THE ROLE OF CREDIT IN THE ADOPTION AND USE OF IMPROVED DAIRY TECHNOLOGIES IN MALAWI: A CASE OF CENTRAL AND NORTHERN MILK SHED AREAS

BY

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DECLARATION BY CANDIDATE

I hereby declare that material contained in this thesis is my own work and has not been submitted anywhere for any other award. Acknowledgement has been duly made where other sources of information have been used.

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CERTIFICATE OF APPROVAL

We hereby declare that this thesis is from the student's own work and effort and all other information used has been acknowledged. This thesis has been submitted with our approval

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DEDICATION

This thesis is dedicated to God; let it be a testimony of your grace

To my parents for the encouragement and support

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ABSTRACT

Dairy farming is seen as potential profitable enterprise for smallholder farmers in Malawi. However, this enterprise is currently characterised by low productivity due to poor feeding, inter alia. To bolster adoption and use of improved feeds extension of credit to farmers is being encouraged. Nevertheless, no detailed research has been carried out to document the linkages that exist between credit and adoption of dairy technology in Malawi. This study was conducted in central and northern milk shed areas. In order to understand the importance of credit in influencing adoption and utilization of improved feeds among smallholder dairy farmers, a total of 301 dairy farmers were proportionately and randomly selected from bulking groups in the two milk shed areas. A tobit model analysis indicated that at 1% level of significance adoption of improved supplementary feeds by smallholder dairy farmers is positively influenced by sex of farmer, education level of the farmer, types of breeds used by the farmer and participation in credit scheme. Overall, the results suggest that smallholder dairy farmers in Malawi are profit oriented and that credit will increase adoption of technologies that will enhance the profitability of farms. As such study recommends that profitability of technologies should be adequately assessed and information provided to farmers if high adoption rates are to be achieved. In addition, affordable credit should be provided to ease the resource constraints faced by most smallholder farmers.

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LIST OF ACRONYMS

ADD	Agricultural Development Division
AI	Artificial Insemination
CIDA	Canadian International Development Agency
DAHI	Department of Animal Health and Industry
DANIDA	Danish International Development Agency
LoL	Land o Lakes
MASAF	Malawi Social Action Fund
MASIP	Malawi Agricultural Sector Investment Programme
MBG	Milk Bulking Group
MDFA	Mpoto Dairy Farmers Association
NAIS	National Artificial Insemination Scheme
NLDP	National Livestock Development Programme
OIBM	Opportunity International Bank of Malawi
SEDOM	Small Enterprise Development Organization of Malawi
SSLPP	Small Scale Livestock Promotion Programme
RATES	Regional Agricultural Trade Expansion Support Program
RF	Revolving fund

CHAPTER ONE

1 INTRODUCTION AND RESEARCH PROBLEM

1.1 Introduction

1.1.1 General Background to Malawi

Malawi is a tropical country with a total area of 118,480 sq. km of which 94,080 sq. km is land and 24,400 sq. km is water. The country lies between latitudes 9ºS and 17ºS and longitude 32º 42E and 36º 36E. Eighteen percent of the total area is arable land, 20% is permanent pastures, and 39% is under forests and woodlands, while the rest is under various uses like roads and buildings. Agriculture is the largest sector in the economy with about 90% of people living in the rural areas. The agricultural sector is divided in into two: the smallholder sector and the estate sector.

Comment [OX1]: What is the source of this information?

1.1.2 Livestock in Malawi

The Malawi economy remains agro-based with the agriculture sector accounting for over 38.6% of gross domestic product (GDP) and employs about 84.5% of the labour force and accounts for 82.5% of foreign exchange earnings (GoM, 2003). Livestock constitute a small sub sector within the agriculture sector, 7% to the total gross domestic product (GDP) and below 12% of Agriculture GDP (LoL, undated). Over 50% of the smallholder households in Malawi are involved in livestock activities, with the majority operating in a low input – output management system. Currently, livestock production in Malawi falls short of the domestic demand. According to Mgomezulu, (2002), Malawi is not self sufficient in livestock products mainly because production potentials of different livestock species have

not been exploited. For example, milk yields of half bred and three quarter bred Friesian dairy cattle are 4.0 and 8.0kgs while the potentials are 6 and 12kgs respectively.

1.1.3 Dairy farming in Malawi

Dairy farming in Malawi started with the colonial settlers (estates sub sector) well before independence in 1964. According to Munthali, (undated), the settlers kept Jerseys, Ayrshire and Friesians for the production of milk. The beginning and the growth of townships such as Blantyre and Zomba created more demand for milk for both the estate and rural farmers. An increase in demand for milk by the white settlers in the southern region of Malawi interested some few farmers to import high yielding dairy cattle from South Africa and Zimbabwe. For instance, between 1952 and 1954 more than fifty four exotic dairy cattle of mixed sexes were imported into the country (Mwenefumbo and Banda 1998).

The efforts to develop the smallholder dairy sector started with the introduction of high yielding breeds in the southern region between 1968 and 1970. These were crosses of Friesian bulls and Malawi Zebu. The Dairy Cattle Multiplication project then followed in 1970. In this project, cross-bred dairy cattle were multiplied at Mikolongwe, Likasi and Choma dairy farms. The animals were sold to farmers in areas surrounding milk processing plants that were erected by government, first in Mikolongwe in 1969, then at Bwemba in Lilongwe in 1973 and Mzuzu in 1974. The multiplied dairy cattle were disbursed to farmers through a loan scheme that was run by the Government Loans Board.

Once a farmer had complied with all the conditions, local extension staff made a recommendation to the Government Loans Board for the farmer to be issued with two lactating cows and a package of equipment and chemicals. These included 5 litres of acaricide, a spary pump, rolls of barbed wire and insurance cover for the animals. Repayment of the loan was through milk sales for a maximum period of 3 years at an interest rate of 10% per annum" (Mwenifumbo and Banda 1998).

1.2 Research Problem

Above 50% of Malawi's population is poor, living below the expenditure threshold of MK16, 165 ($117) per year and about 22% of the population cannot meet the minimum daily food expenditure of MK10, 029 ($72) per annum (NSO 2005). Over the past ten years the government has developed deliberate strategies aimed at pro-poor growth and poverty reduction: Poverty Alleviation Programme (PAP) (1994), Vision 2020 (1998), Malawi Poverty Reduction Strategy (2002), Malawi Growth Development Strategy (2005) all these road maps to economic growth have emphasized on the raising of rural incomes.

The majority of the rural households in Malawi are smallholder farmers deriving almost all their income from agricultural related activities. The stagnant crop output prices has been a disincentive to achieving increased productivity and improved incomes through cash crops. Hence the need for alternate, more profitable, non crop enterprises. Dairy farming is seen as one way of raising household incomes and reducing poverty among smallholder farmers in Malawi. However, Malawi has a total population of 800,000 cattle, and only 16000 of these are dairy cattle, Noteworthy this given cattle population is against a human population of 11 million as a result, Malawi experiences a shortage of all livestock and livestock products (LoL, 2006).

Despite this huge potential, smallholder dairy in Malawi is less profitable. This is attributed to the stagnant production and low productivity levels. The former is mainly due to small population of dairy cattle in the country while the latter is a

result of poor dairy management practices. Mgomezulu (2002) singled out poor feeding and nutrition as a major cause of low productivity in smallholder dairy. Noteworthy, several improved dairy technologies have been developed and disseminated to smallholder farmers in order to improve dairy productivity. However, adoption and use of these technologies has been quite low. Research work to highlight causes of low adoption of improved dairy technologies is scanty and the smallholder dairy farmer adoption decisions have not been adequately assessed.

1.3 Research Justification

Smallholder farmers in Malawi and elsewhere are typically trapped in poverty because they do not have money required to invest in income enhancing technologies (Jabbar, Ehui & Von Kaufmann 2002). This constraint is reduced by provision of credit. Studies on adoption of crop technology in Malawi have shown that credit has an important role in influencing adoption of improved technology (Zeller, *et al.,* 1997).

Mwenifumbo & Banda (1998) indicated that sources of formal livestock credit are limited and quite restrictive due to high interest rates, lengthy and tedious application procedures and demand for collateral by the banks and other lending institutions. Smallholder farmers are usually poor and lack assets, Informal credit schemes have mostly been used by smallholder dairy farmers to access useful inputs and services such as improved feeds, drugs, semen, e.t.c. For example, revolving funds (RF) for inputs and services have been quite common among milk bulking groups (MBG). Using farmers that have received credit and non credit recipients, this study analysed the importance of credit to adoption and use of improved dairy technologies among smallholder farmers in Malawi. The findings from this research are expected to provide empirical evidence and functioning of for the current strategy that uses credit to promote adoption and in general improve the understanding of smallholder dairy farm adoption decisions.

1.4 Research Objectives

1.4.1 Overall objectives of the study

The research was based on the following objectives

a) To analyse the flow of credit in the smallholder dairy sector of Malawi

b) To analyse the role that credit plays in adoption and usage of selected best bet technologies in smallholder dairy farming in Malawi.

1.4.2 Specific Objectives

i. To identify credit providers, type of credit provided and form of loans disbursed to the smallholder dairy farmers in Malawi
ii. To analyse the level of farmer participation in credit programs and identify factors that affect the farmers' decision to participate in credit.
iii. To analyse the relationship between farmer participation in credit and the use of selected best bet technologies in animal health, feeding and nutrition, genetics and breeding and general farm management by smallholder dairy farmers in Malawi
iv. To identify how credit and other factors affect adoption of improved supplementary feeds on smallholder dairy farms.

1.5 Hypothesis

The following null hypothesis was tested:

> Participation in credit does not significantly influence the adoption and use of improved technologies by smallholder dairy farmers in Malawi

CHAPTER TWO

2 LITERATURE REVIEW

2.1 Introduction

This chapter briefly describes the smallholder livestock sector in Malawi with emphasis on the adoption of technologies, past research that has been carried out and approaches that have been used in data analysis.

2.2 The Smallholder Dairy in Malawi

The smallholder dairy farming only became a prominent component of the livestock sub sector in the 1980s. The government then had three main objectives for establishing the dairy sector

- To provide fresh milk for the increasing population in attempts to avoid incidents of nutritional diseases.
- To reduce the imports of milk and milk by products and,
- To provide an alternative source of income to farmers

The smallholder dairy sector consists of 80% of the dairy cattle in Malawi. The Peri-urban smallholder dairy sector supplies about 60 % of the milk that is processed at the formal processing plants in Malawi every year (Banda 1996). It also provides all the milk that goes in the informal sector.

The smallholder dairy farmers are organised in three milk shed areas around the three major cities of Malawi (Blantyre, Lilongwe and Mzuzu). Smallholder farmers operate under milk bulking groups (MBG). Farmers within a radius of 8 kilometres bulk their milk at a cooling centre from where milk processors collect it. Buying of

the milk by the processors is in bulk and a bonus is paid for higher bulk quantities (Chagunda *et al* 2006)

In 2001 it was estimated that there were 13, 257 cattle under smallholder dairy in Malawi, of these 5, 350 were cows owned by 3, 946 farmers operating in 43 milk bulking groups situated in the three milk shed areas (DAHI, 2001). Typically, a smallholder farmer keeps 2- 4 dairy cattle, but groups of smallholder farmers keeping much larger numbers of 20 -30 cows are becoming common in the Southern milk shed area. These are mostly cross breeds of Holstein Friesian x Malawi Zebu crosses of different grades (Chagunda *et al* 2006).

2.3 Smallholder Dairy Development Programs

The diary industry in Malawi has since the mid 1960s benefited from a number of development projects initiated by both multilateral and bilateral donors (Mwenifumbo and Banda, 1998). Some of the major projects that have been implemented in the sector are outlined below.

2.3.1 Malawi Canada Dairy Cattle Project

This was a 5 year project implemented by the Government of Malawi with funding from the Canadian International Development Agency (CIDA). The project implementation started in 1979 with the following as its objectives:

- To provide Malawi with a foundation herd of 500 Canadian Holstein capable of high milk yields
- To increase facilities, infrastructure and foundation stock for multiplication of exotic dairy stock for issue to smallholder intensive cattle units

- To increase production potential of the offspring of existing stock thereby intensifying smallholder production and increasing their economic benefits
- To train small scale farmers and large scale stock managers in the intensive and economic care of high yielding stock
- To alleviate the shortage of liquid milk in Malawi

This project had limited success based on its initial objectives. According to Mwenifumbo and Banda, 1998 one of the major reasons for under achievement was that at that time, Canadian Holsteins were found not to be suitable to smallholder management conditions as the animals are large and high grade requiring a high standard of management and nutrition.

2.3.2 Malawi German Livestock Development Project

This programme started in September 1983 with the aim of boosting cattle, sheep and goat farming in the Central and Northern regions of Malawi. The project ran for 12 years with the broad objective of helping Malawi to attain self sufficiency in milk and red meat production. The project engaged in the following activities:

- Production of dairy cattle, feeder steers and work oxen at Dwambazi and Choma in Mzuzu ADD
- Carrying out a smallholder goat development programme at Lifidzi and surrounding areas in Salima ADD
- Implementing a smallholder sheep development programme at Kasikidzi and other parts of Kasungu ADD
- Providing extension, breeding and livestock planning aids in the fields of the smallholder cattle, sheep and goat farming

Among the achievements of this project was the provision of crossbred cattle to smallholder in Mzuzu milkshed area, with the main output being the Friesian X Malawi Zebu crosses.

2.3.3 The National Livestock Development Project

This is probably the largest project implemented by the Malawi Government in relation to livestock development. The project started its operations in 1990 with the initial 5 year implementation period however due to some delays the project was extended for another 3 year period. The ultimate objective of the NLDP was to improve the welfare and incomes of the smallholder farmers through improved infrastructure and productivity of selected DAHI farms which are involved in the multiplication of breeding and fattening stock for issue to beef, dairy and poultry smallholder farmers.

Complementing the government efforts has been the Land O Lakes and Small Scale Livestock Promotion Program (SSLPP). These nongovernmental organisations have implemented projects that promote the use of improved breeds and improved management practices.

2.3.4 Malawi Dairy Business Development Program

This project was implemented by Land O Lakes between 1999 and 2006. This project adopted the heifer scheme model. The Heifer Loan Scheme had the following objectives:

- To increase farmers' access to high grade dairy animals

- To increase farmers' access to high quality dairy supplemental feed rations and mineral-vitamin supplements
- To increase farmers' access to and availability of affordable high quality veterinary pharmaceuticals.

