According to Mwalukomo (2005) it is believed that under zero grazing a healthy cow produces more milk than under free grazing**,** because zero grazing allows animals to produce more milk due to reduced stress and energy accumulation since the movements are restricted.

Table 11. Grazing systems used by credit participant and non credit participant farmers

Feeding regime	Credit participants		Non-credit participants		Total		P-value
	Freq	%	Freq	**%**	Freq	%	
Zero grazing	153	95.6	212	71.1	59	42.8	0.0000
Free range	5	3.1	50	16.8	45	32.6	0.0000
Zero and Free range	2	1.3	36	12.1	34	24.6	0.0000
Total	160	100	298	100	138	100	

$\chi^2_{(2, 0.05)c} = 101.050 > \chi^2_{(2, 0.05)t} = 5.991$ $P<0.05$

Chagunda *et al.* (2001) found that 80.6% of Land O' Lakes farmers practiced zero grazing; the farmers recognize the fact that most of crosses are not tolerant to low management and diseases that exist in such an environment. In addition breeding management is poorly controlled hence farmers do not take their animals for dambo grazing.

4.2.5 Animal health

Results in Table 12 indicate the main diseases affecting cows of the credit participating and non credit participating farmers. In credit participants, mastitis was the most prevalent (41%) as compared to only 22% in non credit participants. This was followed by fever (25.6% vs. 5.6%). The figures indicate that the credit participants were more prone to non-virulent diseases as compared to non credit participants. The diseases in borrower category are mostly due to hygiene deterioration as animals become more confined.

On the other hand non borrower animals were more susceptible to killer (virulent) diseases that are associated with free range systems. These included East Coast Fever (48% in non borrower as compared to 9% in credit participants) as observed from this study.

Table 12. The main diseases affecting credit participating and non credit participating dairy farmers

Disease	Credit participants		Non credit participants		Total	
	Freq	%	Freq	%	Freq	%
Pneumonia	1	1.3	0	0	1	0.7
Worms	2	2.6	9	12.7	11	7.4
Pink eye	1	1.3	10	14.1	11	7.4
ECF	7	9.0	34	47.9	41	27.5
Mastitis	32	41.0	16	22.5	48	32.2
Coughing	10	12.8	2	2.8	12	8.1
Fever	20	25.6	4	5.6	24	16.1
Diarrhoea	6	7.7	3	4.2	9	6.0
Sore foot	5	6.4	3	4.2	8	5.4

*** Multiple responses**

Although the results reflect high percentage of virulent diseases in the non credit participants, it should be noted that the in kind credit participants animals are also attacked by killer diseases only that credit participants have the capacity to purchase or access drugs and mitigative measures like vaccination for these through the credit in kind and drug revolving funds. This could be another explanation of their low prevalence within the credit participation group.

It is a general observation that farmers do not pay particular attention to kraal hygiene in zero grazing where the animals are mostly improved crossbreeds and are kept longer than those from non-credit participants which are at times released for grazing.

4.2.6 Herd Management

a) Housing of the animals

In the study a farmer was considered to have housed their animals if the farmer provided a roofed shelter for the cows. Otherwise there was no housing.

From Table 13 almost 98% of all credit participating farmers had a roof for their animals while 74% of the non credit participating had one.

When loan scheme in various organisations came to operation, all farmers wishing to get any assistance from had to fulfil one prerequisite and this was to have an animal shelter. This made most prospective farmers to construct shelters irrespective of whether they will be successful in loan acquisition or not. Credit participants have more improved breeds and hence improved housing becomes imperative to protect the animals from adverse weather. It is a forced technology, implying that credit access will encourage safe shelters for the animals.

Table 13. Animal housing used by credit participating and non credit participating farmers

Animal housing	Credit participants		Non-credit participants		Total		*P*-value
	Freq	%	Freq	%	Freq	%	
Roofed	156	97.5	102	73.9	258	86.6	0.0000
No roof	4	2.5	36	26.1	40	13.4	0.0000
Total	160	100	138	100	298	100	

$\chi^2_{(1, 0.05)c} = 45.181 > \chi^2_{(1, 0.05)t} = 5.991$ $P<0.05$

Results from a chi-square analysis however indicate that there was a strong relationship between the credit participation status and housing for the cattle farmers at 5% level of significance.

b) Attendance of trainings and seminars concerning dairy farming

Table 14 below indicates how farmers get technology information concerning dairy farming. There were various channels that farmers get information from and in this particular study it was from, bulking group meetings, friends and school lessons.

Table 14. Attendance of livestock training and seminars

Training seminar	Credit participants		Non-credit participants		Total		*P*-value
	Freq	%	Freq	%	Freq	%	
MBG	144	98	33	86.8	177	95.6	0.0028
Friends	2	1.4	4	10.5	6	3.4	0.0055
School	1	0.7	1	2.6	2	1	0.3160
Total	147	100	38	100	185	100	

$\chi^2_{(2, 0.05)c} = 10.112 > \chi^2_{(2, 0.05)t} = 7.81$ $P<0.05$

Generally most farmers (96%) get livestock training through MBGs facilitated by extension workers whereas formal and informal education as a whole accounts for less than 5% of their skills. This trend is similar in both categories at credit participation status level. Attendance of livestock training was significantly related to farmers credit participation status ($P<0.05$), and this agrees with the studies done in Ethiopia, Kenya and Uganda (Freeman *et al.,* 1998; Kosura, 1999; Mbuza, 2004) on credit uptake

indicating that specific training and extension contacts can enhance farmer's adoption and input allocation decisions.

c) Sources of water

Table 15 indicates the various sources of water used by farmers as part of the improved management practices.

