

**THE IMPACT OF ANIMAL TRACTION POWER ON AGRICULTURAL
PRODUCTIVITY: CASE OF LOWLANDS OF MOHALE'S HOEK DISTRICT OF
LESOTHO.**

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DECLARATION

I, Lepolesa Rampokanyo hereby declare that the work contained in this thesis is my own and that other author's work referred to here have been acknowledged. I also declare that this thesis is original and has not been submitted elsewhere for a degree.

Dated.....

.....

Rampokanyo Lepolesa Michael

DEDICATION

I dedicate this work to my wife; Liapile Rampokanyo and my parents, Mr. T.K and Mrs. J.M. Rampokanyo. You are the greatest blessing that I would ever forget. I love you so much.

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ABSTRACT

Most farming at subsistence level is located in rural areas where the majority of smallholder farmers have low productivity which results in high rate of food insecurity. The areas are characterised by animal traction and poor farming practises, and monoculture is mostly preferred. In light of this, this study analyzed the impact of animal power on agricultural productivity. Smallholder farmers in the lowlands of Mphahle's Hoek district of Lesotho were investigated by means of a case study methodology. The aim of the study was to inform agricultural policy about the level and key determinants of inefficiency in the smallholder farming system so as to contribute to policy designed to raise productivity of smallholder farmers.

The sampling frame comprised farmers and extension workers in the lowlands of Mphahle's Hoek district. From this frame, 118 farmers and 4 extension workers were randomly selected from four villages, namely Mapotsane, Potsane, Tsoloane and Siloe. The four groups of farmers include; the farmers owning and using cattle for ploughing, farmers owning tractor and cattle and using them for ploughing, farmers owning tractor only and using it for ploughing, and farmers who owned neither cattle nor tractor and normally hire these when ploughing operations are to be done on the farm. The interviews of these farmers and extension workers were conducted by means of semi-structured questionnaire which consisted of both open and close ended questions.

The study used the stochastic frontier production model for the production efficiencies and linear regression model for the impact of animal traction on agricultural productivity. Both procedures provided insights into the relative contributions of animal power and traditional systems to poverty alleviation and food security in the project areas. Descriptive statistics were employed for farming systems and challenges facing small scale farmers. Gross Margins analysis was conducted for the animal power and tractor power yield levels for maize crop to compare the two types of power. Some diagnostic tests to detect serial correlation and heteroskedasticity and t-tests were also performed. The significant variables include the area of sorghum ploughed, members of the household that assist with family labour, education, quantity of fertilizer applied, time taken by the farmers in farming, members who are formally employed, household size, area of land ploughed, old age, costs of tractor and animal, marital status, income, area of maize ploughed, area of sorghum ploughed, quantity of fertilizers applied, costs of seeds and fertilizers applied, maize and sorghum yield and amount sold and consumed. The study revealed that monoculture is mainly practised and many smallholder farmers used traditional technologies that fail to replace nutrients in the soil. Nonetheless family labour was not a problem. During the farming season, tractors were used as the main source of power for ploughing. Most farmers hired these for maize production as it is a staple food crop even where animal power is available. It was noted that the tractors were few and in most cases old and malfunctioning. The cost of using animals in farming obviously played a role in the production of both maize

and sorghum in the lowland areas of Mohale's Hoek district. Smallholder farmers who owned both tractors and animals produced more but they were mainly affected by high costs of maintaining the aging tractors, generally purchased on the used-equipment market. The increased challenges resulted in lower productivity of the smallholder farmers, including: unhealthy animals, drought, marketing problems, late ploughing, poor soils, lack of extension services, low yields, low income, lack of information, lack of appropriate implements, lack of support services, nutrition inadequacy, inappropriate farming systems. The study recommended the adoption and promotion of low-cost mechanization in the lowlands of Mohale's Hoek district so as to increase the production of the smallholder farmers. Increased productivity will in turn improve household food security.

Key words: *Animal traction, productivity, maize, sorghum, lowlands, smallholders.*

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THE LIST OF ABBREVIATIONS AND ACRONYMS