The developed credit system was based on the revolving fund principle, but does not follow the classic key principles of micro finance. The scheme currently had four (4) products:

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

2.3.5 SSLPP heifer loan scheme

The general objectives of the heifer loan scheme:

- Increase farmers access to high grade dairy animals
- Increase farmers access to high quality and affordable veterinary pharmaceuticals and artificial insemination services
- Build capacity in smallholder farmers to improve their knowledge and skills in management of dairy animals

Components of the heifer scheme

- ***Heifer in-kind loan:*** a farmer receives a heifer (usually not less than 7 months old) or in-calf heifer and repays a first female offspring to the project to be passed on to another eligible farmer. Selection of eligible farmers involves other stakeholders, local leaders and officers from the Department of Animal Health and Livestock Development.
- ***Veterinary Drug Fund:*** this fund increases farmers' access to veterinary drugs for disease control. Each recipient pays the project an agreed initial amount of money before receiving the heifer or cow.
- ***Contracts:*** each recipient of a heifer or cow signs a contract with the project stipulating terms and conditions of the loan. (other schemes require the recipient to write a will specifying the heir in the event of death so that the cow does not go into wrongs hands)

Eligibility criteria

Eligible target sites

- Farmers must have interest in dairy farming
- Favourable climate and soils and free from tsetse flies
- Availability of market, forages and water
- Effective farmer group leadership

Eligible Farmers

- The farmer must be resident in the target area and farming is main occupation
- Is trainable, physically fit and able to read and write (farm records)
- Can pay group membership fee and initial contribution into drug fund

- Has enough land for pasture establishment
- Has good character and no record of loan default
- At least 50% of recipients are women
- Participates regularly in group activities and trainings
- Does not own cattle (local or improved) & has a household to look after.
- Must be poor to intermediate poor wealth rank and with no viable IGA

Selection Process:

- Farmer executive committee members, SSLPP Staff, local leaders and government extension officers sit down and finalize the list of selected beneficiaries.
- SSLPP staff visit the selected farmers to collect more information and assess farmer suitability against the above criteria
- SSLPP give a final approval of selected farmers

Heifer Pass on strategy

- Heifer should not be less than 7 months old and in good health
- The farmer receiving the heifer is obliged to breed it.
- Old and new farmers in the group are eligible-old farmers include those requiring replacements
- Heifers can be passed on from one area to another as long as logistical costs can be met.

2.4 Improved Technologies for Smallholder Dairy Farmers

A number of improved technologies have been advanced to the smallholder dairy farmers with the view of increasing smallholder dairy productivity. Below are

some of the improved technologies that have been promoted by government and private sector through the programs highlighted above and others.

2.4.1 Improved Pastures

The use of improved pastures has been promoted in smallholder dairy farming since the 1980s. Despite being introduced a long time ago the use of improved pasture has been little in smallholder dairying due to shortage of land in the Lilongwe milk shed area where as labour has been the major factor affecting the establishment of pasture in the Mzuzu milk shed area. In Kapacha and Lusangazi milk bulking groups in the Mzuzu milk shed area the soil conditions do not favour the growing of Rhodes grass and other improved pasture Kumwenda and Msiska, (undated) The following improved grasses and Legumes are available in Malawi Napier (Pennisetum purpureum), Rhodes grass (Chloris gayana), Hamil panic (Panicum maximum), Guatemala (Tripsacum laxum), Glycine (Neonotonia wightii), Greenleaf (Desmodium intortum), Silverleaf (Desmodium uncinatum) and Stylo (Stylosanthes guianensis). However, farmers rarely have forage legumes on their farms. Those who have them have planted them as small plots of pure stands of one or several species (Kumwenda and Msiska, 1990)

2.4.2 Improved supplements

Dairy farming requires good feeding management if full milk potential of breeds is to be achieved. In Malawi dairy cattle are usually fed on grass or crop residues and supplemented by either of the following cottonseed cake, groundnut cake, maize stover, groundnut haulms, dairy mash, Molasses and Mineral block. Munthali (undated) reported that maize bran was the main supplement fed to stall fed cattle.

Efforts to increase adoption of improved supplements have been made in smallholder dairy. Chagunda *et. al,* 2002 reported that the dairy development project provided training on on-farm dairy ration formulation and mixing. In addition the project also established feed revolving funds in selected MBGs.

2.4.3 Improved Breeds

Efforts to develop the smallholder dairy sector in Malawi since independence largely focused on provision of high yielding cross breeds to the farmers. Several farms were introduced to produce crosses that were to be utilised by small scale farms. However, it was until recent years that pure breeds of Friesian, Holstein and Jersey have been introduced in smallholder dairy. The earlier understanding was that the small scale producers cannot manage pure exotic breeds due to their huge demand for feed and low disease resistance. It was later discovered that low level crosses are less productive and inappropriate for any commercially oriented enterprise.

2.4.4 Stall Feeding

A study conducted by Chagunda, *et. al., 2006,* reported that 80.6% of the farmers in that survey practice zero grazing. It further established that Farmers producing milk from Malawi Zebu generally graze their animals at the dambo since the animals are normally large in number hence not warranting stall feeding due to space problems and labour intensity requirements. The Malawi Zebu has been reported as the dominant breed in small holder dairy and these finding suggest that

most small scale farmers do not practice zero grazing a situation that results in poor nutrition and largely contributing to low productivity in smallholder dairy.

2.4.5 AI Services

Artificial Insemination in cattle was first introduced on large scale in Malawi in August 1965 (GoM, 1965). Prior to this, AI was practiced on a limited scale on a few privately owned estates in the shire highlands. All the semen that was used in Malawi from 1965 was imported until 1984 when DANIDA funded the establishment of the National Artificial Insemination Scheme (NAIS), with the first semen collection centre at Mikolongwe.

Despite efforts highlighted above adoption of technology in smallholder dairy has remained low resulting in non increasing levels of productivity. According to Mgomezulu, (2002) Dairy productivity is low. For example, late age at calving (40 months vs. 33 months), long calving intervals of over 440 days, and low milk yields (4.0 kg/day for half – bred, 8kg/day for ¾ bred and above vs. 6 and 12 kg/day respectively contribute to low productivity of dairy herds. All these negative attributes of the smallholder industry are associated with poor management, of which poor feeding forms the major part. However, no study has ever been conducted to analyse the adoption of improved technology in Malawi smallholder dairy. On the other hand, a number of studies have analysed adoption of crop technology in Malawi this has been used to explain the decision making process in smallholder farming.

2.5 Determinants of Technology Adoption and Intensity of Adoption

Since the earlier works of Rogers (1962), efforts to explain the determinants of innovation diffusion and adoption continue. Two major groups of paradigms for explaining adoption decisions can be found in literature: the innovation diffusion model and the economic constraints paradigm (Adesina & Zinnah 1992).

The innovation diffusion model views access to information about an innovation as the key factor determining the adoption decisions. The appropriateness of a technology is taken as given and the problem of technology adoption is reduced to communicating information on the technology to the potential end users. By emphasizing the use of extension, media and local opinion leaders or by the use of experiment station visits and on farm trials the sceptic non adopters can be shown that it is rational to adopt.

The economic constraint model as presented by Aikens, *et. al.* (1975) contends that economic constraints reflected in the asymmetrical distribution patterns of resource endowments are the major determinants of observed adoption behaviour. Lack of access to capital (Havens and Flinn, 1976) or land (Yapa and Mayfield, 1978) could significantly constrain the adoption decisions. The attempts to make the economic constraint model superior to the innovation diffusion model have been challenged.

A third paradigm that is implicitly used in one way or the other suggests that the perceived attributes of innovation condition adoption behaviour. The limited quantitative studies that have considered farmers perception in context of adoption decisions, have included perception variable regarding the severity of the problem in their models.

Awudw A. et al. (2003) conducted research on the role of information acquisition in the adoption of dairy related technologies in Tanzania. The empirical investigations involved farmers in Iringa and Mbeya and it covered 237 farmers that had adopted cross bred cows and 169 farmers who had not. The analytical results indicated that credit availability is the essential factor that can constrain the adoption of new technologies in dairy e.g. it had the most important marginal effect on the decision to adopt a cross bred cow or not. Other factors that were found to positively affect the adoption decision were better education and non farm income and information diffusion.

Renos Vakis (2002) explored the relationship between cash constraints, income diversification and technology adoption using farm-household level data from Peru. The results from this study show that the level of income from the dairy enterprises affect the level of adoption of new technologies but this only depends on effect of the income to relax the credit constraint that farmers face. He observed that income diversification on farms had a positive relationship with technology adoption. He also observed that there was difference in level of adoption between credit constrained farmers and non credit constrained with those with access being more likely to adopt technologies.

2.6 Credit and Adoption of technology

2.6.1 Defining access and participation in credit

The role of credit in adoption of new or improved farming technologies is usually assess at two level of farmer involvement in credit; farmer access to credit and farmer participation in credit. Several methods of determining access to credit have

been used in the past but over the years the weaknesses of such methods have been exposed leading to development of new techniques.

This section presents the several methodologies that have been used to determine access and participation in credit in previous studies as discussed by Diagne and Zeller, 2000.

The standard practice in previous studies on the impact of access to formal credit has been to take the estimated marginal effects of either the amount of credit received or membership in a credit program as measures of the impact of access to credit on various household welfare outcomes. (Diagne & Zeller, 2000). However, the usefulness of using the credit-received variable to assess the impact of access to formal credit is limited unless one assumes that (1) all households in the program were credit constrained when they were receiving credit, (2) the program is their only source of credit, and (3) they cannot use own resources to finance their investments even partially (Feder et al. 1990). However, most households have access to some form of informal credit and use various savings options to transfer resources across time. Furthermore, the different sources of credit and ways of financing investments are likely to be substitutable to some degree. Therefore the amount of formal credit they are demanding, when it becomes available, is likely to reflect (at least partially) substitution away from the other sources of investment funds. These substitution effects alone make it inappropriate to identify the impact of access to formal credit with effects due to changes in formal loan size, even if the endogeneity of the latter has been appropriately dealt with. There are two other reasons why it is inappropriate to use the amount borrowed to assess the impact of access to formal credit:

1. Some households may have access to sufficient credit lines from a program but may have decided not to borrow because it was not optimal for them to do so. Yet the credit lines provided by the program to these non borrowing households may still have a positive effect on their household outcomes (by allowing them not to engage in unproductive precautionary savings, for example),which would not be accounted for.
2. Some households may have received large amounts of credit with little or no marginal impact on their household outcomes because, at that level of credit use, the marginal impact of additional credit received may be negligible. But this negligible impact does not account for the positive effects of the"shields" and flexibility provided by the sufficient credit lines that allowed them to make optimal borrowing choices.

The same criticism applies to the common practice of identifying the effects of membership in a credit program on household welfare outcomes as the impact of access to formal credit on those welfare outcomes. The wider literature on program evaluation demonstrates that if the survey design, sample selection, and econometric analysis are appropriately carried out to resolve the problem of endogeneity of membership status and credit program placement, then the estimated partial effects of the membership status variable should correctly measure the average impacts of the program on the welfare outcomes (see, for example, Moffit 1991; Heckman and Smith 1995; Morduch 1997; Pitt and Khandker 1998). In fact, most of the recent literature on the difficulties of measuring the impacts of credit programs follows the program evaluation literature

and concentrates on the statistical problems related to survey design, sample selection, and endogeneity of program placement. But the studies that emphasize the statistical problems that complicate the identification of program impacts usually neglect the substitution and fungibility issues that are to some extent specific to credit programs. The program impacts measured through the membership status variable, however do not measure the impacts of *access to formal credit* on the same welfare outcomes, and they may not even correlate with access to formal credit. There are at least two reasons why this is so:

1. Most microcredit programs provide an array of additional services besides credit (literacy classes, business training, family planning education, and so forth). Therefore, for these programs the measured "program impacts" on the welfare outcomes include the impacts due to change in behavior as a result of these educational services (Pitt and Khandker 1998).
2. Membership in a credit program does not guarantee access to its credit, especially when it is most needed. In fact, many group-based microcredit programs(including two of the five studied in the report) stipulate explicitly thatat any point in time only half of the group members can have access to their credit. Even in microcredit programs that do not have this rule, but operate within ad hoc or continuously evolving institutional arrangements (especially those that depend on short-term donor funding), members' access to credit is most of the time uncertain.

In summary, because both the partial effects of credit received and membership status do not necessarily correlate with the benefit derived from gaining access to formal credit, they cannot be taken as measures of the effect of access to formal

credit on household welfare outcomes. Therefore, to assess satisfactorily the impact of access to credit, the analysis departs from the standard practice and makes the distinction between *access to credit* (formal or informal) and *participation* (in formal credit programs or in the informal credit market). A household has access to a particular source of credit if it is *able* to borrow from that source, although for some reasons it may choose not to. The extent of access to credit from a given source is measured by the *maximum* amount a household can borrow (its *credit limit* or *credit line*) from that source. A household is participating if it is borrowing from a source of credit. The distinction between *access* and *participation* is also important because a household may benefit from mere access to credit even if it does not borrow. Indeed, with the option of borrowing, it can do away with risk-reducing but inefficient income diversification strategies (Eswaran and Kotwal 1990) and precautionary savings with negative returns (Deaton 1991).Since within this framework *access to credit* and its *improvement* are identified respectively with a *strictly positive* and *increasing* credit limit, measuring the impact of access to credit reduces to measuring the effects of an increase in the credit limit on household behavioral and welfare outcomes. The marginal effects of the credit limit variable for formal credit on household welfare outcomes, controlling for the credit limit from informal sources as well as the credit demanded from both sources, measure the marginal impacts of access to formal credit. Furthermore, by controlling for both the level of access to credit and the amount of credit demanded from formal and informal sources, the changes in the welfare outcomes due to changes in the formal credit limit variables can be separated from the ones due to the substitution effects that arise when formal and informal credit are substitutable

to some degree. Similarly, the direct effect of access to credit (that is, the effect arising from merely having access to formal credit) is separated from the indirect effect that arises.

The role of credit in Adoption of farm technologies

Several studies in the past *(Kabuli, (2005), Mugisha, et.al (2004), Khandker & Farqee, (2003), Smale, et.al., (1995))* have shown that agricultural credit positively affects the adoption of farm technologies by reducing the capital constraints that smallholder farmers usually face. Despite credit reducing the cash constraints that farmers face, on its own, it's not sufficient to encourage technology adoption but rather three other conditions must also be satisfied. These conditions are suitability of technology, availability of favorable markets and availability of supplies (Rice, 1973).

Suitability of technology

The new technology must offer increases over the present yields so substantial as to persuade risk averting farmers to depart from traditional practice. Most of the technologies that have been promoted in the smallholder dairy sector in Malawi aim at improving milk yield. As such it can be assumed that this condition is satisfied by the technologies under review in this study.

Favorable Markets

The existing markets must offer small holder farmers substantial returns to invest in new technologies. The markets that exist should be able to absorb the increase in production resulting from new technologies without causing a decline to the produce price. According to Chindime, (2007) the capacity utilization of the dairy processing plants in northern and central milk shed areas is estimated at 21%. This

suggests that any increases in milk production face a steady market and can not affect the output prices offered to farmers, at least in the short run.

Availability of supplies

The alleviation of cash constraints is not enough in the absence of consistent supply of technologies. In most cases, the technologies are supplied in fewer quantities and not at the right time. This affects the effectiveness of smallholder credit programs. The availability of dairy inputs has always been a challenge in most bulking groups in Malawi. Despite the existence of farm input suppliers in cities of Lilongwe and Mzuzu, the distance from the farm to the city usually affects the usage of technology like dairy mash. However, with NGO support input shops have been established in selected bulking groups in the two milk sheds.