Some investment in the study was regarded as investment in improved management practices. Farmers invested in the improved water sources such as boreholes (38%), wells (35%), and piped water (3.1%) in the borrower group. Of all these water sources boreholes and wells where the most common sources of water among credit participation farmers and for non credit participation farmers, the river was the most important source with 35% followed by bore hole with 26%. Farmers credit participation status was significantly related to the source of water ($P<0.05$).

The results indicate that credit participants tended to use safe water systems than non credit participants. As borrowing involved risk, these credit participants probably know the risk involved in not using safe water for their improved breed of animals. And as a preventative measure to losses related to this they go for secure water sources as compared to non credit participants who have animals that drink straight from the rivers which are not protected water system in terms of diseases.

Table 15. Sources of water for cattle by credit participating and non credit participating farmers.

Source	Credit participants		Non-credit participants		Total		P-value
	Freq	%	Freq	%	Freq	%	
Tap	5	3.1	2	1.5	7	2.4	0.3660
Borehole	60	37.7	36	26.3	96	32	0.0375
Stream	16	10.1	29	21.2	45	15.2	0.0085
Rivers	22	13.8	48	35.0	70	23.6	0.0000
Well	56	35.2	22	16.1	78	26.4	0.0002
Total	159	100	137	100	296	100	

$\chi^2_{(4, 0.05)c} = 34.07 > \chi^2_{(4, 0.05)t} = 7.81$ $P<0.05$

4.2.7 Milk disposal and Marketing

Table 16 shows various outlets the farmers used to dispose the milk. Generally farmers sell their milk to milk bulking groups as compared to the other two channels of marketing. This could be because the farmers are attracted to the monthly payments they get from the cooling centers and are able to budget for the money properly. However, farmers credit participation status had an influence on the choice of milk outlet ($P<0.05$).

Table 16. Milk disposal by credit participating status

Milk Disposal	Credit participants		Non credit participants		Total		*P*-value
	Freq	%	Freq	%	Freq	%	
MBG	152	99.3	119	87.5	27	93.8	0.0000
Middlemen	0	0	11	8.1	11	3.8	0.0004
Within village	1	0.7	6	4.4	7	2.4	0.0428
Total	153	100	136	100	289	100	

$\chi^2_{(3,0.05)c} = 20.45, > \chi^2_{(3,0.05)t} = 14.07$ $P<0.05$

This market of milk had a lot of problems that were found to affect some of the technology use in the bulking groups. Low milk price, offered by the processors, was featured as a significant problem concerning marketing of milk in the bulking groups. This does not match the production costs, and it is highlighted in Figure 3 below.

Chagunda *et al.* (2001) reported that milk prices affect the feed purchases because income realized from the milk sales is little and can not even cater for the employee's payments. Msiska (2003) also reported that low milk producer prices in the formal sector have acted as a disincentive forcing farmers to restrict their feeding and hence low production levels.