AIDS: Acquired Immune Deficiency Syndrome

ATNESA: Animal Traction Network for Eastern and Southern Africa

BAS: Bureau of Agricultural Statistics

BHS: Basotho Health of Statistics

BOS: Bureau of Statistics

CBL: Central Bank of Lesotho

FAO: FOOD and Agricultural Organization

GDP: Gross Domestic Product

GNP: Gross National Product

HDI: Human Development Index

HIV: Human Immune Deficiency Virus

IFAD: International Fund for Agricultural Development

LDTC: Lesotho Distance Teaching Centre

LMS: Lesotho Meteorology Services

LVAC: Lesotho Vulnerability Assessment Committee

MRCSCO: Market Research Consulting Services Company

MOA: Ministry of Agriculture

MOAFS: Ministry of Agriculture and Food Security

MOE: Ministry of Education

NGOs: Non-Governmental organizations

UN: United Nations

UNDP: United Nations Development Programmes

UNICEF: United Nations Children's Fund

WFP: World Food Programme

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CHAPTER ONE

INTRODUCTION

1.1 Background

Agriculture is the pillar for economic development in the rural areas of the developing countries. Therefore, efforts to achieve rapid growth rates in the sector continue to dominate public policy in these countries. One of the major strategies employed in order to achieve such rapid growth rates and get the sector to deliver expanded outputs is mechanization and improved agricultural extension. But for many of these countries, agricultural mechanization at a scale that will make substantial differences in the performance of the agricultural sector is rather difficult to attain due to the other severe constraints faced by these countries, especially in raising and mobilizing the necessary capital for the required investments. For one thing, limited financial capacity and know-how have often revealed a serious constraint to the widespread adoption of a full scale mechanization technology, hence the popularity of animal power especially in the rural areas of many poor countries where agriculture remains the key economic activity.

Starkey (1998) stated that animal power is an important strategy whose efficiency of use could be improved. The power of animals, machines or human beings is required for urban and rural development. In many countries, Lesotho included, the use of animal power has the most impact to rural people for alleviating poverty because it is the most accessible to the generality of the people. This is particularly true in the difficult circumstances of the arid and semi-arid tropics to which the animal power is well-adapted. According to Starkey *et al* (1995), animal power has expanded quite rapidly in the lowlands of Maseru's district in recent years. This is evidenced by the growth of animal populations in the area and also the higher prices for animals and the use of animals for cultivating their lands.

According to Chisango (2008), animal power refers to the implements and machines utilizing animal muscles as the main power source with a view to reducing the drudgery of farm work. In a study conducted in Lesotho, Kotsokoane (1998) enumerated some of the draught animals used in the lowlands of Maseru's district (one of the ten districts in the country) and these

include; horses, cattle, and donkeys. According to FAO (1996), animals can also be used mainly to assist men, women and children in many ways such as pack transport of numerous items including water, wood, grain, manure, forage, bricks; cart transport for people or larger quantities of goods which cannot be handled by pack methods; soil cultivation and weeding.

In comparison to mechanical systems (tractor), animal power has an advantage to rural families of being available, timely and affordable (Krecek, Starkey & Joubert, 1994). As such, it plays a significant role in the livelihoods of the poorer members of the agricultural communities. This is because many of the farmers live at or near the subsistence level of production. Modern machines in contrast, need available spare parts, skilled labour and good road networks if they are to be kept in good working order. As these conditions are hard to meet in many poor countries, the widespread use of modern machines in farming is not possible. These factors are not always considered by development projects and as a result there are many examples of agricultural machines ending up as scrap metal (Smith, 1981; Abdulsalam, Kudi & Tanimu, 2008).

Mechanical power, particularly tractor power, is used by only a small fraction of the community in rural areas of the district. Most of these tractors are in poor state of repair since they were purchased after they had reached or exceeded their useful economic life (Joubert & Simalanga, 1999). With mechanical systems (tractors), hired labour increased while participation of family labour in crop production declined, Carney (1986) stated that the demand for non-farm labour such as servicing, repair and maintenance increased due to the use of mechanical (tractor) systems. According to Ministry of Agriculture (2010), tractor owners and users derived higher per hectare gross income compared to animal users.

Despite the advantages of animal power over mechanical systems in rural areas, there are some challenges facing the rural sectors, which include the migration of young labour force to South African mines, nutrition inadequacy, lack of human capital and low production (FAO/WFP, 2007). In the case of animal power in particular, the problem often revolves around their poor image as people associate use of animal power with abject poverty and backwardness (Starkey, 1998). According to Kingdom of Lesotho (1991), over 90% of the total agricultural value added

nationally comes from smallholder farmers who own an average of less than 1 ha of land. On the other hand, land pressure is intense in the lowlands of Molepolole district where per capita average land holding size could be as low as 0.1 ha.

Lesotho's agricultural productivity is under threat. According to Lesotho Bureau of Statistics (1996), the country's population is estimated at 1.8 million and this puts enormous pressure on the agricultural sector. According to Tshale (2009), the only possible way to improve agricultural productivity is to enhance efficiency of the smallholder farmers. This is because smallholder farmers constitute the largest group in these areas. Chirwa (2003); Edriss, Tshale & Wobst (2004) added that this kind of efficiency could be achieved at a higher cost. This is due to the fact that most of the farmers are limited by shortage of production inputs and low level of income. In such a situation, low-cost mechanization with the provision of extension would stimulate productivity.

In the past, governments in developing countries have designed various policies with regard to farm power and mechanization and these have been aimed at achieving development. However the success of these policies has been limited in some cases while outright failure has been experienced with other policies. Several factors have been mentioned as sources of failure which include lack of human capital, lack of finance, poor natural resources (O'Driscoll & Hoskins, 2003). Lesotho government has implemented a mechanization policy aimed at achieving development through accessibility and affordability in a sustainable manner with minimal negative impact on the environment (Kingdom of Lesotho, 1991).