2.7 Approaches that have been used to analyse adoption and intensity of adoption

In Malawi, a number of adoption studies have been conducted. The majority of them use the binary choice models of Logit and Probit. In a study conducted by Edriss, *et.al.* (2003), on the factors affecting the adoption of land conserving technologies in Shire Highlands of Malawi. A Logit model was used to test a total of fourteen factors for significance to the adoption of erosion control measures. However, only five factors were found to be of significance to adoption of erosion control. These are age of farmer, sex of the farmer, socio status of the farmer, size of the field and level of erosion in the field.

Bokosi, (undated) used the Probit model to assess the factors influencing participation in credit market in Malawi. The results showed that only family size and seasonality had significant influence on the participation decision. Despite the binary choice models being widely used in adoption studies in Malawi, this type of analysis is limited to assessing the farmer's decision to adopt but not the intensity of adoption. In addition the Logit/Probit cannot be used when the dependent variable is limited continuous variable.

In situations where there is need to assess adoption as well as intensity of adoption decisions the Tobit models have been preferred. Kabuli, (2004) using tobit analysis assessed the factors that affect the adoption of soybean within maize based cropping system. In this study it was found out that the determinants of adoption were age of the farmer, sex of the farmer, position in society and education attained. However, the tobit model has a weakness in that it assumes that a farmer makes decisions simultaneous regarding adoption and extent of adoption such that factors that affect adoption are also assumed to affect intensity of adoption. For instance, a positive coefficient assumes increase in probability of adoption as well as increase in extent of adoption.

However Nakhumwa, 2004, argued that smallholder farmers usually follow stepwise decision making process where first, they decide whether to participate or not and the later decide on the extent of adoption. In a study to assess determinants of soil conservation technologies he used a selective tobit analysis. This model was used to simulate the two stage decision making process of farmers with respect to adoption and subsequently the extent of adoption. The study observed that factors

that affected adoption were different from factors that affected extent of adoption. It established that the farmers' decision to adopt marker ridging technology was primarily influenced by Knowledge, age of household head, labour availability and level of erosion. The factors that significantly affected the extent of adoption were farm profitability, farm output, land size, labour availability, and production assets owned by the farmer. However the study observed that some factors had influence on both adoption and intensity of adoption decision.

An alternative approach has been used to analyse the intensity of adoption. This is by using count data models (Poisson and Negative Binomial). These models are largely preferred when dependent variable is non negative but can assume large values. In a study conducted in Louisiana, U.S.A., to examine the adoption of best-management practices (BMPs), in terms of the total number of practices implemented up to a certain period. The count data analysis, Poisson and negative binomial regressions were used to examine the likely determinants of producers' decisions to adopt greater numbers of technologies, and the specific case of dairy producers' adoption of BMPs was explored.

A similar approach was used by Edriss, (2003), to analyse the determinants of adoption of improved groundnut seed technology in Malawi. This approach has a limitation in that it does not explain much on the adoption of the individual technology. For instance it does not explain the factors that influence the adoption of individual best management practice. Due to this there is need to run separate models to derive that sort of information. However, these models have proved to be

handy when the focus is to assess the extent of adoption in terms of number of technologies adopted.

Smallholders are typically trapped in poverty because they do not have the money required to invest in income-enhancing innovations (Jabbar, *et. al.,* 2002). This lack of money is alleviated by provision of credit. The next section presents the credit situation in smallholder.

2.8 Availability of Finance for Smallholder Dairy Production

The main finance provider to Malawi's agricultural sector is the Malawi Rural Finance Company (MRFC), a micro credit institution set up by government in 1995 to provide loans to the agricultural sector after the failure of another government loan providing arrangement (SACA). The MRFC has the mandate to operate as a private entity as such it attached collateral conditions and twenty percent upfront payment on all clients. This has constrained most smallholder farmers as they do not meet the collateral which is 150% of the applied loan. Apart from MRFC the other lending institutions also provide loans but the proportion of loans to dairy farmers is very small. According to Mwenifumbo & Banda (1998), the liberalisation of the output market will break down credit discipline especially when Malawi Dairy Industries Limited is completely privatised. It is much easier to recover credit if there is a single buying agency as is the case with tobacco where stop orders can be effectively used.

This was evident during the policy analysis that the government conducted in 1999. "Prior to the 1998/99 agricultural season the period of market liberalisation and structural reform led to the decline in smallholder access to credit and use of fertilizer" (GOM 1999). It was established that despite government establishing the

MRFC and the APIP program only a small number of smallholder farmers had access to credit.

According to Chindime & Phiri (2006), despite the availability of commercial loans that specifically target dairy farmers (MRFC) and other potential loan providers to the smallholder dairy farmers (OIBM and SEDOM), the in-kind credit offered by the Bulking group based revolving funds was the only source of credit accessed by the dairy farmers in Lilongwe and Mzuzu milk shed areas. These revolving funds were initiated by the LOL and they provide in kind loan for drugs and vaccines, feed and semen. The repayment of these loans is done through deductions from the milk sales. They also reported that on loans to the bulking group, big loans have been gotten from the opportunity international bank to finance the purchase of new cooling equipment for the bulking group.

CHAPTER THREE:

3 RESEARCH METHODOLOGY

3.1 Introduction

This chapter outlines the sampling techniques and data tools used. It also provides detailed description of the statistical analysis carried out in the study. The assumptions behind choice of models and independent variables have also been discussed.

3.2 Data Collection

3.2.1 Target Population

The smallholder dairy farmers in Malawi are organised in associations. The Shire Milk Producers Association in the southern region, Central Milk Producers Association is in the Central region of Malawi while the Mpoto Milk Producers Association is for the dairy farmers in the northern region of Malawi. According to Land O Lakes (2005), the membership in the associations is 2900, 2255 and 684, respectively.

The study was conducted in Lilongwe and Mzuzu milk shed areas. The Lilongwe Milk shed area is located in the central region of Malawi and has 18 functional bulking groups surrounding the city of Lilongwe. The Mzuzu milk shed area is located in the Northern region of Malawi and has six functional bulking groups. The only form of credit accessed by smallholder dairy farmers at the time of the exploratory survey was through the revolving funds set up with assistance from LOL and Heifer scheme for improved breeds initiated by SSLPP and LOL smallholder dairy projects. The two milk sheds have been selected purposively

because there is evidence of functioning revolving funds whereas in the Southern Milk Shed functioning smallholder dairy credit schemes could not be traced.

3.2.2 Sampling Design and Instruments

The survey collected cross sectional data and made use of both primary and secondary data. Primary data was collected through

- Questionnaires that were administered to 300 farmers in the nine bulking groups. The information collected included socio economic characteristics of dairy farmers, technologies they have adopted, sources and amount of credit gotten, daily production, sales and production costs.
- Checklist was used to collect qualitative information from MBGs Committees on how the revolving fund schemes are being run and sustainability of such funds. Checklists were also used in interviews with key informants Government/NGO filed officers.

Secondary data was collected from Land O Lakes Malawi, SSLPP and Department of Animal Health and Livestock Development.

3.2.3 Sampling Frame

The sampling frame narrowed down from

i. All Dairy farmers in Malawi organised in 3 regional associations (Shire Milk producers, Central milk producers and Mpoto milk producers
ii. Two associations with evidence of smallholder credit were purposively selected (Central and Mpoto milk producers)
iii. Two milk sheds with functional cooperatives were then selected, one in each association (Lilongwe and Mzuzu milk shed areas)

iv. The following milk bulking groups; Chitsanzo, Lumbadzi, Mponela, Mpalo, Nathenje, Lusangadzi, Kapacha, Kawindula, Doroba were sampled and then random sampling was used to identify farmers within these bulking groups.

3.2.4 Sample Size

The sample size was calculated using the following formula

Sample Size (n) = $\mathbf{Z^2 (1\text{-}P) P/e^2}$

Where

Z is the tabulated Z value

P is the proportion of dairy farmers in the areas

e is the absolute size of error

The study maintained a 95% confidence interval that has a tabulated Z value of 1.96 (two tailed test). The absolute value of error has been estimated at 0.05 and the proportion of dairy farmers in the central and northern associations as a proportion of the total population of small scale dairy producers is 75%

Calculation

Sample size n = $(1.96)^2$ (0.25) (0.75) / $(0.05)^2$ = 288

Due to the possibility of non respondents a 10% was added making the sample size 302

3.2.5 Sampling Methods

A Stratified sampling technique was used in which the 24 Milk bulking groups were divided into two strata. The first stratum contained milk bulking groups in

which the revolving fund credit schemes were operational and the other consisted of all bulking groups where there were no revolving funds. In the exploratory survey, it was established that apart from the revolving fund credit schemes the available lending institutions have loaned out to insignificant number of farmers who are mainly the large scale farmers.

The study emphasized on the contribution that credit makes in adoption of improved dairy technologies and it further analysed the flow of credit to small scale dairy producers hence the separation of strata based on this characteristic. In every stratum several enumeration areas were identified and the enumeration areas in which to draw samples were selected using Probability proportional to size sampling to ensure that enumeration areas (milk bulking groups) that have large populations are given a greater chance of containing elements in the sample. According to Edris *et al.* (2003), the use of proportional probability sampling in stratified samples removes the need to adjust estimates arising from different size strata.

The second stage involved selection of samples from enumeration areas using simple random sampling. In this stage farmers were selected from each of the nine selected enumeration areas making the total sample size 302.

3.2.6 Training of Enumerators

The study engaged enumerators to conduct the data collection process. To avoid interviewer errors, the enumerators went through training on the importance of adhering to research ethics and how to collect the required information from the respondents especially income and expenditure data that is very confidential to the

farmers. The enumerators were also drilled on how to estimate production and income in absence of records to reduce bias. The enumerators together with researchers also went through the questionnaire to ensure that they fully understand the content and the information that the researcher was interested in. The training process also translated the questionnaires that were formulated in English into Chichewa and Tumbuka for easy communication with the respondent in Central and Northern milk sheds respectively.

After the training the questionnaire was pre tested in the study area to check for consistency of questions and missing responses on closed questions.

3.2.7 Sensitisation of Respondents

The sampled respondents were communicated to through the government field agents and Milk Bulking Group committees notifying them of our intent to visit them for the interview.

3.3 Data Analysis

3.3.1 Smallholder farmer socio economic characteristics and analysis of the relationship between the smallholder farmer participation in credit and farm and farmer characteristics

Descriptive statistics mainly means and frequencies were used to describe the socio economic characteristics of smallholder dairy farmers. Chi-square tests were performed to determine if there is association between participation in credit and socio economic characteristics. P-Values were also computed to check for significant differences between proportions. A p-value of less than 0.05 was considered significant.

3.3.2 Analysis of determinants of farmer participation in credit

3.3.2.1 Choice of model

The decision to participate or not participate is choice variable that can only take two values, 1 if the farmer participates and 0 otherwise. In presence of such a dependent variable the multiple linear regression is unflavoured. If ordinary least squares is used the error term has a highly non normal distribution and suffers from heteroscedasticity because $\mathbf{y_i}$ (dependent variable) has two outcomes (0,1) the error term for a given value of x (independent variable) has two possible outcomes as well (Verbeek 2004).

The alternative is to use binary models such as logit and probit. This study used the binary logit model to identify the factors that influence the farmer's decision to participate or not participate in credit. The choice between logit and probit is a matter of computational convenience because the two models yield same estimates.

Operational definition of participation in credit

Access to formal credit is often confused with participation in formal credit programs. Indeed the two concepts are used interchangeably in many studies. However, to analyze satisfactorily the determinants of participation in credit programs and to assess their respective impacts on adoption of improved dairy technology, one needs to make clear distinction between *access to credit* and *participation* in credit programs. A farmer has *access* to a particular source of credit if her/she is *able* to borrow from that source, although for a variety of reasons may choose not to. A farmer is said to be *participating in credit* if he/she is borrowing from a source of credit.

3.3.2.2 Empirical Logit Model

Qualitative response models--also called binary-choice, discrete or dichotomous models are often used to evaluate the farmer's decision-making process. These models are based on the assumption that farmers are faced with a choice (participate in credit or not participate) and the choice depends upon identifiable characteristics (Pindyck & Rubinfeld, 1997). Based on the assumption that the decision made by farmers is guided by a utility maximization objective, a farmer will choose to participate in credit (t_2) over non participation (t_1) as long as the utility derived from participation is greater than the utility derived from not participating in credit. Based on Rahm and Huffman, 1984 the utility function of the i^{th} farmer is presented below.

$$U (R_{ti}; A_{ti})$$

Where utility U depends on a vector R_{ti} , describing the distribution of net returns for decision $\mathbf{t_j}$,and a vector A_{ti} ,corresponding to other attributes associated with the credit package $\mathbf{t_j}$. The variables R_{ti} and A_{ti} are not observable, but a linear relationship is postulated for the $\mathbf{i_{th}}$ farmer between the utility derived from the $\mathbf{t_j}$ technology and a 45 vector of observed farm and farmer characteristics X_i and a zero mean random disturbance term μ_t:

$$U_{ti} = X_{it} + \mu_t \text{ where } t = 1, 2 \text{ and } i = 1, 2, \ldots.n. \quad (1)$$

As mentioned previously, the $\mathbf{i_{th}}$ farmer chooses $\mathbf{t_2}$ if $\mathbf{U_{t2}}$ is greater than $\mathbf{U_{t1}}$.

A qualitative variable Y can represent the farmer's choice decision.

$$Y = 1 \text{ if } U_{t2} > U_{t1}$$

$$Y = 0 \text{ otherwise} \quad (2)$$

The probability that Y_i is equal to one is expressed as a function of specific farm and farmer characteristics:

$$Pi = Pr\,(Y = 1) = Pr\,(U_{t1} < Ut2)$$

$$Pr\,(X_i \alpha_1 + \mu_{1i} < X_i \alpha_2 + \mu_{2i})$$

$$Pr\,[\mu_{1i} - \mu_{2i} < X_i (\alpha_2 - \alpha_1)]$$

$$Pr\,(\gamma_i < Xi\,\beta) = F\,(X_i\beta) \quad (3)$$

Where

Pr (.) is a probability function**,**

$\gamma i = \mu_{1i} - \mu_{2i}$ is a random disturbance term

$\beta = \alpha_2 - \alpha_1$ is a coefficient vector and;

F ($X_i\beta$) is a cumulative distribution function for γ_i evaluated at $X_i\beta$.

The marginal effect of a variable X_j on the probability of adopting new technology can be calculated by differentiating P_i with respect to X_j:

$$\partial Pi / \partial Xij = f(Xi\beta) \,.\, \beta j, \qquad (4)$$

Where f (.) is the marginal probability density function of γ_i and j = 1, 2,……J is the number of explanatory variables. The general form of the univariate dichotomous choice model is expressed as:

$$P_i = P_i (y_i = 1) = G (X_i, \theta) \text{ where } i = a, 2, \ldots.n. \qquad (5)$$

Equation (5) states that the probability that the i_{th} farmer will participate in credit is a function of the vector of explanatory variables X_i and the unknown parameter vector θ.