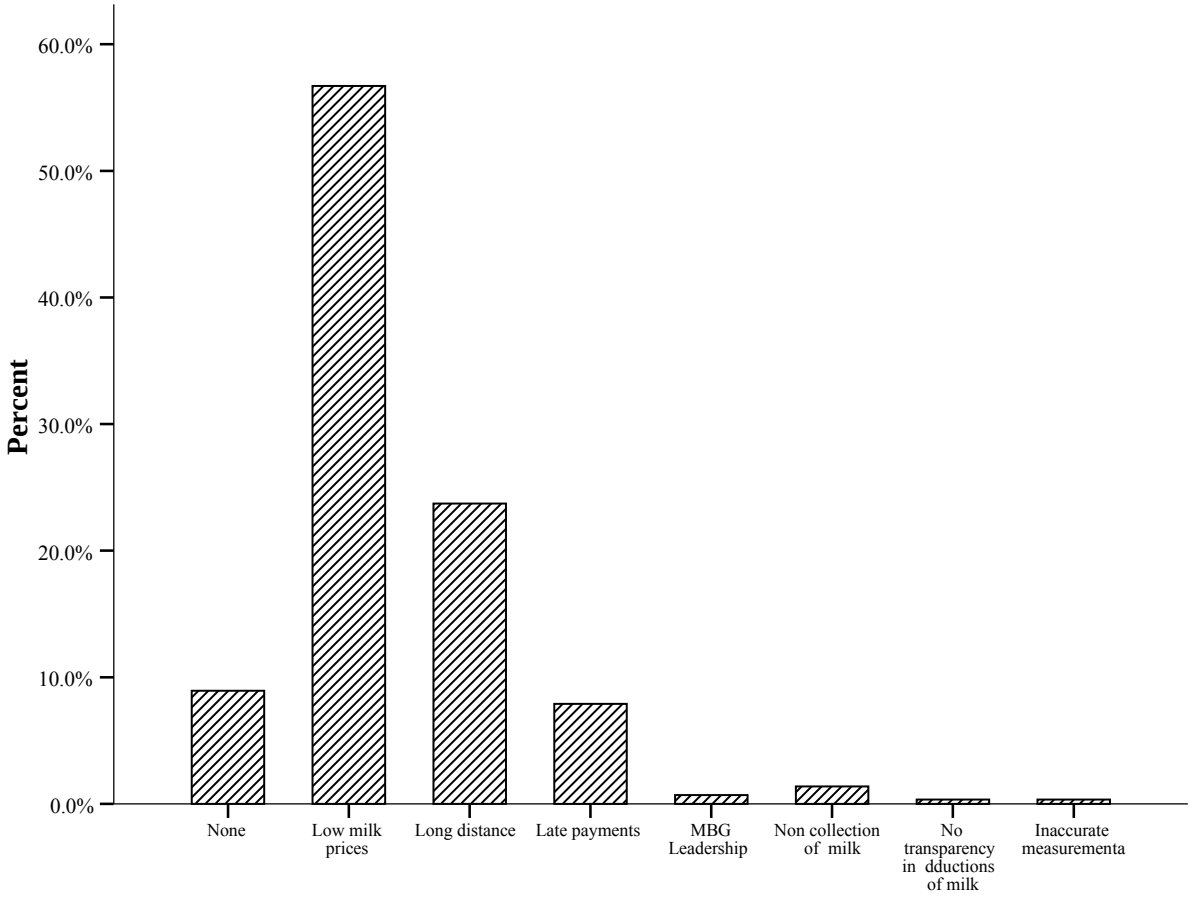

Figure 3: Marketing problems faced by the farmers expressed as percentage

4.3 Effects of Credit on Reproductive Performance of Small holder Dairy Animals

Table 17 gives results for reproductive performance of the cows such as calving interval and number of services per conception. Reproductive performance is one of the chief components that determines the productivity and economic efficiency of an animal or the whole herd. In addition the reproductive parameters measure the efficiency of technologies dairy animals are exposed to. Fertility of the herd is crucial to obtain replacements and milk production for the calf or for human consumption

(Villa-Godoy and Arreguin, 1993). Therefore, an important starting point in any program to improve productivity is to evaluate the reproductive performance of the herds.

Table17. Least square mean (months ± SE; n=303) of calving interval and number of services per conception of cattle for credit participating and non credit participating

Reproductive traits	Credit participants	Noncredit participants	*P*-value
Calving interval (months)	15.04±0.62[b]	13.01 ±0.39[a]	0.000
Services per conception	3.13±0.39[d]	1.63±0.12[c]	0.001

Means in the same row designated by different superscripts are significantly different at $P<0.05$

4.3.1 Calving Interval in months

The mean calving interval for credit participants was slightly higher (15± 0.62 months) than that of the non credit participants (13 ± 0.39 months) and the difference between the two groups of farmers in terms of calving interval was significant (P<0.05). The maintenance of a lower calving interval is desirable in cows. A dairy animal that calves every twelve months will produce more milk per annum than if she calves every 15 months (Revesai, 2003).

Credit participation was expected to have reduced calving interval because farmers access AI straws any time the animal is on heat and secondly, farmers are educated on how to detect heat signs through the extension in the in kind credit package, and this enables the farmers to have a desirable calving interval because they can service the animal at the right time. Confined systems pose problems as efficient breeding

depends on skills of A.I technicians and the availability of transport facilities. In non-credit participants, due to increased use of bulls, this risk is reduced.

4.3.2 Number of Services per Conception

The mean numbers of services were 3.13±0.39 and 1.63 ±0.12 for credit participants and non credit participants, respectively. The number of services per conception in the credit participant farms was slightly higher and significantly different from that of the non credit participants probably because most of them use natural service which is believed to be efficient than artificial insemination technology which credit participation farmers obtain as in-kind credit from World Wide Sires. However the AI depends on several factors such as the semen viability, semen concentration, expertise of the inseminator, mode of insemination ability to detect heat by the farmer and access to transport by AI technician. The study revealed that the shortfalls in logistical delivery of AI have often resulted in increased number of services per conception.

Number of services per conception is supposed to be one. A higher number of services per conception is undesirable since it increases costs of insemination in terms of number of straws, leading to reduced milk yield and low profitability of the dairy industry due to longer calving intervals.

4.3.3 Major problems associated with reproductive parameters of animals in the study areas

A number of reproduction problems are affecting milk productivity among smallholder farms. Results in figure 4 reflect some of the problems that were identified to limit reproduction efficiency of the animals among credit participating and non credit participating farms