Some studies have shown that the use of tractor and animal power led to increase of area to be cultivated due to higher average cropping intensity, larger area and increased productivity of farm labour (Gopinath, 1975). Furthermore, both tractor and animal power increased agricultural productivity and profitability on account of timeliness of operations, better quality of work and more efficient utilization of crop inputs (Starkey & Kroot, 1995). There is therefore a conviction that low-cost mechanization is one sure strategy for increasing productivity among resource-poor households in rural areas. For most resource-poor communities, the low-cost mechanization is

best derived from animal power whose efficiency practices can be transmitted to farmers (Owens *et al.*, 2003). Agricultural extension on the other hand, not only accelerates the diffusion process and the adoption of new varieties but also improves the managerial ability of farmers and affects the efficient utilization of existing technologies by improving farmers' know-how.

1.2 Overview of poverty in Lesotho

Lesotho is regarded as one of the poorest countries in the world. According to the World Bank (1999), the country's real per capita GDP measured in Purchasing Power Parities (PPP) was USD 1,860 in 1997, placing Lesotho among the world's lowest income countries. Moreover, Lesotho ranks 127th out of 174 countries on UNDP's Human Development Index, which includes indicators of education and life expectancy along with the traditional measure of GDP to create a broader measure of a country's development situation (UNDP, 2000).

According to Mphale *et al.*, (2002), poverty is defined and measured in a number of ways. Income unequivocally plays a highly significant part in achieving well-being for individuals. There are other factors that show the extent to which individuals are deprived of access to basic human needs, such as food, shelter, schooling and health services, which should contribute to enhanced well being and poverty reduction. So should factors that describe the 'end' results of the development process, the general capability of individuals to lead long and healthy lives in a manner they have reason to value. Indicators of these human capabilities include life expectancy and literacy rates. In the following sub-sections these factors are examined to provide an overview of the poverty situation in Lesotho.

1.2.1 Levels of income and inequality

A few years ago, there was some discussion on the basis for the measurement of poverty in Lesotho as well as the extent of this scourge in the country. There were different thoughts from different researchers about the issue. According to the Maseru-based Sechaba Consultants (1990), the term "poor" was used to refer to persons with monthly expenditures below M80¹ and it was estimated that a total of 68% of the population fall in this category. Moreover, out of the total number of the poor, more than 70% were defined as destitute with monthly expenditures of

¹ M=Maloti, the national currency of Lesotho which exchanges at 1 to 1 with the South African Rand

M40. However, World Bank (1995) adjusted the Sechaba Consultants findings down to a poverty rate of 49%. It was also concluded that most Basotho are trapped in poverty and that the situation does not seem to improve despite the macro-economic boom that Lesotho has enjoyed since the late 1980's. He further stated that conventional economic growth is not enough to reduce poverty situation in Lesotho. According to Sechaba (1993), poverty is mostly concentrated in rural areas throughout the country.

The most striking feature resulting in poverty in Lesotho is the uneven distribution of income. According to UNDP (1999), about 45% of the total national income accrues to the richest 10% of the population, compared to less than 1% of the national income going to the poorest 10%. When the United Nations Development Programme and the World Bank, in their respective 1999 reports, compared Lesotho with other countries, it noted that there was an unequal income distribution with a higher proportion of national income going to the richest segment of the population. As a result, the bulk of the GNP is likely to benefit the richest members of the society rather than the poor.

1.2.2 Human capabilities and basic needs

According to Bureau of Statistics (1996), life expectancy was estimated at 55 years in 2000, a situation confirmed by UNDP (2000). There was a drop in life expectancy of Lesotho in 2010 to 45 years as a result of an HIV/AIDS pandemic which is devastating the country. The health care delivery system in Lesotho is relatively well developed. The strong focus in providing improved access to health services should be regarded as a key factor in the improvements of the life expectancy of Basotho people. As a result, the infant mortality rate has improved a lot in the past years, in 1985, 85% of children born died before their first birthday while in 1996 the rate had decreased to 55% (Bureau of Statistics 1996).

One of the great works for development in the government education strategy for the country has been the plan for free primary education which took effect from January 2000. According to the Ministry of Education (1999), data stated that 55% of children 6-12 years of age attended the primary school in 1998, compared with 76% in 1990. Moreover, primary school enrolment rates were higher for females.

According to the national literacy survey undertaken by the LTC (2000), about 39% of the populations are illiterate. Illiteracy continued to be higher for men than for women. Furthermore, employment is noticed to be one of the factors contributing to income poverty in Lesotho. According to Sechaba Consultants (1993), 7 out of 10 people were unemployed.