Three alternative functional relationships are commonly used by researchers to specify G: Linear Probability (LP), Probit, and Logit models. A Linear probability model

$$(Yi = \alpha + \beta X_i + \mu_i)$$

has been used extensively in econometrics applications. However, its specification has caused estimation problems and the non-normality of the disturbance terms makes the use of traditional tests of significance (t-test and F-test) in adequate. Pindyck & Rubinfeld (1997) summarize the limitations of the LP functional form as

follows:

- It gives a heteroscedastic regression model and its variance-covariance matrix varies systematically with the independent variables;
- The predicted value of X β is not restricted to lie between 0 and 1, which is inconsistent with the definition of Y_i as a conditional probability;
- Some studies have revealed that adoption decision functions are curvilinear rather than linear. Thus, Ordinary Least-Squares (OLS) would produce inefficient parameter estimates.

Given the problems associated with the linear probability model, economists have developed alternative functions that confine the estimated probabilities between 0 and 1.

The two most common functions used in econometric applications are the logistic and the cumulative normal distributions, creating the logit and probit models, respectively. Thus, the probability that a farmer will adopt a new technology is expressed as a function of:

$$P (Y = 1) = F (X \beta)$$

According to the logit model, the probability of a farmer participating in credit $\mathbf{t_2}$, given a well-defined set of socio-economic and physical characteristics (X), is represented as:

$$P (t_2 \mid X) = \exp (X \beta + \mu) / [1 + \exp (X \beta + \mu)]$$

Likewise, the probability of not participating in credit by a farmer $\mathbf{t_1}$ is given by:

$$P(t_1 \mid X) = 1 - P(t_2 \mid X) = 1 - \{\exp^{(X\beta+\mu)} / [1 + \exp^{(X\beta+\mu)}]\} = 1 / [1 + \exp^{-(X\beta+\mu)}] \quad (6)$$

The relative odds of participating versus not participating in credit are given by

$$P(t_2 \mid X) / P(t_1 \mid X) = [\exp^{(X\beta+\mu)}] \{1 + \exp^{(X\beta+\mu)}\} / [1 + \exp^{(X\beta+\mu)}] = \exp^{(X\beta+\mu)} \quad (7)$$

Taking the logarithm of both sides: $\ln [P(t_2 \mid X) / P(t_1 \mid X)] = X\beta + \mu$ (8) In a logit model, the parameter estimates are linear and, assuming a normally distributed disturbance term (μ), the logit maximum likelihood (LML) estimation procedure is used to get efficient, consistent, and asymptotically normal estimators. Those estimates will represent the effects and statistical significance of the explanatory variables on the adoption of a particular technology (Pindyck and Rubinfeld, 1997). In a logit model, the marginal effect of the explanatory variable is generally computed at the mean value of the independent variable for continuous variables; while the marginal effects of categorical variables are estimated by the difference before and after the change takes place.

The probit model is also more appealing than the linear probability model, since it incorporates nonlinear maximum-likelihood estimation. Probit analysis accounts for heteroscedasticity of the error terms and restricts predictions to lie between 0 and 1 range. The probability of a farmer adopting or not improved technology in the probit model is defined in terms of an index that may have any value between $-\infty$ and $+\infty$. This index is converted into probability values by using a standard cumulative normal distribution and this transformation guarantees that all

corresponding probability values are confined between 0 and 1(Pindyck and Rubinfeld, 1997, Maddala G., 1983). The functional form is represented as follows:

$$P_i = F(Z_i) = 1 / (2\pi)^{0.5} \int \exp^{-\mu 2/2} d\mu$$

$$\text{Where } Z_i = X_i \beta + \mu_i$$

An estimated β value in a logit or probit model does not give the change in the dependent variable, due to a unit change in the explanatory variable. This effect is obtained by computing the partial derivative of the Prob ($Y_i = 1$) with respect to β.Since logit and probit models yield similar results in the case of binary choice models (Maddala, 1983, Amemiya, 1981), the choice of one above the other is a matter of convenience.

This study uses the logit model to determine factors that influence the decision of a smallholder dairy farmer to participate or not participate in credit.

3.3.2.3 Analytical Model for Participation in Credit

Dependent Variable *(Participation in credit)*

The dependent variable assumed the value of 1 if a farmer participates in credit (a farmer that borrowed for dairy purposes from any source within the last 12 months) and assume the value of 0 if otherwise.

Independent Variables

Sex of the farmer

A dummy variable for sex was used 1 if the farmer is male and 2, otherwise. It has been hypothesized that male farmers have superior access to productive resources as such they have an upper hand in access to credit. Hence a positive relationship is expected

Farmer education level

This variable assumed the value of the highest grade reached by the farmer. 0 if the farmer did not go to school. In most studies Edriss & Bokosi, (2003) education has shown to have a positive relationship with participation in credit. In this study a positive relationship was also hypothesized.

Landsize

This variable was measured in hectares of farm land owned by the farmer. A positive relationship is hypothesized because land can be pledged as collateral. As such, farmers with more land are more likely to participate in credit.

Herd size

This variable represented the number of dairy cattle owned by a farmer. A positive relationship is also expected between farm size and participation in credit. Farmers with large herd were expected to be more likely to participate in credit because lenders prefer providing credit to large farms.

Farm site

A variable for location of the farm was included in the model. Different lending institutions exist in the two milkshed areas as a result the probability of participation is expected to differ across the milk sheds because farmers are subjected to different conditions.

Annual crop farm income and non farm income

These variables were measured in Malawi Kwacha. Crop farm income and non farm income variables are expected to have negative relationship with participation in credit. Farmers with high amounts of non dairy income are very unlikely to get small loans because the can easily finance small expenditure using own savings.

Age of the farmer

Lenders prefer giving loans to the economically active age group as such a positive relationship is expected for the age variable

Dairy farm income

A positive relationship is expected as farmers who generate high revenues from dairy are compelled to invest in new technologies to sustain that level of income.

Milk selling price

A positive relationship is also expected because farmers with a high selling price are able to absorb additional cost arising from use of credit without completely removing the profit margin.

3.3.3 Analysis of usage of selected best bet technologies

The several best bet technologies were identified in this study. These technologies can be grouped into Nutrition *(Improved Concentrates, Mineral, Forage, Feeding Regime)*, Genetics & Breeding *(Improved Breeds, Controlled Breeding)*, Animal Health management *(Vaccines and Dipping, Improved Khola, Khola Hygiene)* and General management *(record keeping).*The usage of these technologies was analysed using means and frequencies and the level of usage between borrowers and non borrowers was analysed using cross tabulations with chi – square test to check for significant differences between the two groups. P-Values were also computed to check for significant differences between proportions. A p-value of less than 0.05 was considered significant.

3.3.4 Factors affecting adoption and intensity of adoption of improved supplementary feeds

As described in chapter two several best bet technologies have been identified and promoted in the smallholder dairy sector. Out of these technologies, past research (RATES, 2004, Mgomezulu, 2002) has single out poor feeding as the main culprit causing low productivity as a result the adoption analysis in this study focused on improved supplementary feeds.

3.3.4.1 Empirical Model

The tobit model was chosen for this analysis because it can measure the probability of adoption and intensity of adoption (McDonald & Moffit, 1980; Tobin, 1958.). Given the manner in which improved feeds were introduced in smallholder dairy

farming in Malawi, the decision to adopt is often made simultaneously with the decision to use improved feeds and the decision to participate in credit. This implies that the use of improved breeds and participation in credit are endogenous variables.

Modelling such variables as exogenous variables in a standard tobit model would result in a violation of an important assumption underlying regression models that all right hand side variables are predetermined or exogenous or independent. The problem when estimating these models without worrying about endogeneity is that you get spurious results. In other words it is difficult to tell whether the causality is running from the independent to the dependent variable or vice versa because both cases are equally likely.

Therefore, a three-equation simultaneous equation tobit model was used to determine the factors affecting the adoption of improved feeds in smallholder dairy farming in Malawi.

Following McDonald & Moffit (1980) the tobit model may be expressed as

$$\alpha = X\beta + \varepsilon_i \quad \text{if} \quad X\beta > \varepsilon_i, \qquad 0 \; if \; X\beta \leq \varepsilon_i$$

Where α is the solution to the resource use maximization problem of intensity of adoption of improved feeds, subject to X, the vector of explanatory variables. The vector of coefficients is β and ε_i is the independently distributed normal random error term with mean zero and variance σ^2

The above standard tobit model can be embedded ina system of recursive simultaneous equations, such as in a two-equation model

$$\alpha = X\beta + \varphi_2 y_2 + \varepsilon_1 \; (Tobit)$$

$$y_2 = n_2 x_2 + \varepsilon_2,$$

Where y_2 is the variable assumed to be endogenous, x_2 is the vector of instrumental variables, and φ_2 is the coefficient on y_2, which is distributed in β in Eq. 1.

Blundell & Smith (1986) explain how the two-equation model can be extended in a simple three step procedure to models with many regressions and requiring similar maximum likelihood estimates. Following this a recursive three equation simultaneous tobit model used in this study is

$$\alpha = X\beta + \varphi_2 y_2 + \varepsilon_1 \ (Tobit)$$

$$y_2 = n_2 x_2 + \varepsilon_2,$$

$$y_3 = n_3 x_3 + \varepsilon_3,$$

3.3.4.2 Analytical Model

Model specification

From the conceptual model in chapter 3, a simultaneous equation system is specified to explain the adoption of improved supplementary feeds. In the first stage the following equations were used to obtain predicted values of the endogenous variables participation n credit (DLOAN) and use of improved breeds (DBREEDS).

$$DLOAN = f(DNGO, DNREGION)$$

$$DBREEDS = f(DNREGION, DNGO)$$

The DBREEDS and DLOAN are then incorporated into the second stage which we specify as

$$PROPEXPEND = f(EDUCLEVE, DLOAN, LANDSIZE, AGE, AGESQUARE, DBREEDS, SEX, PERDFINC)$$

Dependent Variable

This is the proportion of supplementary feed expenditure that is attributed to expenditure on improved supplementary feeds.

Choice of independent variables

Participation in credit

This was measured by a binary variable 1 if farmer borrowed and 0 otherwise. A positive relationship between the two variables is expected because credit reduces cash constraints faced by smallholder farmer's thereby increasing capacity to adopt technologies.

Type of Breeds

This was measured as a dummy variable, 1 if the farmer has improved breeds and 0 otherwise. A positive relationship is also expected with the dependent variable because it is assumed that farmer are profit oriented and would want to achieve maximum productivity of the improved breed which is largely influenced by the type of feed.

Membership to NGO supported MBGs

Membership to NGO supported MBG is expected to have a positive relationship to adoption of improved feeds. The members learn about the improved technologies from the revolving funds and have a steady supply through the same funds hence their probability of adoption is increased

Farm site

Farm site was measured as a dummy, 1 if the smallholder farm is located in the Northern milk shed area, 0 otherwise. It is expected that differences that exist between the two milk sheds will result in differences in adoption probabilities

Age of Farmer

The role of farmer age in explaining technology adoption is somewhat controversial in the literature. Order people are sometimes thought to be less amenable to change and hence reluctant to change old ways of doing things. In this case we have age having a negative impact on adoption. On the other hand, older people may have accumulated capital, more contacts with extension, better preferred credit institutions, larger family sizes e.t.c all of which may make them more prepared to adopt a technology than younger one (Langyintuo & Mekuria 2005). Despite the type of effect age has on adoption it has proven to be a key determinant of adoption in most studies as such it will be included in this study.

Education attained by farmer

This variable assumed the value the highest grade reached by the farmer. 0 if the farmer did not go to school. In past studies on adoption of farm technologies in Malawi, Kabuli, (2005) education has shown to have a positive relationship with adoption of technology. This has largely been due to the fact that educated (literate) farmers process information and are able to search for appropriate technologies to alleviate their production constraint.

Land size

This will be measured in hectares of land that are owned by a farmer. In technology adoption studies in Malawi (Nakhumwa, 2004, Edriss *et al.* 2003) landholding size was found to have a significant bearing on the farmer's decision to adopt technologies.

Herd size

This is to be measured in number of dairy cattle per farmer. The herd size will determine the benefits in terms of revenue that a farmer generates by adopting improved feeds. Farmers with large herd will benefit more from adopting technologies; as such the herd size is expected to have positive relationship with the adoption.

CHAPTER FOUR:

RESULTS AND DISCUSSIONS

4 SMALLHOLDER DAIRY FARMS CHARACTERISTICS AND PARTICIPATION IN CREDIT IN CENTRAL AND NOTHERN MILKSHED AREAS

Introduction

This chapter gives an account of the dairy farmer and farm characteristics in the central and northern milk shed areas in relation to participation in credit schemes. In addition, factors influencing demand for credit have also been analyzed.

4.1 Farmer Socio Economic Characteristics

Credit market participation would depend on household's personal characteristics such as education attained, age of farmer, household composition, sex of farmer and land holding size. According to Bokosi (2002) these characteristics are important for two reasons: first, they influence the household demand for credit. Secondly assessment of a borrower's credit worthiness is likely to be based on these characteristics.

Table 4-1*:* Age, Education Attained, Household Composition and Land size of the farmers in Central and Northern Milk shed Areas

Variable	Total Sample Mean	Milk shed		Mean Diff	t
		(North)	(Central)		
Age of farmer	44.0	43.1	45.7	-2.6	1.780
Education Attained	6.0	7.1	5.6	1.5	4.124
Household Size	7.0	7.2	6.9	0.3	0.937
Land Size	2.1	1.9	2.2	0.3	1.522

4.2 Participation in credit and age of the farmer

Table 4-1 report that the average age of the sampled farmers was 44, farmers in the Central Milk shed area had a slightly higher average age of 45 than those in the Northern Milk shed area that had an average age of 43. Age is a very important element in credit participation because most credit institutions will lend to the economically active group (Bokosi, undated).

Table 4-2: Age distribution by category of the farmer

	Participant in credit		**Non Participant in credit**		**Total**		**P-value**
Age	***n***	**(%)**	**n**	**(%)**	**n**	**(%)**	
Less 30	24	(15.5)	17	(12.5)	41	(14.1)	0.4637
30 – 39	35	(22.6)	31	(22.7)	66	(22.7)	0.9838
40 – 49	44	(28.4)	44	(32.4)	88	(30.2)	0.4593
50 and above	52	(33.5)	44	(32.4)	96	(33.0)	0.8423
Total	**155**	***(100)***	**136**	***(100)***	**291**	***(100)***	

Pearson Chi-square 0.867 P-Value 0.833

It is hypothesized that age could serve as a proxy to experience, and more experienced farmers would be more likely to borrow to adopt new technologies (Jabbar, *et al,* 2002). In addition, accumulation of assets is known to be positively correlated to age. Accumulation of assets increases the ability to meet collateral demanded by lenders as such it is expected that older farmers are more likely to borrow. However, the results from the sampled farmers show that change in age group did not affect the level of participation in credit (P>0.05). This most likely

because most of the sampled farmers borrowed from informal sources that do not use conventional credit appraisal methods.

The little participation in formal credit is among other factors attributable to the fact that about one-third of the sampled farmers were above the economically active age group of 15 to 49. This most likely had an impact on their ability to participate in formal credit as lenders give preference to those within the economically active age group.