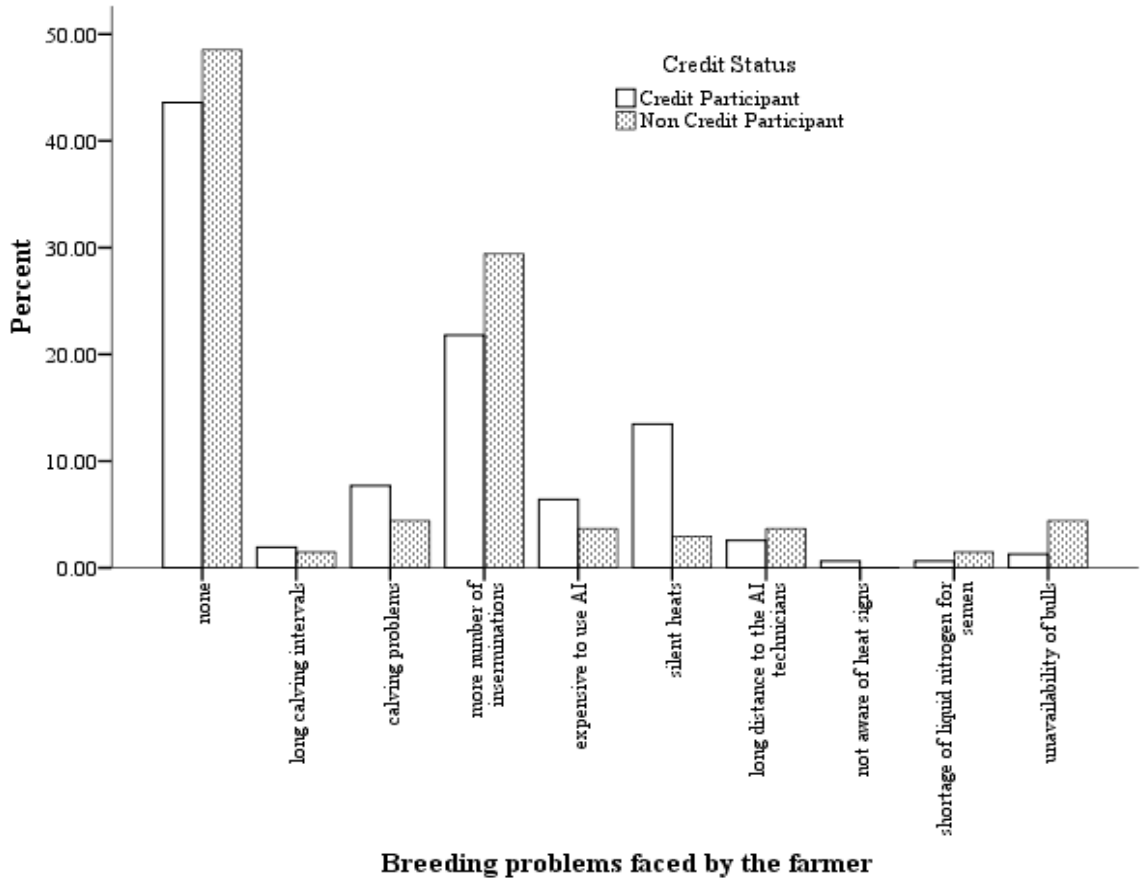

Figure 4: Breeding problems faced by the farmers expressed as percentage

a) Long calving intervals

The ideal calving interval for dairy animals is 12 months, but the situation is different with farmers in the study areas who complained to have longer calving intervals.

The animals take along time to give a calf. This has an implication on milk output of the cow hence affecting the profitability of the farms.

b) Increased number of inseminations

A low conception rate of artificial insemination was highlighted as a major problem. This has resulted into increased inseminations; farmers felt that this is because of insufficient knowledge of artificial insemination by technicians, who are not aware of the reproduction levels. Farmers go to the AI technician immediately they observe that the cow is on heat ready for mating but sometimes the livestock officer is unavailable, and the mating opportunity is lost. As a result it becomes expensive to use AI with several numbers of attempts. For those who already have bulls they prefer natural mating as this result in higher conception rates much faster.

c) Silent heats

This is a reproduction disorder condition where a cow has no observed heat. Many of the credit participants reported to have experience such situations as a result they either serve a cow with no observed heat or the animal has more number of days open. This has been found to affect farmers calving interval, since they aim at having a calf every year.

d) Long distance to technicians

Artificial insemination technician travel long distance to reach out the farmers when a cow is on heat. This agrees with what Mwenifumbo and Banda (1998) reported that there seems to be substantial decrease in the responsiveness of AI services due transport and communication. Breakdown of motor cycles is frequent due to large areas and large number of farmers to cover in bad terrain. As a result, missing of crucial heat periods is common hence long calving intervals.

In summary gains obtained on access to improved technologies in the borrower group are lost by the poor reproductive performance of this group, implying the need to repackage the in-kind credit to include improvements in reproduction.

CHAPTER 5

MAJOR PHYSICAL FACTORS INFLUENCING MILK PRODUCTION

5.0 Introduction

Cobb-Douglas Production Function (CD) was used to determine factors influencing milk production. This was only restricted to improved dairy breeds because the animals were confined and it was easy to weigh and collect the inputs such as feed, water etc. feeding regimes by smallholder dairy farmers were closely monitored and data was carefully measured and collected on daily basis. Table 18 below gives the results of Cobb-Douglas production function of small holder dairy farms.

Table 18. Cobb-Douglus function of smallholder dairy producers

Variable Name	Coefficient	SE (±)	t-Value	*P*- Value
Constant	-1.183	0.254	-4.651	0.00***
Concentrate	0.095	0.012	7.865	0.00***
Forage	0.344	0.344	3.863	0.00***
Water	0.473	0.102	4.661	0.00***
Labour	0.001	0.014	0.091	0.928

*** Statistically significant at 1% level; R^2=0.97; SE- standard errors

According to results in Table 18, all the parameters have expected signs. The positive sign for the coefficients of the independent variables concentrate, water, forage and labour have a positive relationship with the dependent variable, milk yield level. Thus, *ceteris paribus*, increasing one of the variables will also increase levels of milk produced. The model fit the relationship between milk yield and various physical

factors very well. (R^2 =0.97); ($P \leq 0.01$).With exception of labour, all other inputs (forage, concentrates and water) are highly significant at 1%.