1.2.3 Food insecurity status of households in Lesotho

FAO *et al.*, (2009) indicated that Lesotho continues to face chronic food insecurity. According to FAO (2010), Lesotho is the only country in Southern Africa to harvest less in 2009/10 season than in 2008/09 season. Table 1.1 illustrates the production levels of cereal crops from 2002 to 2007. This also follows from the fact that only about 30 to 40% of national food requirements are met through domestic production. The least harvested cereal crop was the staple crop; maize. On the other hand, Lesotho Vulnerability Assessment Committee (2002) said that about 70600 households in rural areas and peri-urban areas needed food assistance.

Ministry of Agriculture and Food Security (2010) identified a decline of areas planted in 2009/10 season compared to 2008/09. A total of 123,051.4 hectares were planted in 2009/10 season. According to FAO (2010), most of the smallholder farmers still utilize seeds from the previous harvest which affect their production negatively. FAO (2010) further explained that smaller proportion of smallholder farmers (about 22,551) were provided with vouchers amounting to M800.00 per farmer to purchase inputs in 2009 season. A further complication was the observation by FAO/WFP (2007) that the country was also experiencing a decline in livestock quantities in recent years due to theft and long term drought conditions in the past years.

Expectedly, FAO/WFP (2007) found that levels of chronic malnutrition were very high where, at about 45% in the mountainous areas of Lesotho. FAO *et al.*, (2009) further declared that there is need for updated information on 2008/9 season's production and 2009/10 season progress given that the Bureau of Statistics (2009) had reported a delay in publishing the results of the post-harvest crop assessment done late in 2009 to verify the findings of the earlier crop.

Table 1.1: Average yield levels of cereal production (tonnes) from 2002 to 2007

	2002	2003	2004	2005	2006	5years mean	2007	2007 as % of average
1.Butha-Buthe	3.7	2.9	6.2	5.1	10.3	5.6	5.4	96
2.Leribe	31.2	34.3	23.7	23.7	28.6	28.3	11.6	41
3.Berea	23.2	13.3	10.4	10.7	19.5	15.4	10.4	67
4.Maseru	23.3	15.1	17.4	23.7	20.5	20	10.8	54
5.Mafeteng	19.1	16.2	13.1	12.5	17.1	15.6	9.6	61
6.Mohales'Hoek	6.0	14.2	9.6	9.0	5.7	8.9	4.3	48
7.Quthing	2.8	6.2	5.5	4.5	6.0	5.1	3.8	74
8.Qachas'nek	4.5	0.6	1.3	4.1	2.0	2.5	2.6	104
9.Mokhotlong	10.7	6.2	6.5	9.1	4.6	7.4	3.4	46
10.Thaba-tseka	10.1	9.4	10.4	16.5	11.9	11.7	5.6	48
Lesotho	134.6	118.9	104.1	118.9	126.2	120.5	72.4	60

Source: FAO/WFP, 2007

1.3 Statement of the problem

Most of the poorer households are located in rural areas with the majority of household heads being pensioners (Lesotho Bureau of Statistics, 1996). There is high rate of poverty in the lowlands of Mohale'sHoek district, where most of the households lack income and unemployment is rife. These ultra-poor people spend most of their limited income on food. This is because of low production levels from the cultivated fields and the fact that a large number of fields are left idle under prolonged fallow. Bolaji (1989) said that this has also led to an increase in food insecurity in these areas. However, FAO/WFP (2007) stated that the type of farming employed in traditional agriculture is predominantly monoculture. With respect to the dominant technology, there seems to be widespread indigenous preference for animal traction while very few households still utilize tractor power. The adoption of mechanical technology, whether animal or tractorization, seems to be as a result of the fact that most men and youth frequently

migrate from Lesotho to South Africa in search of work in the mines and in other sectors of the economy. This situation presents the households with serious challenges of finding the requisite manpower for tilling the land and expanding cultivated area in order to improve their farm production and productivity. The fact that fuel prices are constantly rising and tractor charges are generally high makes the situation more complicated and seemingly irreversible. Food prices therefore continue to rise unabated.

Animal traction use is not without its problems. At one level, the use of animal traction can be a very slow process such that it takes an awful amount of time to complete even the most basic tasks compared to tractor use. At the same time, the animals are sometimes in poor condition and therefore not able to deliver the right amount of services to the farmer. According to Joubert and Simalanga (1999), most households were no longer able to cultivate their lands using animals because they think they are backward as an increasing number of farmers use tractors for cultivation.

Another dimension to the constraints facing the agricultural sector in Lesotho is that most youth do not see agriculture as a viable career opportunity but still return to the rural areas for food. Thus, while agriculture is estimated to provide employment and is a source of income to as many as 60% of the population, more than 95% of these households cannot produce adequate quantities of food to meet their own requirement. Even for those with enough land, home-grown food often lasts for fewer than five months of the year, even in good years (FAO, 2004).