4.3 Participation in credit and Highest Education level of dairy farmer

Most farmers have at least received some form of education. However, 6.8% of the sampled farmers have not gone through any level of the formal education system while the majority of the farmers have at least been to primary school (76.1%), 15.7% and 1.4% of the farmers have been to Secondary and Tertiary respectively. The literacy level of dairy farmers was found to be above national estimates. According to NSO (2004), twenty two percent of rural residents are illiterate while the estimates from this study indicate that only 17% of farmers were illiterate.

Table 4-3: Education level of dairy farmer by category of farmer

	Participants in Credit		**Non Participants in credit**		**Total**		**P-value**
Education	**n**	**(%)**	**n**	**(%)**	**n**	**(%)**	
None	12	(7.8)	8	(5.8)	20	(6.8)	0.4991
Primary	118	(76.6)	105	(75.5)	223	(76.1)	0.8257
Secondary	24	(15.6)	22	(15.8)	46	(15.7)	0.9626
Tertiary	0	(0)	4	(2.9)	4	(1.4)	0.0342
Total	**154**	**(100)**	**139**	**(100)**	**293**	**(100)**	

Pearson Chi-square 4.890 P-Value 0.180

The results in table 4-3 show the absence of correlation between the Education Level and participation in credit. The results tally with Bokosi, (undated) who reported that education showed a positive relationship with credit but the correlation between the two variables was not statistically significant.

4.4 Participation in credit schemes and sex of the dairy farmer

Out of the sampled respondents about 48% were women. This almost equal participation of women in smallholder dairy farming has come about due to emphasis by organisations that introduce dairy heifer schemes to involve women in the beneficiary ranks. An at least 50% participation of women is an eligibility criteria for heifer loan scheme (Land O Lakes, 2005).

In Malawi, female farmers are considered to be less privileged in terms of access to productive resources such as Land, Labour and Credit. Most researchers had shown that female headed households were found to be poorer, coupled with traditional discrimination that women faces as well as, people perhaps prefer not to lend to this particular group of households heads (Edriss and Bokosi 2003).

Table 4-4: Sex of the dairy Farmer by category of farmer

	Participant in credit		**Non Participant in credit**		**Total**		**P value**
Sex	**n**	**(%)**	**n**	**(%)**	**n**	**(%)**	
Male	75	(48.4)	79	(56.4)	154	(52.2)	0.1706
Female	80	(51.6)	61	(43.6)	141	(47.8)	0.1706
Total	**155**	**(100)**	**140**	**(100)**	**295**	**(100)**	
Chi-square 1.906						P-value	0.164

The participation in small scale credit in Malawi is dominated by women this is due to a deliberate effort by credit institutions and government to target women. GoM, (1995) Poverty Alleviation Program (PAP) strategy include promoting increased participation of women and youth in economic, social and political affairs by provision of basic services that enable them to take advantage of opportunities.

The proportion of female farmers participating in credit (56%) was observed to be higher than the proportion of men participating in credit (48%). Edriss & Bokosi, (2003) also reported high participation of women estimated at 53.5% of all borrowers.

4.5 Land Sizes

The smallholders in Malawi are associated with small land size estimated at an average 0.2 hectors. Contrary to the common view, the mean landholding size for the sampled dairy farmers was 4.3 hectors. However, about 80% of the sampled dairy farmers have less than 2 hectors. Although this land is enough for average crop production, it however, limits the ability of farmers to engage in pasture farming which is an essential component of improved management of commercial dairy farms. The average land sizes in the Central and Northern milk shed areas were estimated at 4.0 and 4.5 hectors. A test of equality of the means show that there is no significant difference between the farm sizes in the two milk sheds.

4.6 Credit in smallholder dairy

The analysis in this section includes all loans that were gotten by farmers for use in dairy production except the heifer loan scheme (heifer loan scheme has been described in Chapter 2: literature review). The heifer scheme can be regarded as a grant to the MBG members. In these schemes there is no specific loan value, no repayment period and the repayment is in kind. These schemes are designed to channel aid to poor households as such analysis of farmers' participation and willingness to participate in credit basing on such schemes could be misleading as could not reflect the behaviour of a farmer under normal loan conditions. Over 55% of the sampled farmers indicated that they had gotten credit in the last 12 months for use in the dairy farm. However, only 14% of farmers from MBGs without revolving funds participated in credit as compared to 85% participation in MBGs with revolving funds.

4.6.1 Type of credit sources

Credit is usually categorized into formal and informal credit. In this study, formal credit sources were defined as those sources that fulfilled the following conditions:

- Be a registered and legally recognized lending institution
- Interest on loans should be guided by the base lending rate set by the central bank
- Should be a commercial oriented organisation

Otherwise, it was considered to be an informal source.

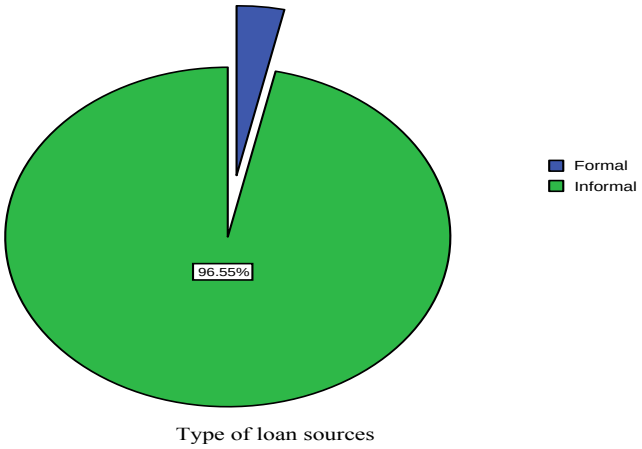


Figure 4-1: Distribution of formal and informal loans among dairy farmers participating in credit

Figure 4.1 indicates that majority of the credit participants (96%) got loans from informal sources this is different from the findings of Diagne & Zeller (2001) that estimated the supply of credit by the informal sector at 59%. This suggests that the smallholder dairy enterprises have poor access to formal credit compared to the smallholder crop enterprises.

Table 4-5: Reasons why farmers that participated in informal credit and not formal

Reason why farmer did not participate in formal credit	Percent
High interest rates	28.0
Cumbersome procedures associated with formal credit	24.7
Unaware of formal credit sources	21.5
Inputs are supplied by informal credit sources	11.8
Insufficient collateral	8.6
Not allowed by MBG	2.2
Applied but not given	3.2
Total	**100**

High interest rates in formal credit

Twenty eight percent of the respondents indicated that they did not borrow from formal sources because of high interest rates. Diagne, (1999) observed that almost all informal loans in Malawi were interest-free loans (98%). In contrast formal loans carried an average annual interest rate of 39%. This interest rate has considerably reduced to 22.5% (RBM, 2007). Despite this reduction in interest rates over the years, farmers still act rationally and borrow without interest from informal sources. The farmers will only consider borrowing from formal sources if the amount they want to borrow cannot be sourced through their informal credit networks.

Cumbersome procedures associated with formal loans

Twenty four percent of the participants in informal credit indicated that they shun formal credit because of the cumbersome procedures that are associated with

formal loans. For instance, the farmers are required to fill paper work, wait for the institution to come for verification of information and then vet the application. This process usually takes more than 10 weeks such that the loan is disbursed late often resulting in loss of business opportunity or ineffective use of the loan due to changes in input prices.

Unaware of formal credit sources for smallholder dairy farmer

Livestock credit schemes have been greatly overshadowed with tobacco credit schemes. All sampled farmers indicated that they are aware of formal credit sources for tobacco but 22% of the participants in informal credit indicated that they do not participate in formal credit because they are unaware of the existence of formal sources for smallholder dairy credit. This underlines the need to promote the existing livestock credit scheme to make farmers aware of the opportunity. For instance, farmers knew that MRFC provides loans for tobacco and other crop enterprises but did not know that MRFC has a specific dairy loan product.

Inputs suppliers are also informal credit sources

Twelve percent of the participants in informal credit indicated that they got informal loans because the loan providers are also input suppliers. The Milk bulking groups were both main sources of inputs and credit for the most smallholder farmers (80%). Since the loans obtained by smallholder dairy farmers are mostly for the purchase of inputs (98%) the farmers found it convenient to get the credit in kind instead of obtaining a loan from a different source and buy inputs from another source.

Insufficient Collateral

Over 8% of participants in informal credit indicated that they lacked sufficient collateral to participate in formal credit. Insufficient collateral has always been a constraint to smallholders' access to formal credit. However, in livestock enterprises this is compounded by the fact that lenders do recognize the herd as collateral.

4.6.2 Credit sources

Table 4-6*:* Percentage distribution of farmers by credit provider

Lending institution	**Frequency**	**Percent**
MBG revolving fund	124	80
MRFC	1	0.7
SSLPP	5	3.2
MARDEF	1	0.7
Friend & Relatives	18	11.6
Commercial Banks	3	1.9
MBG without revolving funds	3	1.9
Total	**155**	**100**

Table 4.7, indicates that the main provider of loans to the smallholder dairy farmers was the revolving fund (80%). This implies that in absence of the revolving funds smallholder dairy credit would almost be nonexistent as it has been the case in MBG without revolving funds.

4.6.3 Loan Value

The value of loans obtained by the sampled dairy farmers ranged from K90 to K130, 000 per annum with a mean of K26, 305.

Table 4-7: Percentage of participants in dairy credit by loan amount

Loan Value in Malawi Kwacha	Percent
Less than 1000	3.7
1000 – 5000	21.5
>5000 – 10000	9.6
>10000 – 15000	8.9
>15000 – 20000	16.3
>20000 – 25000	3.7
>25000 – 30000	5.9
>30000 – 35000	0.7
>35000 – 40000	3.0
>40000 – 45000	5.2
>45000 – 50000	4.4
>50000	17
Total	**100**

Table 4.8 indicates that 35% and 17% of borrowers got a loan not exceeding K10, 000 and above K50, 000 respectively. This result shows that smallholder dairy is capable of supporting loans of over K50, 000.

4.6.4 Loan Usage

All borrowers indicated to have used the loans to purchase inputs (Feed, Semen and Drugs). Only 1.9% reported to have used part of the loan on other farm expenses. This is attributable to the revolving funds that provide in kind credit in smallholder dairy. Once a farmer obtains a loan in kind the probability of using that

loan in the dairy enterprise is high as compared to cash loans that can easily be put to alternative use. Table 4.9 presents a summary of loan usage.

Table 4-8: Loan usage

Loan used to purchase	**Percent (multiple response)**
Drugs	44.9
Molasses	62.9
Dairy Mash	77.7
Semen	57.7
Other expenses	1.9

4.7 Determinants of farmer participation in credit

A logit model was run to establish factors that influence the decision to participate in credit on smallholder dairy farms. The dependent variable (participation in credit) assumed a value of zero for farmers that did not borrow and for those that borrowed it assumed the value of one i.e. Participation in credit {1=Participation, 0=otherwise}.

Table 4-9: Results from logit regression of factors affecting the decision to participate in credit

Variables	Coef.	Std. Err.	z	P>z
Igaincom	-0.398	0.325	-1.220	0.221
DFincom***	0.000	0.000	5.340	0.000
Cfincom**	0.000	0.000	-2.120	0.034
Landsize	0.005	0.044	0.120	0.906
Herdsize***	-0.318	0.053	-5.940	0.000
Milkprice***	0.075	0.023	3.210	0.001
Age	-0.060	0.121	-0.490	0.621
Educlevel	-0.154	0.250	-0.620	0.536
Hholdsize	-0.007	0.201	-0.040	0.971
Sex	-0.032	0.251	-0.130	0.899
Constant	-1.610	1.280	-1.260	0.209
LR chi2(10) = 94.51			Prob > chi2 = 0.0000	
Log likelihood = -202.49116			Pseudo R2 = 0.189	

***significant at 1%, ** significant at 5%, * significant at 10%

The results presented in the Table 4-10 show that the size of herd on the farm, annual dairy farm income, annual crop farm income and milk selling price have influence on the decision to participate in credit on smallholder dairy farms.

Herd Size

As expected the herd size was found to significantly affect the decision to participate in credit however, it exhibits negative relationship as shown by the negative coefficient that is contrary to expectation. This negative relationship can be attributed to the fact that on most farms, large herds are predominantly unimproved breeds that are subjected to inexpensive management systems such as free range. These inexpensive management regimes undermine the need for credit which is to reduce financial constraints faced by farmers. These findings do not tally with Jabbar, *et at.,* 2002 who reported that herd size did not significantly affect the decision to participate in credit in a study conducted in Sub Saharan Africa. This difference can be attributed to the fact that the latter study was not only based on smallholder farmers as is the case with the former. The large farms usually have large numbers of improved breeds such that the effect of inexpensive methods is ruled out.

Milk selling price

Milk price was found to have a significant influence at 1% (P=0.001), indicating that the probability of a farmer borrowing increases with increasing milk selling price. Borrowing involves incurring costs such that farmers will only borrow if the revenue from the dairy enterprises can pay back the loan and interest. The revenue is a function of quantities and price, farmers with a high selling price can easily absorb additional costs in form of loan charges and interest without actually losing the profit margin as a result they are more likely to borrow.

Annual crop farm income

As expected annual crop farm income has shown a negative and significant relationship with the decision to participate in credit on smallholder dairy farms. This entails that increase in the level of crop farm income reduces the probability of a farmer participating in credit schemes. This is because when crop farm income increases a farmer is able to finance dairy expenditure using savings thereby reducing any need for borrowing.

Dairy farm income

The dairy farm income was found to be significant ($P<0.01$) and with a positive influence on the decision to participate in credit. Farmers with high dairy income are compelled to invest in new technologies to sustain or increase that level of income as a result they are more likely to participate in credit to finance their adoption.

Land size

The size of farmland was found to have insignificant influence on the decision to participate in credit. The negative sign entails that as land size increase the probability of a smallholder dairy farmer participating in credit reduces. The results agree with Edris & Bokosi, (2003) who reported a negative relationship between landholding size & credit market participation of a household. This was attributed to the ability of a household to rent out part of its land to generate cash in time of need. However, in this study the result was found to be insignificant at 5%.

Education attained by farmer

Education was found to be positive and statistically insignificant. This meant that the probability of participation is positively dependent on education, implying that

the more education a farmer has attained, the more likely he is to participate in credit. Edriss & Bokosi, (2003) also reported a positive significant relationship between the two variables. The insignificance observed in this study could be due to less involvement of farmers in formal credit where farmers with more education are favoured.

Sex of the farmer

Sex of the farmer was also found to have no significance in the decision to participate in credit. The positive sign indicate that men still have an upper hand in credit than women. However, the insignificant difference in probabilities can be attributed to nongovernmental organisations such as LOL and SSLPP than put emphasis and promoted women participation in credit schemes.

Age of the farmer

Age of the farmer was found to have insignificant influence on the decision to participate in credit. Age of the farmer is instrumental in assessment of credit worthiness in formal credit schemes as lenders prefer giving loans to the economic active group. Since about 90% of the sampled farmers that participated in credit got the loans from informal sources the significance of formal credit worthiness was undermined rendering the variable insignificant.