The output elasticities for forage, water, concentrate and labour were 0.3, 0.5, 0.1, and 0.001 respectively. This means that holding other factors constant, a one percent increase in forage will lead to 4% increase in milk yield. Similarly, holding other factors constant, one percent increase in water use will result in 5% increase in milk yield, while a one percent increase in concentrate will lead to about 1% increase in milk yield. The results therefore suggest that milk productivity or output could be increased by simultaneous increases in the amounts of forage, water and concentrate.

Results have shown that under current dairy management, water and forage are the two most important inputs in milk production as portrayed by high coefficients. Most farmers depend more on forage because of easy accessibility and availability throughout the year. Forage is grown by farmers raising livestock or utilise communal grazing lands for free, hence low cost in adopting the two technologies. In rural areas, water is free or cheap and is therefore one of the greatest input in milk production. Concentrates are usually expensive and as a result minimally used smallholder dairy producers. Current dairy production depends on forage and not much of the concentrates which would improve productivity significantly.

Labour had a positive sign but not significant and had a low influence on production. Probably because it is not as direct in influencing milk production as labour overall influences other inputs such as availability of water, forage concentrates, The outcome

for labour agrees with Tung *et al*. (2005), Ishaq *et al.* (2005) who found out that labour, insignificantly contribute in milk yield.

The results presented suggest that currently smallholder dairy farmers are using low levels of concentrates because of inadequate availability coupled with high prices. Therefore increase in use of concentrates gives room for improvement in milk yield levels. On the other hand, the use of concentrate should be increased for maximum milk yield; this can be done by ensuring accessibility and availability of supplementary feeds at affordable prices.

The small coefficient for concentrate is mainly due to limited use of this feed type in dairy. Concentrate are quiet expensive and also are scarce, with erratic supply in some parts of the country. However, increased use of concentrate which have high nutrient content, would significantly improve dairy productivity in these milkshed areas.

CHAPTER 6

PROFITABILITY ANALYSIS AMONG DAIRY BREEEDS LOCAL AND EXOTIC BREEDS IN SMALLHOLDER FARMS

6.0 Introduction

This chapter assesses the economic returns of local and exotic cross breeds in both borrower and non borrower group. The economic analysis was based on the Gross Margin Analysis and returns to labour,

In the analysis, the value of the gross output (gross revenue) included the value of sales of milk. Obvious enterprise variable costs such as bought-in feed costs were calculated on the basis of financial prices, veterinary costs, labour, breeding cost and other miscellaneous costs incurred. The results of the gross margin analysis are presented in Table 19.

Table 19. Economic returns (Mean gross margins) analysis of dairy cattle breeds for credit participants and non credit participants per animal per year (interaction between breed and access to credit)

	Local		Improved Breeds	
	Credit participants	**Non credit participants**	**Credit participants**	**Non credit participants**
Revenue				
Production/ day (litres)	4	2	20	10
Period in milk (months)	6	5	8	8
Total production (annual)	720	600	4,800	2,400
Selling price (MK)	40	40	40	40
Gross revenue (MK)	**28,800**	**24,000**	**192,000**	**96,000**
% Difference of Gross revenue	**7%**		**33%**	
Expenditure				
Supplemental feed (MK)	-	-	42,125	9250
Veterinary costs (MK)	480	400	10,455	750
Casual labour (MK)	4,800	4,000	12,000	4,500
Breeding costs (MK)	1,000	1,000	8,225	4500
Other costs (MK)	1,000	1,000	21,000	9,684
Total Variable costs (MK)	7,280	6,900	93,805	28684
Gross Margin/cow (MK)	**21,520**	**17,100**	**98,195**	**67,316**
% Differences of Gross margin	**11.4%**		**19%**	
Labour (person days)	365	365	365	365
Return to labour (MK/day)	**58.98** **46.85**		**269.03**	**184.43**

6.1 Revenue structure

All the farmers in the current study obtained their revenue from milk. Gross revenue for credit participants were higher than for non credit participants at both breed levels.

For local breeds gross income was 6% higher for credit participants than non credit participants which almost increased 5- fold within the improved breed category (33%). For gross revenue differences; as observed in the previous chapter, production inputs were significantly different between the two groups; high and better for credit participants than non credit participants. This is further observed in the high variable costs incurred by credit participants in Table 19.

Willis (2004) found out that credit participants realised a large proportion of cash income from dairy sources as opposed to non credit participants. Similar trends were also observed in the Ethiopian highlands by Freeman *et al.* (1998). These authors also attributed this to credit participants improving management, and labour intensity as a result of fear of borrowed capital and having their assets as collateral. This commitment to get rid of the debt led to improvement in milk yield and was reflected in high incomes.

6.2 Expenditure structure

The study reflected on variable costs as major expenditure component in gross margin analysis. These included bought in feeds, veterinary costs, casual, labour, breeding costs and other miscellaneous costs incurred by farmers. From Table 19, it can be noted that overall, expenditures on improved breeds were higher than for local breeds, revealed by the total variable costs at both credit participation status. Expenditures for exotic breeds comprised mostly of concentrates (45%) while 11% accounted for drugs and veterinary services.