According to Hayami and Ruttan (2010), an improvement in agriculture comes as a result of technical change which can be endogenous to the system and results from changes in relative prices. Hayami *et al.*, (2010) further declared that one such technical change accessible to rural households is the use of animal traction as the level of farm mechanization that fits the income, knowledge and skill profiles of the poor local people desperately working to enhance their livelihoods and welfare by expanding area under cultivation as a means of improving agricultural production and productivity. While considerable progress has been made in the discipline of agricultural economics to understand the nature of induced innovation and the role of technical change, little is known about how these issues apply to small land locked countries such as

Lesotho. Lesotho is characterised by being land locked, mountainous terrain, with difficulties in accessibility, low or virtually absent manufacturing capacity, limited technical and managerial skills and have scarce foreign exchange reserves. For these reasons, there is urgent need for research into this area. This is more so because, most existing studies have largely focused on the subject of technical change in traditional agriculture in general terms and have hardly examined the impact of specific elements of technical change such as animal traction and tractorization, etc. This study therefore is an attempt to fill this gap.

1.4 The main objective

The main objective of this study is to determine the impact of animal traction on agricultural productivity in the lowlands of Molepolole district of Lesotho. The study specific objectives are to:

- i. determine the relative contributions of animal traction and other farming technologies to poverty alleviation and food security in the project area.
- ii. identify the challenges to and opportunities for widespread use of animal traction in the project area.
- iii. determine the efficiency of animal traction in the farming systems of the Project area.

1.5 The research hypotheses

The study tested the following hypotheses:

- i. Affordable and low-cost farm mechanization in the form of animal traction has no effect on food security and poverty reduction.
- ii. The productivity levels of the smallholder farmers in the project area are not affected by technical and institutional constraints faced by the farmers.
- iii. Access to affordable and low-cost farm mechanization among smallholder farmers has no impact on farm efficiency and agricultural productivity.

Table 1.2 shows the summarized relationships among the research objectives, research questions and hypothesis.

Table 1.2: Relationships among the research objectives, questions, study hypothesis and analytical framework for this study.

Research Objectives	Research Questions	Research Hypothesis	Analytical frame work
1. To determine the relative contributions of animal traction and traditional systems to poverty alleviation and food security in the project area.	What are the relative contributions of animal traction and traditional systems to poverty alleviation and food security in the project areas?	Affordable and low-cost farm mechanization in the form of animal traction has a positive effect on food security and poverty reduction.	Gross margins analysis. Comparisons of group means; simple t-tests.
2. To identify the challenges to and the opportunities for increased use of animal traction in the project area.	What are the challenges to and the opportunities for increased use of animal traction in the project areas?	Wide spread challenges would negatively affect the productivity levels of the smallholder farmers in the project area.	Descriptive statistics.
3. To determine the efficiency of animal traction in the farming systems of the project area.	What are the efficiency effects in the farming systems in the project areas?	Access to affordable and low-cost farm mechanization among smallholder farmers has a positive impact on farm efficiency and agricultural productivity.	Stochastic Frontier production will be used.

4. To make recommendations for policy relevant to affordable, low-cost farm mechanization in Lesotho.			
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Source: Researcher (2010)

1.6 Justification of the study

Agriculture plays an important role in the economy of Lesotho. It provides employment and income to about 95% of the population and contributes about 30% of the GDP nationally (Kingdom of Lesotho, 1991). According to FAO (1996), the smallholder farming sector comprises at least 90% of the population. In Lesotho, the importance of livestock kept by the smallholder community is now being recognized by the Government as a source of draft power for increased cultivated area for crop production. Compared to other countries, animals provide approximately 80% of draught power used for farming in Lesotho (FAO/WFP, 2007). On the other hand, availability of animal and tractor power can allow farmers in the lowlands of Mole's Hoek to increase their efficiency and to reduce drudgery, compared with their alternatives. Animal power is generally more affordable and accessible to the smallholder farmers (FAO, 1996). The research seeks to investigate the use of animal and tractor power on agricultural productivity among farmers. There is a view that animal traction is mostly preferred and tractor power is used by fewer farmers in the lowlands of Mole's Hoek district. The exact patterns of use and the returns to alternative farm power sources have not been evaluated in a systematic manner. Such information is crucial to enable government to more accurately determine the distribution of the population in respect to use of animal traction and its relative popularity and what support is needed for the farmers to optimize their production. The research findings will provide a basis for official policy decision on the rationale for such choices and how the farmers can be supported to improve production and productivity. According to Joubert and Simalanga (1999), the expanded access to land with ownership of both tractor and animal powers with improved access to information would lead to commercialization of farmers. Figure 1.1 shows the use of animal-drawn plough within the farming system of the project area.



Figure 1.1: Animal-drawn plough

Source:Joubert *et al* (2004)

1.7 Delimitations of the study

Although all four agro-ecological zones, namely Mountains, Foothills, Lowlands and Senqu River Valley, are represented in the Mohale's Hoek district, the study was limited to the small scale farmers in the lowland areas of the district of Mohale's Hoek because this is where most of the maize production takes place in the district. The study concentrated mainly in the following villages: 'Mapotsane, Potsane, Siloe and Tsoloane where the small-scale farmers rely on animal and tractor power for cultivation purposes. The study focused on maize and sorghum crops in the farming systems of the project area.