Farm household size

The farm household size has a negative coefficient entailing that it has a negative influence on the decision to participate in credit schemes. However, the result was found to be insignificant at 10% ($P>0.1$)

Annual income from non farm activities

As expected, the non farm income had a negative coefficient indicating that the probability of participating in credit reduces with increasing non farm income. This is because farmers are able to use this income to finance dairy investment thereby reducing the credit needs. Nevertheless, the result was insignificant at 10% (P>0.1).

CHAPTER 5

5 DETERMINANTS OF ADOPTION AND USE OF IMPROVED TECHNOLOGY IN SMALLHOLDER DAIRY IN MALAWI

Introduction

This chapter highlights the results from analysis of the usage of best bet technologies in smallholder dairy. It also presents the results from a Tobit regression on the factors that affect adoption on improved supplementary feeds.

5.1 Herd size and sources

The herd size in this study referred to the number of cows that are owned by the farmer. On average a farmer had 2 cows. These findings tally with Mgomezulu (2002), where he reports that a typical smallholder farmer owns between 2 to 3 dairy animals. On cow sources, 50.5% purchased locally, 1% imported, 7.4% SSLPP scheme, LOL scheme, 4% inherited, 0.3% MASAF and 6.7% got cows from MDIFA scheme.

5.2 Breeds and Breeding Practices

5.2.1 Breeds of Cows

Table 5-1: Percent distribution of dairy cow breed by milk shed

Breed	Northern milkshed	Central milkshed	Combined
	(%)	*(%)*	*(%)*
Malawi Zebu	3.9	60.5	35.9
Friesian	50.8	44.9	47.5
Holstein	53.1	30.5	40.3
Jersey	31	16.2	19.7

Table 5-2: Breed Level of dairy cows owned by milkshed area

Breed Level	Northern milkshed	Central milkshed	Combined
	(%)	*(%)*	*(%)*
Pure Local	7.6	52.1	32.4
½	32.8	41.8	37.8
¾	26	41.8	20.6
7/8	20.7	0.0	4.7
15/16	6.9	0.0	3
Pure Exotic	48.1	40.6	43.9

It was observed that only 3.9% of the sampled farmers from Northern milk shed had Malawi zebu in the dairy herd as compared to 60.5% observed in the Central milk shed. This is attributable to the heifer scheme that is run by MDIFA in all bulking groups in the Northern milk shed that has assisted farmers in acquiring improved breeds on loan while in the central region heifer schemes for improved breeds are only operational in selected bulking groups that were initiated by projects from LOL or SSLPP. The Operational model of the heifer schemes for LOL, MDIFA and SSLPP have been described under smallholder dairy credit providers section. In addition to these schemes the proximity of the Northern milk shed area to breed improvement farms of Choma and Dwambazi also makes the northern farmers have superior access to improve dairy breeds compared to their central counterparts. Figure 5-1 shows some of the improved breeds kept by the sampled smallholder dairy farmers.

Figure 5-1: Improved Breeds kept by smallholder farmers (Friesian/Holstein crosses)

5.3 Breeding Practices

Table 5-3: The breeding method used by the farmer in each milk shed area

	Northern milkshed		Central milkshed		Total		P value
Method	**n**	**(%)**	**n**	**(%)**	**n**	**(%)**	
AI	98	(74.0)	75	(45.7)	173	(58.6)	0.0062
Bull	4	(3.1)	43	(26.2)	47	(15.9)	0.0000
Both	29	(22.1)	46	(28.1)	75	(25.4)	0.2407
Total	**131**	**(100)**	**164**	**(100)**	**298**	**(100)**	

Chi-square 32.6 P-Value 0.000

About 60% of the sampled farmers use only artificial insemination in breeding. This high usage can be attributed to heifer schemes that are operational in Kawindula, Lusangazi, Kapacha in Northern milk shed and Chitsanzo, and Lumbadzi in central milk shed. The use of AI is a must for beneficiaries of the scheme, heifer scheme beneficiaries can only use bulls upon recommendation by extension workers otherwise they risk losing the cow. However, the response from the farmers show that despite the use of AI being a must they have understood its importance and farmers use it largely for their own interest, the most prominent, being the need for improved breeds and increased milk yield. The farmers cited the following reasons for using artificial insemination:

Table 5-4: Reasons why farmers use artificial insemination

Reason	Percent (Multiple response)
Need for improved breeds	68
Need to increase milk yield	47
Unavailability of bulls	9.7
Encouraged by extension workers	7.3
AI a part of heifer scheme loan terms	6.5
To prevent diseases	6.9

n = 173

5.3.1 Participation in credit and breeding methods used by farmer

Table 5-5: Participation in credit and breeding method

	Participants in credit		Non Participants in credit		Total `		P value
Method	**n**	**(%)**	**n**	**(%)**	**n**	**(%)**	
AI	103	(66.5)	71	(50.7)	174	(59.0)	0.0000
Bull	8	(5.2)	40	(28.6)	48	(16.3)	0.0000
Both	44	(28.4)	29	(20.7)	73	(24.7)	0.1270
Total	**155**	**(100)**	**140**	**(100)**	**295**	**(100)**	
Chi-square 29.300						P – Value	0.000

The results from the table above suggest that there is a strong correlation between the breeding method used and the farmer participation in credit. The most convenient source of semen is usually the MBG this is because it close to the farmer and the ability to get it on credit. The farmers find it easier to pay for semen and the agent services through deductions from sales rather than cash, hence its strong correlation to participation in credit. Noteworthy, is that the proportions for the use of both AI and bulls in breeding in the two categories is not significantly

different ($P>0.05$). This result can be attributed to AI inefficiency resulting from incompetent technicians and low quality semen that force farmers to seek bulls. Since the farmers in the two categories are subjected to same technicians and same type of semen the proportion of AI failure is also the same.

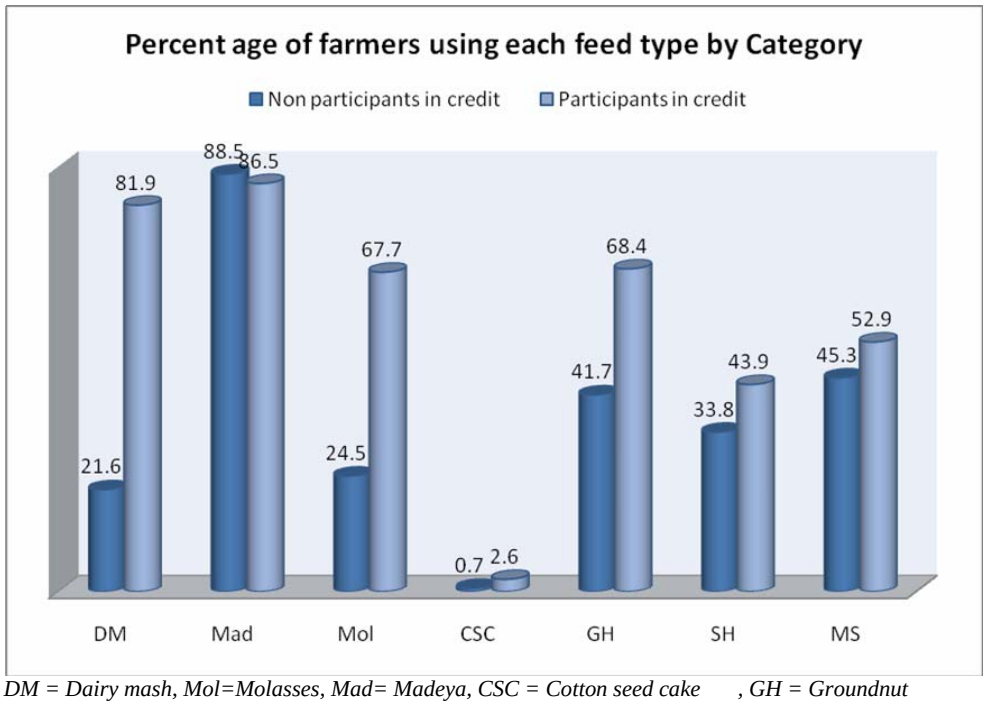
5.4 Feeding Practices

5.4.1 Feeding Regimes

It was observed that 71% of the sampled dairy farmers use zero grazing while 16.8% use free Grazing and 12.1% indicated that they combine the two feeding regimes. Zero grazing is also a condition for heifer scheme loans entailing that over 50% of the sampled farmers must use zero grazing to fulfil loan requirements.

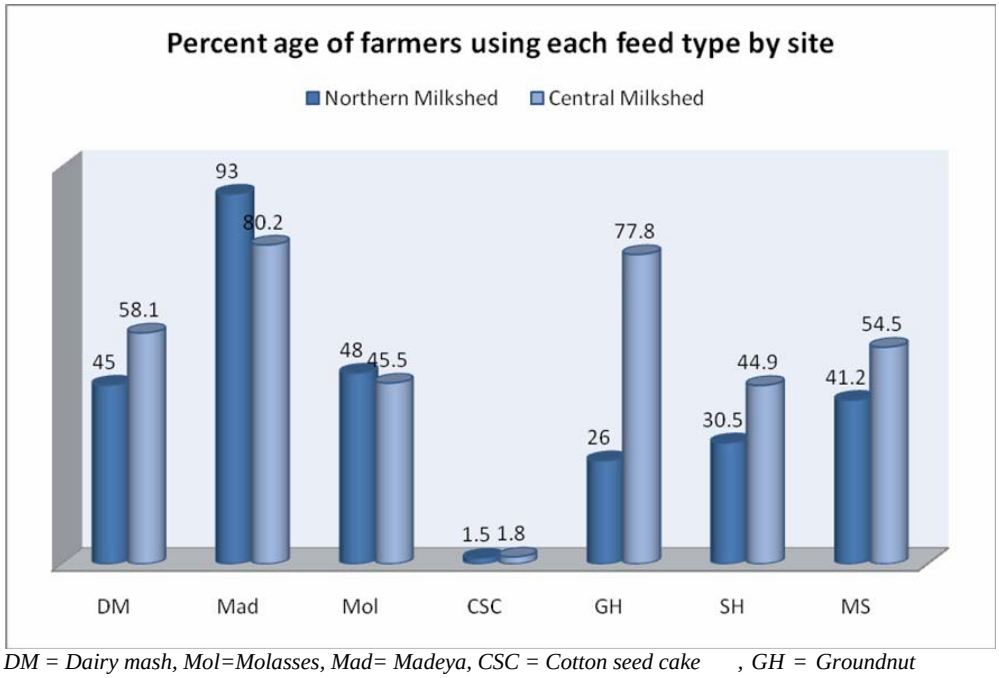
5.4.2 Feed Types

All the farmers indicated that they feed forage to their dairy stock. In addition to forage the following feeds are also given to the dairy herd.



DM = Dairy mash, Mol=Molasses, Mad= Madeya, CSC = Cotton seed cake , GH = Groundnut haulms, SH = Soya haulms, MS = Maize stover

Figure 5-2: Percentage of farmers using a particular feed type by category



DM = Dairy mash, Mol=Molasses, Mad= Madeya, CSC = Cotton seed cake , GH = Groundnut haulms, SH = Soya haulms, MS = Maize stover

Figure 5-3: Percentage of farmers using a particular feed type by category

Figure 5-2 indicate that the majority of the smallholder farmers in both categories still use madeya (maize bran) as a concentrated. This is also the case across milkshed areas where 93% and 80.2% of farmers reported to have been using madeya in the northern and central milkshed areas respectively. This is because madeya is much cheaper compared with other concentrates such as dairy mash. On average, Madeya costs 240 per 50kgs while Dairy Mash costs 1500 per 50kgs.

5.5 Improved Concentrates

Proper feeding is a catalyst to improved performance in dairy farms. Improved concentrates such as Dairy mash (Commercial or Homemade), molasses and seed cakes have been used by the sampled farmers. The majority of the farmers (90%) reported that they learnt about the use of improved concentrates from the bulking groups, the other learning channels indicated were extension agents, friends and relatives and in school. The farmers indicated the following as benefits that were derived from use of improved concentrates.

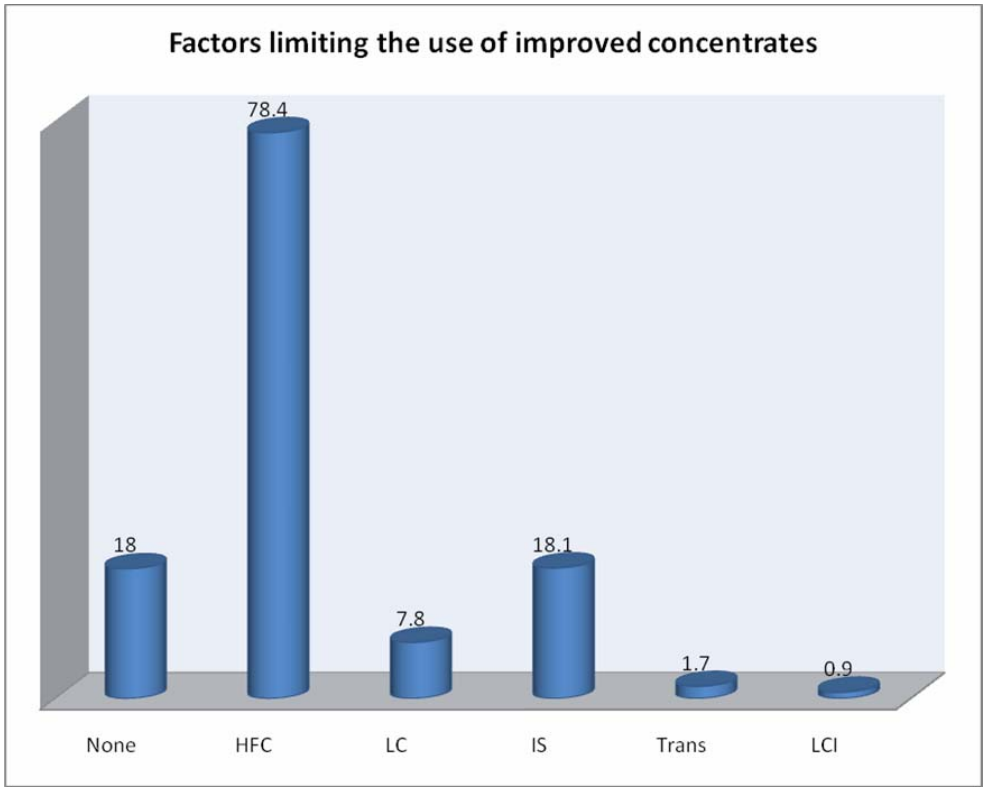
Table 5-6: Benefits from using improved concentrates

Reason	Percentage (Multiple responses)
Increased milk yield	82.5
Good quality milk	29.6
Improved animal health	35.4
No benefit	3.2

The most used concentrate is the dairy mash, reported to be used by over 75% of the respondents. The dairy mash is in two forms, homemade which is a mixture of Madeya (maize bran), Minerals (Mono Calcium Phosphate) and salt. The other is the commercial dairy mash that is manufactured and supplied by proto feeds. The farmers' rated commercial dairy mash as superior to homemade dairy mash in terms of milk yield. This result suggests that the former is more nutritive. Commercial molasses and seed cakes are also used as an energy supplement by 31% and 29.5% respectively.