Since these are high variable cost inputs, its not surprising that they are mostly taken on the credit participating farmers for the reasons explained in the previous chapter (in kind credit and cash availability).

According to Kosura (2004) input costs per farm show their largest portion allocated to buying concentrates. The author reported that there was a positive relationship between concentrates use and milk yield. Even though the concentrates were expensive farmers opted for them as they were assured of better returns in comparison to the money invested other than using locally available feeds.

6.3 Profitability

Profitability was reflected in the gross margins and returns to labour. From results in Table 19, it can be seen that irrespective of credit participation status and breed, dairy farming was profitable as evidenced by the positive gross margins at all levels. Credit participants on average reported high gross margins in excesses of 11.4% for local breeds and 19% for improved breeds than non credit participants. Similar reasons related to in kind credit and revolving funds could be probable explanation for this improved profitability in relation to credit.

Credit is costly in terms of the periodic payment or contributions to the credit scheme, but the associated benefits are far much greater. Therefore, this could explain the observed profitability of dairy farming in the credit participants group.

Generally returns to labour were higher in credit participants than non credit participants (Table 19) irrespective of the breed. improved breeds had more returns to labour in both farmer categories as compared to local breeds. Credit participants had returns to labour of 12.11MK/day more than non credit participants on local breed. On the contrary a big difference between credit participants and non credit participants was seen for improved breed which showed a gain of 84.6MK/day for participants on non participants.

As by 2005 the Malawian poverty line stood at 44.29MK/day according to (NSO, 2005). Using the above figure, it can be seen that the returns to labour observed from the current study irrespective of credit participation status are profitable. Using local breeds, dairy farming does not seem to earn much above this poverty line which is the opposite for improved breed farmers who realise returns almost 5 fold this average.

According to a survey carried out by the USAID in 2007, the average supported dairy farmer earns around 230MK/day ($600/year) as compared to the per capita income of 69MK/day ($180/year). Findings of the current study are in agreement with this report.

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

7.0 Conclusions

The key conclusions and recommendations of the study are summarized in the following sections:

- The study accepted the hypothesis that technology advance through in-kind credit for the dairy enterprise has contributed significantly toward the success of farmers through increased productivity. With respect to milk production the credit participants were found to have significantly higher milk yield per day per animal due to regular availability of dairy technologies that were introduced by Land O' Lakes. This overall high performance was probably attributed to better access to supplementary feeding, quality health services, improved breeds of animals and access to extension services and trainings for borrower compared to non borrower group whose access to improved technologies might have been erratic.

- The productive parameters accessed through in-kind credit were all significantly influenced by credit participation status ($P<0.05$) which affected breed of cow used, method of breeding, feeds (supplementation and improved forage), method of grazing, housing and drug availability. Improved management i.e. source of water and dairy training to the farmers were found

to have had a positive and significant relationship with credit participation status of farmers ($P<0.05$). Milk marketing was another factor that also had a significant influence on uptake of technologies, mainly when the price offered by processors was high, the farmers where able to purchase and access concentrates, drugs and artificial insemination.

- Reproductive parameters and their associated problems such as number of services per conception (3.1vs.1.6) and calving interval (15.0 vs. 13.9) were poorer in credit participation than in non credit participation group and the differences were significant. The values for the credit participants are poorer than ideal indicating reproductive problems despite use of AI as a breeding technology. This necessitates the need to solve problems associated with implementation of AI services in the milk shed areas in order to maintain the gains obtained from access to in-kind credit.

- Production factors i.e. forage, concentrates and water had a statistically significant positive relationship to milk output. This reveals that there exists a substantial scope to increase the milk output through making a lucid use of important inputs, particularly forage, concentrate and water levels. Furthermore the results showed that currently smallholder farmers are using low levels of concentrates which constitutes a major input to increased milk yield because of

erratic supply coupled with high prices as indicated by its low coefficient as compared to the other inputs.

- Credit participants recorded highest gross margins and returns to labour irrespective of breed as compared to the non credit participants. This gives strong indications that credit had an important role to play in overcoming financial constraints and in the use of the improving technologies and subsequently increased milk yield. Indirectly, it would indicate ability for the dairy enterprises to repay the loans if credit was obtained on commercial basis.

7.1 Recommendations

The following recommendations were drawn from the study.

1. In-kind credit has helped a lot in improving dairy production as seen from the results of this study and therefore its continued provision by NGOs and the government is highly recommended as away of improving the economic welfare of the farmers
2. Farmers should make lucid use of forage, concentrate and water. Particularly, the in-kind credit should consider the availability of concentrate and how the price can be reduced in order to increase its use for increased productivity.
3. The reproductive technology, artificial insemination at milk bulking group centres should be improved to increase the reproductive performance of heifers. Farmers also noted that supplementing at least one pure exotic bull at each of the centres can greatly reduce the mishaps associated with AI to increase the gains achieved through increased access to technologies.

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APPENDICES

Appendix I QUESTIONNAIRE FOR THE SURVEY

QNR No:……

AN ANALYSIS OF THE ROLE OF CREDIT ON MILK PRODUCTION OF DAIRY CATTLE IN MALAWI

Hello. My name is …….. from Bunda College of Agriculture. Iam conducting research on the role of credit on milk production of Dairy Cattle in Malawi. The information that you provide will be used for academic purposes only and will be treated confidentially.