1.8 Thesis outline

The dissertation is composed of six chapters, mostly in the order in which the study was carried out. Chapter 1 which is the introduction is concerned with the assessment of the impact of draught power for agricultural productivity on the small scale farmers. The chapter introduced

the study by stating the problem statement and the main objectives of the study. The hypothesis is also presented. The justification and the delimitations of the study on the impact of draught power for agricultural productivity on the small scale farmers are also discussed.

Chapter 2 is the literature review focusing on the poverty situation in Lesotho, general overview of mechanization, impact of mechanization. Some of the constraints facing mechanization in Lesotho were considered and how these constraints can be addressed in these areas in order to achieve household food security.

Chapter 3 provides the description of the study area. These include the location, climatic weather conditions, vegetation, soils, land tenure and some of the economic activities of the households of the study areas (Potsane, 'Mapotsane, Siloe and Tsoloane) in the lowlands of Mole's Hoek district of Lesotho. The characteristics of these areas give a brief picture of the areas concerning agricultural productivity of both maize and sorghum and type of power used.

Chapter 4 describes the Methodology with a focus on the sampling procedure, data collection procedure and the variables collected. It further describes the method of data analysis while Chapter 5 (Results and Discussions) presents results of the analysis. Separate sections are devoted to the descriptive data analysis and the inferential analysis, including the interpretations of the simple hypothesis testing based on the t-test approach and the linear regression model as well as the Stochastic Frontier Production model which measured production and technical efficiencies.

Chapter 6 presents the summary and conclusions as well as recommendations for policy and further research.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter offers a review of literature which highlights some of the production constraints in small-scale farming in developing countries. The review highlights the specific constraints identified in the literature as contributing to an increase in food insecurity and the general overview of mechanization programmes which the government has implemented in order to improve the food security status of rural households. Particular emphasis is given to communal households. Views of different authors regarding the use of mechanization to improve food security in rural households and the challenges facing the use of mechanization are also presented and discussed. This is followed by a review of studies on the impact of animal traction on households in developing countries, especially in Southern Africa. Questions regarding adoption of improved technology and some of the constraints to adoption are also covered in the review. Finally, the chapter will present a review of the analytical model adopted for the study.

2.2 Production constraints in smallholder agriculture

Smallholder agriculture in developing countries has been shown to face serious institutional and technical constraints (Obi, 2011). According to Zyl and Vink (1988), smallholder farmer is a relative term used for individuals and households who either farm under a traditional communal basis or on relatively small plots of land. Zyl and Vink (1988) further stated that these may also produce for the markets or subsistence and agriculture may make up a major or minor part of overall households livelihood. Zyl and Rooyen (1990) said that most of the smallholder farmers are poorly resourced with little access to capital investment and poor access to services, markets, credit. Zyl and Rooyen (1990) further indicated that food insecurity has increased due to a number of factors such as increase in fuel prices, climatic conditions, income sources, land. This has resulted in continued food deficits. However, Mphale *et al.*, (2002) stated that the low exchange rate of the Loti to Dollar has resulted in price increases of imported food commodities. The crisis is high and also confirmed by the Ministry of Agriculture and Food Security report (2010) that there has been low production of cereal crops in the 2009/10 season. Some of the

constraints that limit production were identified as high fuel prices, climate change, health challenges among resource poor farmers, lack of technical knowledge, low income sources, technology adoption and lack of technical know-how, lack of capital to purchase agricultural inputs, limited access to markets, limited land availability, poor soils, climatic variables, pressures on land. These factors are examined in turn.

2.2.1 The impact of energy prices on food prices

Energy is one of the most important elements in production processes in developing countries (Central Bank of Lesotho, 2005). The overall feature has been characterised by an increase in commodity prices, with food inflation rising faster (Food and Agricultural Organization / World Food Programme, 2007). Since agricultural inputs are products, they are reflected by the rising price of fertilisers and other inputs. However, mechanization is one of the programmes for expanding area to be cultivated for agricultural productivity (FAO, 2008). Therefore, the rising fuel prices impact on productivity as some farmers fail to use the relevant technology which is, in turn, translated into high food prices (CBL, 2005). As a result, production becomes very low as there is less area to be cultivated and sometimes nothing which has been cultivated due to costs as most farmers lack animal power which would be a last resort at the moment (Mbata, 2001). According to FAO/WFP (2007), fuel price increase, influenced the production costs for smallholder farmers and thereby leading to less areas to be cultivated in the following season and increase in the rate of food insecurity and increase in the price of food especially cereal crops.