5.5.1 Constraints to use of Improved Concentrates

High cost and erratic supply are the major factors constraining use of improved concentrates amongst most farmers as depicted in Figure 5.3. However 18 % of the respondents indicated that they do not face constraints in providing concentrates to their herd. This result is encouraging as it shows that projects that have invested effort in increasing smallholder farmer access to improved technologies are yielding positive outcomes.



HFC = High feed cost, LC = Lack of credit, IS = Inconsistent supply, Trans = Transportation problems, LCI = Local calving interval

Figure 5-4: Factors affecting the use of Improved Concentrates

Figure 5-2 shows that high cost of concentrates is a major constraint in usage of improved concentrates while erratic supply of mostly commercial dairy mash and molasses also affect their use. However, 18% of the respondents indicated that they face no constraints in their quest to provide concentrates to their herd.

5.5.2 Participation in credit and use of improved concentrates

Table 5-7: Improved concentrate usage by category of farmer

	Participation in credit		Non participants in credit		Total		P value
Improved concentrates	**n**	**(%)**	**n**	**(%)**	**n**	**(%)**	
Yes	138	(89.0)	38	(27.1)	176	(59.7)	0.0000
No	17	(11.0)	102	(72.9)	119	(40.3)	0.0000
Total	**155**	**(100)**	**140**	**(100)**	**295**	**(100)**	

Chi-square 119.526 P-Value 0.000

Overall about 60% of the sampled farmers used improved concentrates, 89% of the sampled borrowers use improved concentrates as opposed to only 27% of non borrowers. This high usage of improved concentrates in participants is attributable to the feed revolving funds that were instituted to ease access to dairy inputs. The provision of the feeds on loan to farmers has greatly increased the usage of the concentrates by reducing the cash constraints that farmers face.

5.6 Mineral Usage

The provision of minerals to dairy cows is essential; otherwise it can have adverse effects to breeding and milk production. For instance 1.6% of the sampled farmers indicated that their cows suck their own milk. This behaviour can be grossly attributed to shortage of minerals. Forty five percent of the respondents use minerals and the most common form of minerals used was the mineral block that is suspended in the cow houses.

5.6.1 Mineral Usage and Participation in Credit

Table 5-8: Mineral Usage and Participation in Credit

	Participants in credit		**Non Participants in credit**		**Total**		**P value**
Minerals	**n**	**(%)**	**n**	**(%)**	**n**	**(%)**	
Yes	98	(63.2)	34	(24.3)	132	(44.7)	0.0000
No	57	(36.8)	106	(75.7)	163	(55.3)	0.0000
Total	**155**	**(100)**	**140**	**(100)**	**295**	**(100)**	
Chi-Square	45.111					P-Value	0.000

Table 5.8 indicates that majority of the farmers that used minerals also participated in credit. Seventy eight percent of farmers that reported to have used minerals were from bulking groups with revolving funds. This is because of the steady supply of minerals and provision of minerals on loan through the revolving funds hence the strong correlation between participation in credit and mineral usage.

Constraints to mineral usage in smallholder dairy farming

Table 5-9: constraints to usage of minerals

Constraint	**Percent *(Multiple response)***
High cost of minerals	57.5
Inconsistent supply	46.9
Poor quality	3.9
Lack of knowledge	4.3

n = 295

Table 5-9 indicates that the main deterrents to use of minerals in smallholder dairy farming are high cost of minerals (58%) and inconsistent supply of minerals (47%). It is also worth noting that about 5% of sampled households were not aware of mineral provision to dairy cattle. A result which calls for continued extension.

5.7 Animal Health Practices

5.7.1 Vaccination

Table 5-10: Participation in credit and vaccination of dairy herd

	Participants in credit		Non Participants in credit		Total		P value
Vaccine	**n**	**(%)**	**n**	**(%)**	**n**	**(%)**	
Yes	50	(32.3)	64	(45.7)	114	(38.6)	0.0189
No	105	(67.7)	76	(54.3)	181	(61.4)	0.0189
Total	**155**	**(100)**	**140**	**(100)**	**295**	**(100)**	

Chi-Square 5.66 P-Value 0.017

It was also established that only 39% of the sampled dairy producers had their herd vaccinated in the previous twelve months. The majority of them were in Kawindula MBG where there was East Coast Fever and the government initiated a vaccination campaign. The results show that proportion of non-borrowers that vaccinated their herd was higher than that of borrowers ($P<0.05$). This is because the government vaccination campaign targeted MBGs where participation in credit was low. The high proportion of unvaccinated stock (61%) suggests that farmers still do not understand the importance of vaccinating their herd against diseases possibly due to inadequate extension. Munthali, et. al, (un dated) also observed that herd health support services in Malawi are inadequate. Only East Coast Fever receives a great deal of attention while gastro-intestinal parasites and pneumonia that are often more important are usually overlooked.

5.7.2 Dipping

Dipping is a vital component in animal health management. It is carried out to remove ticks and other disease causing parasites. One of the causes of mortality

and morbidity in cattle are tick-borne diseases (DAHI, 1999). The main tick borne diseases are East Coast Fever, Anaplasmosis, Babesiosis and Heart Water. The most cost effective way of controlling these diseases is through tick eradication by dipping livestock (DAHI, 1999). In recent years dipping of livestock has been affected by the non functional dipping facilities, previously managed by the department of animal health and industry (DAHI) and now under community ownership and management since 1993/1994.

Table 5-11: Dipping of dairy cattle by category of farmer

	Participants in credit		**Non Participants in credit**		**Total**		**P value**
Dipping	**n**	**(%)**	**n**	**(%)**	**n**	**(%)**	
Yes	143	(92.3)	101	(72.1)	244	(82.7)	0.0000
No	12	(7.7)	39	(27.9)	51	(17.3)	0.0000
Total	**155**	**(100)**	**140**	**(100)**	**295**	**(100)**	

Chi-Square 22.49 P-Value 0.000

Table 5-10 indicates that the majority of the sampled producers (83%) dipped their herd. In terms of dipping frequency 82% of the producers indicated that they dip their herd once and twice a month in dry and rain season respectively.

5.8 Animal Housing

The traditional cow houses in Malawi are made of a wooden fence with mud floor and are un thatched (Kraal or Khola). These houses are muddy in rainy season and result in high incidences of bacterial infections. The government of Malawi and Non Governmental Organisations have promoted adoption of improved houses which usually has a roof and a brick or stone floor. Figure 5-5 shows an improved khola belonging to a farmer in Chitsanzo milk bulking group.

Figure 5-5: Improved khola in Chitsanzo milk bulking group

Table 5-12: Type of Housing by farmer category

	Participants in credit		Non Participants in credit		Total		P value
Housing	**n**	**(%)**	**n**	**(%)**	**n**	**(%)**	
Improved	147	(94.8)	108	(77.1)	255	(86.4)	0.0000
Traditional	8	(5.2)	106	(22.9)	40	(13.6)	0.0000
Total	**155**	**(100)**	**140**	**(100)**	**295**	**(100)**	

Chi-Square 19.65 P-Value 0.000

Table 5.11 summarises the results on adoption of improved hoses in relation to participation in credit. The results show that there is strong relationship between participation in credit and type of kola owned by the dairy producer at 5% level of significance ($P < 0.05$). Only 14% of the respondents did not have the improved houses (traditional). This high adoption can be linked to the massive promotion of the improved khola by NGOs such as LOL and SSLPP that have set it as one of the conditions for the heifer scheme.

Problems faced in animal housing

Despite the improved Khola being widely used by smallholder dairy farmers, the following animal housing related problems were reported by the sampled farmers.

Table 5-13: Animal housing problems faced by farmers

Problem faced	Percent *(multiple response)*
Leaking roof	27
Expensive raw materials	31.4
Termites	51.0
Muddy floor	10.3

n = 246

Almost all the problems reported by farmers are related to Khola maintenance. This result suggests that there is lack of adequate extension on issues of khola maintenance.

5.9 Record Keeping

Record keeping is one of the elements of good farm management. In this study farmers were asked if they keep records or not. Available records were scrutinised to check for record consistency. In modern dairy farming, successful management relies on good record keeping and on information that can be derived from it (Chagunda, *et.al.*, 2006).

Table 5-14: Record keeping by farmer category

	Participants in credit		**Non Participants in credit**		**Total**		**P value**
Records	**n**	**(%)**	**n**	**(%)**	**n**	**(%)**	
Yes	129	(83.2)	57	(40.7)	186	(63.1)	0.0000
No	26	(16.8)	83	(59.3)	109	(36.9)	0.0000
Total	**155**	**(100)**	**140**	**(100)**	**295**	**(100)**	

Chi-Square 57.06 P-Value 0.000

The results indicate a strong relationship between participation in credit and record keeping. Over 60% of the respondents indicated that they keep records of their financial transactions. However, very few farmers kept records consistently regarding farm expenditures. Income recording is promoted indirectly by the marketing system. Revenue from milk sold through the MBG is collected monthly, as such; farmers are compelled to keep record of daily sales volume in order to verify if the correct value is given at the end of the month.

5.10 Factors affecting adoption of improved technology among smallholder dairy producers in Malawi

5.10.1 Introduction

Inadequate feed and nutrition are major constraints to livestock production in sub-Saharan Africa (Gebremedhin, et.al., 2003). Despite the proven advantage of supplementing with urea/molasses/mineral licks, these supplements are rarely used (Mgomezulu 2002). A three equation simultaneous tobit model was used to assess the factors that influence adoption and extent of use of improved supplementary feeds.

5.10.2 Model Estimation

Table 5-15: Definitions of variables in the model

Independent variables	Description
DNGO	Membership to NGO supported/previously supported MBG, measured as a binary variable: 1 if the farmer is a member , 0 otherwise
HERDSIZE	Number of dairy cattle owned by the farmer
AGE	Age of the dairy farmer, measured in years
AGESQUARE	Age of the farmer, measured as a square of a farmers age
EDUCLEVE	Education level of the farmer, measured as number of schooling years attained
DLOAN	Participation in credit, measured as a dummy variable: 1 if the farmer borrowed , 0 otherwise
LANDSIZE	Size of land owned by the farmer, measured in hectares
DBREEDS	Type of breeds , measured as a dummy variable: 1 if the farmer has improved breeds, 0 otherwise
SEX	Sex of the farmer measured as a dummy variable 1 if the farmer is male, 2 otherwise
PERDFINC	Contribution of dairy farm income to household income expressed as a percentage of the total income

Table -5-16: Results of Tobit regression for the adoption of improved supplements

Variable	Coef.	Std. Err.	z	P>z	6
DBREEDS***	0.4186905	0.0994824	4.210	0.000	
DLOAN***	0.4874306	0.0629104	7.750	0.000	
AGE	0.0127297	0.0080993	-1.570	0.116	
AGESQUARE*	-0.0001454	0.0000879	1.650	0.098	
SEX**	0.0760584	0.0363203	2.090	0.036	
PERDFINC	0.0183132	0.0201458	0.910	0.363	
EDUCLEVEL***	0.0203696	0.0055737	3.650	0.000	
FAMSIZE	0.0065875	0.0050779	1.300	0.195	
CONSTANT**	-0.3939059	0.193158	-2.040	0.041	

*** significant at 1%, ** significant at 5%, significant at 10%
6.1.1

Instrumented: DBreeds Dloan
Instruments: Age Agesquare Sex percnetDFinc Educlevel FAMSIZE DNregion
Dngo

Wald test of exogeneity: chi2(2) = 11.22 Prob > chi2 = 0.0037

Wald chi-square(8) = 176.85 Prob > chi2 = 0.0000

Participation in credit

The coefficient for participation in credit was also positive and highly significant at 1% level. This is due to the easing of resource constraints. These results were consistent with findings by other researchers (Jabbar, *et al.*, 2002 and Zeller, *et al.*, 1997) that reported that credit access/participation had positive influence on the adoption of innovations.

Education level of farmer

Education level of the farmer was also significant at 1%, with a positive coefficient entailing that as the education attained by the farmer increases, the probability of the farmer adopting improved supplements also increases. Educated farmers understand the importance of adopting particular technologies easier than non educated farmers hence the high probability of adoption. Similar results were also reported by other Weir & Knight, 2000 and Kabuli, 2005.

Sex of Farmer

Contrary to usual expectation that male farmers are more likely to adopt technologies than female farmers. The results in this analysis indicate otherwise, Sex of the farmer was found to be positively related to adoption and extent of adoption of improved feeds implying that female farmers are more likely to adopt improved supplementary feeds their male counterparts. This result can be attributed to NGO support in the smallholder dairy sector that emphasizes participation of women and the use of best bet practices as conditions for support.

Type of Breeds

The results in table 5-16 show that the type of breed had a positive and highly significant influence on adoption of improved supplements. Farmers' possession of improved breeds increases probability of farmers adopting improved supplementary feeds. The differences in profitability arising from the differences in milk yield response to recommended feeds between improved and unimproved breeds contribute largely in the decision making process. The low milk yield response of the unimproved breeds create a disincentive to adoption of expensive

improved supplements as these farms may not be able to easily offset their cost in the short term. On the other hand, improved breed's milk yield is very responsive to improved supplementary feed such that farmers are compelled to adopt improved supplements and increase the profit margins. As a result farmers with improved breeds are more likely to adopt improved feeds than those with unimproved breeds

Contribution of dairy farm income to household income

The tobit analysis has shown that there is a relatively higher probability of adoption in farms where dairy income constitute a large proportion of the household income than in farm families where dairy farming is a minor source of income. This result suggests that farmers will prioritise enterprises that are regarded as the major sources of income when investing in new technologies. Nevertheless, the result was insignificant at 5%

Land size

The model results present evidence that the amount of land owned by the farmer is positively related to adoption. Land sizes affect the size of crop enterprises; large land sizes are usually associated with large crop enterprises and high non dairy farm income. The high level of non dairy income makes it easier for farmers with large land size to adopt dairy technology. However the results were insignificant at 5% level.

Age of the farmer

Age of the farmer was found to have a positive coefficient entailing that older farmers are more likely to adopt improved supplements. This is probably because older farmers have accumulated capital that makes them more likely to adopt

technologies than young farmers. However the variable age square was found to be negatively related to adoption of improved feeds entailing that beyond a certain age the probability of adoption will start to decline with age. This variable was, nevertheless, insignificant at 5%.

Herd size

The size of the herd showed a negative relationship with adoption entailing that producers with big farms are less likely to adopt improved supplements. This can be attributed to the fact that large farms were found to be composed of unimproved breeds (Pure Malawi Zebu). It follows, therefore that large herd size farms are less profitable due to poor milk yields associated with local breeds. This variable is not significant in influencing adoption as it is insignificant at 5%.

7 CONCLUSION AND RECOMMENDATIONS

7.1 CONCLUSION

This study was carried out to understand the role of credit in adoption and use of improved dairy technologies in Malawi. Two milk shed areas, Central and Northern milk shed areas were identified for this study and these covered sites where revolving funds are operational.