HOUSEHOLD IDENTIFICATION

A1	Respondents name & signature	
A2	Region 1 – Northern 2- Central	
A3	District	
A4	Village	
A5	Name of bulking group	
A6	Date of Interview (dd/mm/yyyy)	
A7	Name of interviewer	

SECTION 1 DEMOGRAPHICS OF THE RESPONDENT

1.1	**Sex of the respondent** 1- Male 2- Female	
1.2	**Respondent's relationship to household head** 1- Head of household 2- Spouse to head of household 3- Child or grandchild to household head 4- Other relation 5- Non relative to household head	
1.3	**Age of respondent** 1- Less than 20 years 2- 20 – 39 years 3- 30 – 59 years 4- Over 60 years	
1.4	**Marital status of respondent** 1- Married 2- Divorced/ separated 3- Widowed 4- Never married	
1.5	**Highest educational qualification** 0 – no schooling 1- PSLCE 2- JCE 3- MSCE 4- Diploma 5- Degree 6- Other (specify)	
1.6	**Are you involved in other income generating activities other than rearing cattle?** 1- Yes 2- No skip to next section	
1.7	**If yes, what do you do?** 1- Farming 2- Formally employed 3- Seasonal worker 4- Business/ vending 5- Other (specify)	
2.1	**Do you have access to dairy loans**	

	1. Yes (borrower) **2.** No (non borrower) **Skip to 2.7,If no)**	
2.2	**For how long have you been using dairy loans** (in Years)	
2.3	**What prompted you to start using dairy loans**	
2.4	**What is the source of the dairy loans you obtain?** 1. L 'O' L 2. Gorvernment 3. SSLPP 4. .Other specify	
2.5	**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	
2.6	**What about loans for other livestock sectors, do you have access? (If not skip to 3.0)** 1. Yes 2. No	
2.7	**Can you specify the type of livestock** 1. goats 2. poultry 3. sheep 4. pigs 5. other	
2.8	**2.8 What is the source of the loan?** 1. Government 2. Self help 3. MRFC 4. Friends 5. Specify	
2.9	**2.9 How is the loan mentioned above designed**	

QUESTION 3 INFORMATION ON CALVING RATE AND PREGNANCY RATES (for the past 12 months)

3.1	**HOW MANY CALVES WERE BORN IN LAST YEAR? (IF NONE SKIP TO 4.1)**	
3.2	**How many of the calves died**	
3.3	**How many calves survived?**	
3.4	**What was the cause of the death (if any calf died)?**	
3.5	**Number of females that were bred last year?**	
3.6	**What was the number of females that gave birth after confirmed pregnant last year?**	

QUESTION 5. INFORMATION BREEDING (for the past 12 months)

5.1	**HOW DO YOU BREED YOUR ANIMALS**? 1. AI **1.** 2.BULLS (**SKIP TO 5.10)** 2. BOTH AI & BULLS	
5.2	**What is the cost of AI? (Price in MK)**	
5.3	**What influenced you to start using AI?** 1. Need for improved breeds	

	2. Need for more milk production 3. Unavailability of bulls 4. LOL encourages it	
5.4	**How do you acquire semen for AI in your MBG?** 1. L'O'L 2. World wide sires **3.** From other sources (specify)	
5.5	**How do access the AI?** 1. Cash 2. 2.Loan	
5.6	**Indicate whether AI is beneficial or not** 1. Beneficial **(Skip to 5.8 if beneficial)** 2. 2.Not beneficial	
5.7	**If not, what can be the possible causes, to your farm?**	
5.8	**Who administers AI** 1. Government Extension workers 2. LOL extension workers 3. Farmer AI technician	
5.9	For how long have you used AI (in years)	
5.10	What are some of the breeding problems that you encounter at your farm?	

QUESTION 6.0 INFORMATION ON FEEDING (for the past 12 months)

6.1	**DO YOU PROVIDE YOUR ANIMALS WITH SUPPLEMENTARY FEEDS?** 1. YES 2. NO **(IF NO SKIP TO 6.9)**	
6.2	**If yes, what type of supplementation do you use? (Tick the appropriate ones)** 1. dairy mash 2. Madeya plain 3. commercial molasses 4. Any with cotton seed cake 5. Any without cotton seed cake	
6.3	**If yes, how do you feed the dairy animals in a day?** 1. Once 1. Twice 2. more than twice	
6.4	**If yes how many kgs do you offer to one lactating cow at one moment?** 1- 1.< 1kg 2- 1 kg 3- >1 kg 4- 2 kg 5- >2kg 6- 3 kg 7- >3kg	
6.5	**What is the cost of Supplemental feed mentioned in the question above?** 1. Molasses price 2.Commercial Dairy mash price …… 3. Madeya price…….. 4. Any with cotton seed cake Price	
6.6	**What feed regime do you use?** 1. Zero grazing 2. Free range 3. 3. Zero and free range	
6.7	**Do you give mineral premixes to your cows?** 1. Yes **2.** No (**skip to 6.9)**	
6.8	**If yes, in what form?** 1. Powder 2. Block	
6.9	**How many times a day do you milk your cows a day**? 1. Twice 2. Once	

QUESTION 7. INFORMATION ON FORAGES (for the past 12 months)