2.2.2 The impact due to climatic conditions

Climate change has an impact on agriculture and food production in developing countries due to the effects of elevated carbon dioxide in the atmosphere, higher temperatures, transpiration regimes, increased frequency of extreme events (Easterling *et al.*, 2007). However, Rosenzweig *et al.* (2007) concluded that physical and biological systems in the developing countries had been affected by recent climate changes, particularly regional temperature increases. On the other hand, the prolonged drought weather conditions facing developing countries posed a threat to the productivity of cereal crops. According to FAO/WFP (2007), most of the rural households in Southern Africa faced a shortfall of about 42% in cereal production. This led to a large proportion of food to be imported commercially.

In Southern Africa, the livestock numbers have declined due to drought and other adverse weather conditions that were experienced over the past few years (FAO/WFP, 2007). This has increased food insecurity as most farmers lost their livestock which led to decline in the use of animal power and led to an increase in the hiring of tractors for ploughing. According to Mbata (2001), animal power was found to be the cheapest and most affordable source of power for the smallholder farmers in rural areas. This is as most of the farming activities would be utilised very well by farmers without incurring costs. To counter the problems of drought and loss of livestock, Starkey *et al.*, (1995), in a study in the Eastern Cape province, found out that donkeys were identified among other animals to be well suited in the dry conditions.

2.2.3 Health

Some of the health care centres in Southern Africa seemed to play an important role in the lives of the households. Mbata (2001) indicated that the poor development of some of these health care centres lead to low production of food in the developing countries which then lead to increased food insecurity especially in rural areas because more farmers are no longer active in the fields due to poor health. Kingdom of Lesotho (1991) indicated that there were some clinics, hospitals, village health workers and traditional birth attendants that bring services closer to the poor. This also led to some efforts to strengthen partnerships with churches, and the network of traditional healers. According to Basotho Health Statistics (2010), most of the farmers are patients of HIV/AIDS. According to FAO/WFP (2007), most of HIV/AIDS patients are farmers who should be producing both maize and sorghum but are unable to do so due to ill-health. FAO/WFP (2007) was of the view that this situation severely affected production due to the drastic reduction in family labour to assist during farming. The upshot is an increase in dependency rates in the rural areas. According to Ministry of Agriculture and Food Security (2010), most of the smallholder farmers hire tractors for ploughing due to shortage of labour during farming and this resulted in more fields being left idle, leading to high fixed costs of production that worsen the incidence of food insecurity in rural areas.

According to Basotho Health Statistics (2011), life expectancy has declined in the developing countries. This is because of the increasing HIV/AIDS pandemic in the rural areas. According to Joubert *et al.*, (1999) from the study conducted in the Eastern Cape, experience plays an

important role in farming. The reason is that the higher the age of the farmer, the more the experience of the farmer and his/her ability to improve productivity.

2.2.4 Low Income Sources

Low level of income in the developing countries seems to be one of the most serious constraints to agricultural production (Sechaba Consultant, 2002). This is because income level determines the amount of production inputs that would be bought which in turn leads to an improvement of yield. However, FAO/WFP (2007) indicated that the mine retrenchment during the 1990s had an effect on the key sources of income for rural households. This is because mineworkers' remittances translated into food security through agricultural production and purchasing power. A link has been established between the presence of a migrant in the household and not being poor. The effects of food insecurity related to unemployment resulting from retrenchments, was even more serious for households affected by HIV/AIDS. This is because, according to Mphale *et al.*, (2002), this vulnerable group with low income, mainly men, even before the current food crisis where prices for food increased, were reported to have stopped working either because they could not cope with work and decided on their own to stop working or were retrenched because of illness. This affected those employed in the South African mines and locally, particularly in the construction works under the Lesotho Highlands Water Projects (LHWP). Loss of income had already impacted on the living standards of the HIV/AIDS affected households, forcing them to make difficult choices. Food shortages and starvation, lack of clothing, lack of basic groceries such as soap and lack of money to pay for basic services such as grinding maize and sorghum as well as medical fees were some of the daily experiences even before the impending crisis.

According to Mbata (2001), the mine retrenchments raised the popularity of piecework which was given to rural households such as weeding, harvesting to decline, which is usually available during the growing season of the year. This has negatively affected both cash and non-cash income normally accessed by those who do not have fields or cereal food at the cropping time of the year. Mbata (2001) further stated that most farmers while still working in the mines with enough income were able to buy inputs and adopt new technologies for high production of cereal crops but low level of income resulted in low production and most fields are left idle.

2.2.5 Technology adoption and lack of technical know how

Farm inputs are basic and essential to any farm enterprise; without them, no output is possible (FAO, 2008). Consequently, efforts aimed at developing efficient and effective technologies to improve farm productivity have focused on high quality inputs (Ortman, 2000). Ortman (2000) further explained that these efforts have, however, achieved limited success in the case of smallholder farmers, who are often regarded as resistant to change. On the other hand, Francis (1999) stated that smallholder farmers' failure to adopt improved technologies is partly attributed to the inadequacy of support systems, such as extension services, credit, and input supplies.