A three equation simultaneous tobit model was used to determine how credit and other factors influence the adoption and intensity of adoption of improved supplementary feeds among smallholder dairy farmers in Malawi. In addition, the usage of selected best bet technologies was analysed using descriptive statistics. Chi- square tests were also conducted to determine if significant differences exist between borrowers and non borrowers. Descriptive statistics were also computed from household survey data and secondary data to present a picture of livestock service provision in these areas.

After descriptive statistics, logit model was also used to determine the factors that have influence on the smallholder dairy farmer decision to participate in credit/borrow. To substantiate findings of the model descriptive statistics were also used to analyse the credit sources, forms and type of credit and other characteristics of smallholder dairy farmer in Malawi.

Following these analyses, some interesting findings were obtained

Descriptive analyses from household survey and secondary sources reveal that use of improved concentrate such as dairy mash and molasses is still low among the smallholder dairy farmers. Maize bran still remains the major concentrate in smallholder dairy farming. However, high usage of improved concentrates (dairy mash and molasses) has been observed in farmers that participated in credit at 1% level of significance, reported to be used by 82% of the borrowers compared to only 22% of non borrowers.

The use of minerals in smallholder dairy is still far from impressive at less than 50%. However, high usage of minerals has been observed in farmers that borrowed at 1% level of significance, 63%, against only 24% in non borrowers. High feed cost and inconsistent supply of improved concentrates are still major limiting factors in usage of improved feeds most especially in MBGs without feed revolving funds.

Artificial insemination is widely used by smallholder dairy farmers in Malawi (60%). The results show that at 1% level of significance the proportion of borrowers using AI (66%) is significantly higher than the proportion of non borrowers using AI (50%). It was also observed that there is high usage of AI in northern milk shed area as opposed to the central. This is because the farmers in the northern milk shed most especially in non project supported MBGs have superior access to semen compared to farmers in similar situation in the central milk shed area.

Despite animal health being a vital component in dairy cattle management, the reported levels of herd vaccinations were very low at 38%. The proportion of borrowers using vaccines was significantly less than that of non borrowers at 32% and 46% respectively. The observed differences were significant at 5%.

Most farmers (82%) reported to dip their cattle at least once a month despite the closure of formerly government operated dip tanks. The results indicate that a higher proportion of borrowers dip there dairy cattle than the non borrowers at 92% and 72% respectively. The proportions were significantly different at 1%.

The results indicate that most farmers are keeping records (60%). High levels of recording were observed in participants in credit 83% as opposed to 40% in non participants. The proportions were found to be significantly different at 1% However, record keeping was promoted by projects; these projects supplied materials to be used in recording such that recording may fall again after the phase out of the projects.

The form of credit available to the smallholder dairy farmers in Malawi is informal and mostly supplied by revolving funds (80%). The farmer's decision to participate in credit was influenced by feeding annual income from dairy farm, annual income from crop farm, herd size and milk selling of the farmer. High interest rates in formal credit, lack of knowledge on credit sources and cumbersome procedures were the major deterrents to smallholder farmer involvement in formal credit.

A tobit model analysis indicated that at 1% level of significance adoption of improved supplementary feeds by smallholder dairy farmers is positively

influenced by education level of the farmer, types of breeds used by the farmer, sex of farmer and participation in credit scheme.

The results suggest that smallholder dairy farmers in Malawi are profit oriented and will only adopt technologies that enhance the profitability of their farms. Farmers will adopt improved supplementary feeds if the resulting revenue after adoption exceeds the cost of production involved. This agrees with findings by Pagiola, (1993) who indicated that farmers would adopt any technology as long as it is profitable. Nakhumwa (2003) also found that variables that reveal profitability of technology influenced extent of technology adoption.

7.2 Recommendations

The study has come up with useful results from which some policy recommendations have been derived

Participation in credit has shown to influence significantly adoption and intensity of use of technologies. As such the study recommends that more smallholder dairy credit schemes be established to ease cash constraints and improve technology adoption in smallholder dairy farming in Malawi.

The existence of smallholder dairy farmer groups (MBG) reduces the cost of administering credit but also reduce default rate. These groups make deductions from milk sales and remit to the lending institution before the money goes to the farmer. This mode of repayment has effectively reduced default especially if such groupings have been empowered to manage themselves and also decide on composition of their membership. The study therefore recommends that lenders use this mode of repayment to reduce default and high administration costs.

Ownership of high yielding breeds highly influenced the adoption of improved supplementary feeds. Thus farmers are conscious of technology profitability as they decide to adopt. As such the resulting profitability of a particular technology should be adequately assessed and information provided to farmers if high adoption rates of that particular technology are to be achieved.

The mineral usage and herd vaccination was reported at less than 50% a situation that will continue to have negative impact on smallholder dairy productivity as

such the study recommends provision extension, supply of minerals and vaccines and support services to improve productivity.

This study limited its analysis of the role that credit plays in adoption and extent of adoption of improved supplementary feeds. As such further studies examining the influence of credit on adoption of other technologies are recommended to develop a complete understanding of how credit affects adoption of technologies in smallholder dairy farming in Malawi.

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9 APPENDIX

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	
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	

1. FARMER CHARACTERISTICS

1.1 Age	1.2 Educ. Year in School	1.3 Marital Status Code 1	1.4 Family Size	1.5 Sex Cod 2	1.6 Main Occupation Code 3

Code1 1=Single 2=Married 3=Divorced 4=Widowed 5=widower 6=Separated 7=Cohabitation

9.1 **Code 2** *1=Male 2=Female*

Code 3 *1=Agriculture 2=formal employment 3=School going 4=unemployed 5=petty trading 6=ganyu 7=fishing 8=fish-selling 9=charcoal-selling 10= Others (specify*

1.7 Are you involved in other income generating activities other than rearing cattle?

1- Yes
2- No (skip to next section)

1.8 If yes, what do you do?

1- Farming
2- Formally employed
3- Seasonal worker
4- Business/ vending
5- Other (specify)

2. AGRICULTURAL PRODUCTION

2.1 **What is the total land owned by the household?**

|____|____|acres

2.2 **What crops do you grow**?

Crop	Reason
Maize	
Beans (nyemba)	
Soybean (soya)	
Irishpotato (kachewere)	
Groundnuts	
Cassava	
Paprika (tsobola)	
Tobacco	
Sweet potato	
Others (Specify)	

2.3 What type of Livestock do you keep

Type of livestock	Quantity or number
Cattle	
Goats	
Sheep	
Chicken	
Pigs	
Rabbits	
Guinea fowls	

2.4 For what reasons do you keep cattle?

1. Food
2. Cash
3. Food and Cash
4. Dowry
5. Prestige
6. Other Specify _____

2.5 How many dairy cows do you have? |____|____

10 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 5)

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)?

1. dystokia
2. pneumonia
3. stress
4. poor beddings
5. nutrition
6. Other specify _____

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? |____|____|

3.7 What are the problems you face on this farm regarding to calving and calves?

_____
_____
_____
_____
_____
_____
_____

QUESTION 4 **COW INFORMATION ON REPRODUCTIVE AND PRODUCTIVE PERFORMANCE**

4.1 Name of cow or tag no	**4.2** 1. Local 2. Friesian 3. Holstein 4. Jersey	**4.3 Breed level** 1. Pure local 2. ½ 3. 3/4 4.7/8 5. pure exotic	**4.4 Lactating stage** 1. Early 2.middle 3. Late pregnancy	**4.5 Milk production (Litres/day)**	**4.6 Age at first calving**	**4.7 Number of services per conception**	**4.8 Calving interval**	**4.9 Calving ease** 1.ease 2. no ease	**4.10Source** 1. Local Purchase 2. Imported 3. SSLPP 4. heifer scheme 5. inherited 6. Other	**4.11 Cost of cow**

5. **INFORMATION BREEDING (for the past 12 months**

5.1 How do you breed your animals?

1. AI
2. .bulls (**skip to 5.10)**
3. .both AI & bulls

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

a) **Per straw**|____|____||____|____|

b) **Per breeding**|____|____||____|____|

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. Other specify_____

5.4 How do you acquire semen for AI in your MBG?

1. L'O'L
2. World wide sires
3. SSLPP
4. From other sources (specify)_____

5.5 How do access the AI?

1. Cash
2. .Loan

5.6 Indicate whether AI is beneficial or not

1. Beneficial
2. Not beneficial

5.7 If not beneficial, what are the problems?

5.8 Who administers AI

1 Government Extension workers
2 LOL extension workers
3 Farmer AI technician
4 SSLPP extension workers
5 Other specify_____

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?

6.INFORMATION ON DISEASES DISORDERS AND TREATMENTS (for the past 12 months)

6a. What major problems/ causes of the following

a) Diseases	
b) Disorders	

6b. what steps do you take on

a) Diseases	
b) Disorders	

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

6.2 What is the reason for dipping frequently?

1. recommended
2. to prevent disease attack
3. dipping facilities available
4. other specify_____

6.3 Indicate if there is any vaccination that was given to the cows and why

6.4 Did you experience any calving problems in previous years?

1. Yes
2. No

6.5 If yes, **What could be the possible cause of the case?**

1. AI.
2. Feeding (nutritional problems)
3. Natural mating by bulls
4. Diseases
5. Other specify_____

6.6 No of treatments |____|____|

6.7 Total costs |____|____||____|____|

6.8 Major problems on disease disorders and treatments faced

7. INFORMATION ON HOUSING

7.1 What is the roof of your khola

1. iron sheets
2. thatch
3. no roof

7.2 What is the floor for the khola?

1. mud
2. cement
3. bricks

7.3 What is the wall of the khola?

1. Poles
2. Bricks
3. No wall

7.4 What materials are used for beddings?

1. grass
2. no beddings
3. Other materials (specify)_____

7.5 **How often do you clean your khola?**

1. once a day
2. twice a day
3. every time when there is dung

7.6 Appropriate cost of khola?

a) Total cost_____

b) Monthly or annual repairs and maintenance_____

7.7 What are the major problems you faced with housing?

1. Leaking roof
2. Expensive raw materials
3. Other specify_____

8. INFORMATION ON FEEDING (for the past 12 months)

8.1 **Do you provide your animals with concentrate feeds?**

1. yes
2. no (if no skip to 8.9)

8.2 When did you start using the concentrates? |____|____|

8.3 **How did you come to know about supplementary feeding**?

1. Through MBG
2. From MOA extension staff
3. From friends and relatives
4. From radio
5. Other specify_____

8.4 What benefits have you derived from using supplementation?

1. increased milk yield
2. Quality milk
3. Others specify

8.5 What factors do you think affect the number of supplements used by farmers?

1. High cost of feed
2. Inadequate land
3. Labor availability
4. Credit
5. inconsistent supply of supplements
6. other specify_____

8.6 What type of concentrate do you use? (Tick the appropriate ones)

1. dairy mash
2. Madeya plain (home made madeya)
3. commercial molasses
4. Any with cotton seed cake
5. Any without cotton seed cake

8.7 What is the cost of the concentrate mentioned in the above question

Concentrate	**Unit of measure**	**Price (MK)**
molasses		
Commercial dairy mash		
Home made concentrate(madeya)		
Other specify		

8.8 If yes how many kgs do you offer to one lactating cow at one moment? (Specify amount given)_____

8.9 If yes, how do you feed the dairy animals in a day?

1. Once
2. Twice
3. more than twice

8.10If yes how many kgs do you offer to one lactating cow at one moment? (specify amount given)_____

8.11 What feed management system regime do you practice?

1. Zero grazing
2. Free range
3. Zero and free range

8.12 Do you give mineral premixes to your cows?

1. Yes
2. No (**skip to 8.11)**

8.13 If yes, in what type and form?

1. Powder
2. Block

8.14 How many times a day do you milk your cows a day?

1. once
2. twice

8.15 What are major problems with feeding of supplementary feeds?

1. High cost of feed
2. Inadequate land
3. Labor availability
4. Credit
5. Inconsistent supply of supplements
6. Other specify_____

9.0 INFORMATION ON FORAGES

9.1 What type of forages do you frequently use at your farm?

1- Napier
2- .Rhodes
3- Lueceana
4- Other (specify_____
5- None

9.2 What type of forages do you grow?

1- Napier
1. Rhodes
2- Sesbania
3- Desmodium spp
4- Other legumes_____

9.3 How much land has been allocated for pasture (specify the size)_____

9.4 What is the reason for allocating such land to pasture

1. recommended by Land O Lakes
2. personal wish
3. not enough land
4. Other specify_____

9.5What are the major problems with forage feeding

1. inadequate land
2. labour availability
3. inerratic rainfall
4. other specify_____

10.0 INFORMATION ON WATER PROVISION

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

1. tap water
2. bore hole
3. stream
4. river

5. Other specify _____

10.1 What quantities of water do you provide to your cows in a day? (specify amount in litres)_____

10.2 How many times a day do you provide water to your animals in a day? (Specify number of times)_____

10.3 Is this sufficient in your opinion

1. yes
2. no

10.4 What material do you use for watering the animals?

1. bucket
2. cemented water trough
3. Other specify

10.5 What are problems you face with watering your animals?

1. long distance to water source
2. small buckets available
3. no clean water available
4. Other specify _____

11.0 INFORMATION ON MARKETING

11.1 where do you sell your milk?

1. MBG
2. Middle men
3. Within the village
4. Other specify_____

11.2 What is the average price of milk in the following years?

2003_____

2004_____

2005_____

2006_____

11.3 How far are you from the nearest market? (estimate if possible)

11.4 What are the reasons for selling milk at these market

1. better prices
2. L'O'L encourages it
3. Direct cash payment
4. Easy market
5. less stringent on quality
6. other specify_____

11.5 Home consumption (litres per day)_____

11.6 Milk given to calf (litres per day)_____

11.7 Milk sold to MBG (litres per day_____

11.8 Milk wasted (litres per day) _____

11.9 What problems do you face with the marketing of your Milk

1. low milk prices
2. long distance
3. late payments
4. leadership at the MBG
5. non collection of milk
6. Other specify_____

12. ACCESS TO CREDIT

12.1 Did you acquire loan for the use in the dairy enterprise

1. Yes (borrower)
2. No (non borrower) **Skip to 2.6,If no)**

12.2 If yes, what type of loan?

1. heifer scheme
2. cash loan
3. other loans (specify) _____

12.3 For how long have you been using dairy loans?

(in Years)_____

12.4 What prompted you to start using dairy loans?

12.5 What is the source of the dairy loans you obtain?

1. L 'O' L
2. Government
3. SSLPP
4. Other specify_____

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

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

12.7 What about loans for other livestock sectors, do you have access?

(If not skip to 3.0)

1. Yes
2. No

12.8 Can you specify the type of livestock the loan is for

1. goats
2. poultry
3. sheep
4. pigs
5. other specify_____

12.9 What is the source of the loan?

1. Government
2. self help
3. MRFC
4. Friends
5. Other Specify_____

How is the loan mentioned above designed?

13.0 **PROFITABILITY OF DAIRY ENTERPRISES**

13.1 Do you think you attain the maximum profit in dairy?

1=yes, 2=no

13. 2 If no, What factor do you think reduce your profit?

_____

_____

13.3 Do you keep consistent records?
1=yes, 2=no

13.4 If no, why don't you keep records consistently?