7.1	**WHAT TYPE OF FORAGES DO YOU FREQUENTLY USE AT YOUR FARM?** 1- NAPIER 2- RHODES 3- LUECEANA 4- OTHER 5- NONE **(IF NONE, SKIP TO 9.1)**	
7.2	**What type of forages do you grow?** 1- Napier 1. Rhodes 2- Sesbania 3- Desmodium spp 4- Other legumes	
7.3	**How much land has been allocated for pasture** 1. less one acres 2. two acres 3. three acres 4. four acres	
7.4	**What is the reason for allocating such land to pasture** 1. recommended by land O lakes 2. personal wish **3.** not enough land	

QUESTION 8. INFORMATION ON WATER PROVISION

8.1	**WHAT IS THE SOURCE OF WATER FOR YOUR COWS TO DRINK?** 1. TAP WATER 2. BORE HOLE 3. STREAM **4.** RIVER	
8.2	**What quantities of water do you provide to your cows in a day?** 1. <10 litres 2. 10-19 litres 3. 20-29 litres 4. 30-39 litres 5. 40-49 litres	
8.3	**How many times a day do you provide water to your animals in a day?** 1. Once a day 2. Twice a day 3. Twice a day	

	4. Four times a day 5. more than four time	

QUESTION 9. INFORMATION ON MARKETING (for the past 12 months)

9.1	**WHERE DO YOU SELL YOUR MILK?** 1. MBG 2. MIDDLE MEN 3. WITHIN THE VILLAGE 4. OTHER SPECIFY	
9.2	**What is the average price of milk**?	
9.3	**10.3 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	
9.4	**10.4 What are the reasons for selling milk at these market** 1. better prices 2. L'O'L encourages it 3. Direct cash payment	
9.5	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	
9.6	Home consumption (litres per day)	
9.7	Milk given to calf (litres per day)	
9.8	Milk sold to MBG (litres per day	
9.9	Milk wasted (litres per day)	

QUESTION 10. INFORMATION ON DISEASES AND DISORDERS (for the past 12 months)

10.1	**HOW OFTEN DO YOU DIP YOUR ANIMALS** 1. ONCE A WEEK 2. TWICE A MONTH 3. ONCE A MONTH **4.** .TWICE A YEAR	
10.2	**What is the reason for dipping frequently**? 1. recommended 2. to prevent disease attack	

	3. dipping facilities available 4. other specify	
10.3	**Indicate if there is any vaccination that was given to the cows and why**	
10.4	**Did you experience any dystokia cases in previous years?** 1. Yes 2. no	
10.5	**If yes**, **What could be the possible cause of the case?**	

QUESTION 11 INFORMATION ON HOUSING (for the past 12 months)

11.1	**WHAT IS THE ROOF OF YOUR KHOLA** 1. IRON SHEETS 2. THATCH 3. NO ROOF	
11.2	**What is the floor for the khola** 1. mud 2. cement 3. bricks	
11.3	**What is the wall of the khola** 1. 1.poles 2. 2.bricks 3. 3 no wall.	
11.4	**What materials are used for beddings** 1. grass 2. no beddings	
11.5	**What material is used for watering the animals** 1. bucket 2. cemented water trough	
11.6	**How often do you clean your khola** 1.once a day 2.twice a day 3. every time when there is dung	

INDICATE YOUR INCOME per month ……..Gross…….Net

Appendix II. CHECKLIST FOR THE EXPLORATORY SURVEY INFORMATION ABOUT THE DAIRY FARMERS

1) When did you become a member of the bulking group?
2) How long have you been in dairy farming?
3) How many dairy cattle do you have?
4) Of what breeds is your stock?
5) How did you acquire the dairy stock?
6) What is your dairy milk production period?
7) Does the milk production vary? If yes what are the reasons for variation?
8) Do you know of any improved dairy production technologies available to farmers in your bulking group and surrounding areas?
9) How did you know of these technologies?
10) Of these which ones have you adopted?
11) When did you adopt?
12) Why did you adopt these technologies?
13) What is benefit of using the new technology?
14) What type of credit is available to dairy farmers within your bulking group
15) Other comments about the stated types of credit
16) Do you keep records?
17) Do you keep financial records
18) What other records do you keep?
19) How do you compare dairy farming to other farm enterprises?
20) What physical factors do you think affect milk production on your farm
21) What factors do you think affect the profitability of dairy farms?
22) What constraints are faced in dairy farming?
23) What do you think should be done to address these constraints?
24) What is the price of milk
25) What markets of milk do you have
26) What is the distance to the market

Appendix III. EXPLORATORY SURVEY FOR THE MILK BULKING GROUPS

1. When was the bulking group established
2. How many farmers belong to this bulking group
3. How many are non members
4. What is the number of farmers with dairy cattle in the bulking group
5. What is the number of female and male farmers
6. What is the number of male and female farmers on heifer loan scheme
7. What is the number of farmers on other loan scheme (formal or informal)
8. What is the requirement for the membership
9. How do farmers access credit in the bulking group
10. Who provides credit to this bulking group
11. Which credit institutions provide credit to this bulking group
12. What type of credit is available to dairy farmers within your bulking group
13. What is the proportion of dairy farmers accessing each type of credit
14. What are the terms and conditions given to the bulking group
15. What are the marketing prices
16. What are the sources of technology in this bulking group
17. Which are the best bet technology to this bulking group
18. Can you rank the technology on impact for milk productivity and profitability