According to Ozowa (1995), smallholder farmers are unable to access and utilize new agricultural technologies. World Bank (2003) suggested that problems related to access include the collapse of formal transfer structures, which has resulted in poor extension services and no feedback mechanism, poorly designed technology transfer campaigns which do not attract a critical mass of adopters, high cost of science and technology applications, low disposable incomes and inadequate support institutions.

In explaining the adoption problem, Worth (2001) stated that, the adoption problem does not totally lie in dysfunctional extension systems or in the poverty of the people in the region. The problem results from the lack of credit to access new technologies and lack of markets where farmers can sell the produce they get from using the new technologies. Ozowa (1995) further stated that in areas (commercial farms) where new technologies have been diffused, productions is high, whereas in other regions (remote rural areas) where new technology have not yet been adopted, production is low and the majority of farmers still rely on subsistence techniques.

2.2.6 Lack of capital to purchase agricultural inputs

It is widely recognised that lack of access to capital is a key constraint in smallholder farming systems in Southern Africa (Ellis, 2000). Smallholder farmers in the developing countries generally finance their productive efforts in two ways, firstly, with the profits from the previous season's harvest paying for diesel, seeds, labour etc., and secondly, from other sources of income such as sales of livestock, waged work etc. which raise the necessary capital for the inputs

needed for the farming year (Ellis, 2000). In good years this presented no problems for most households. However, Ellis (2000) further stated that when assets became depleted, or could not be mobilised easily, (lack of waged work opportunities, no livestock to sell, no security for loans) households faced extremely tough circumstances and in many cases were unable to cultivate.

Ellis (2000) stated that, farming for most rural households is simply not a viable livelihood option even though some of them have the potential and the zeal to become productive farmers. For these households the key constraints are either lack of finance or the inability to transfer certain assets into productive use. According to Francis (1999), access to credit is viewed as an important way in which farmers can raise the finance necessary for farming, but the challenge arises when loans cannot be repaid because farmers are left unable to farm with large debts.

2.2.7 Lack of access to market

Enhanced access to markets by smallholder farmers would improve the productivity of the farmers and the standard of living of the farmers in rural areas. This is because most of these farmers will be able to export their produce and get income to improve their living (Mphale *et al.*, 2002). According to Moyo (2002), smallholder farmers often face constraints when they want to access markets or when they want to improve their competitiveness in markets. Market access and competitiveness relate to the options farmers have to sell their products and purchase inputs. Smallholder farmers often have low market access as compared to their larger and more capitalized colleagues. Moyo (2002) further stated that, smallholders are disadvantaged due to small size of operations, weak technical capacity, high vulnerability to natural and market risks, and lack of capital. These constraints are being worsened when smallholders are in remote areas. In addition, smallholders have difficulties in complying with the high quality standards that international markets and domestic supermarkets require. Barriers to entry into markets are mostly a result of physical limitations in reaching the market, such as; low quality of roads, to restrictions on international trade, or to minimum product characteristics required. These barriers entail that a certain market does exist, as smallholders are hindered in selling their products on that market.

Poulton *et al.*, (2000) indicated that with the rise in relative number of urban consumers, as well as in the number of supermarkets, barriers to entry are increasing also in domestic markets in developing countries and transition economy markets. Smallholders, because of their low resource endowment, tend to be highly vulnerable to production risks, as well as to marketing risks that may result from price fluctuation or opportunistic buying behaviour. In most developing countries, institutions (e.g. insurance) that can alleviate risks are missing or weakly developed as a result smallholders are exposed to high market risk.

2.2.8 Land availability

Hilly, mountainous, and arable land suitable for crop farming is estimated to have declined as a result of degradation due to erosion and urban encroachment in developing countries (NES, 1999). Kollavali (2002) shown further decline to about 7% of arable land. Mphale *et al.*, (2002) stated that the average area cultivated was estimated to be low and only 11% of households cultivate more than 3ha in the developing countries. These factors combined to limit the resource base for agriculture and livestock thus negatively impacting on food security.

2.2.9 Soils

Due to increasing population in the developing countries, there is a challenge of food security with minimal risks to environment and per capita irrigated land area, severe scarcity of renewable fresh water resources, high risks of soil degradation, resource poor farmers and weak institutional support (Lal, 1995). According to Morapeli (1990), the scarcity of agricultural land is compounded by volcanic soils, which are shallow, friable, poorly structured and highly susceptible to erosion. In particular, soils found in the lowlands along the valley bottoms are often characterised by extensive gully systems, while in the mountains and foothills zones, the topsoil tends to erode more easily than the sub soils. Morapeli (1990) further indicated that most of these soils are mainly found on steep slopes and are vulnerable to erosion and the most visible form of erosion is gully erosion. However, sheet and rill erosions take place throughout the areas and account for the most loss of the soil (38,842,399 tons per year), while the gully erosion accounts only for 730,771 tons a year (Ministry of Natural resources, 2000; Conservation Division, 1988). Ministry of Natural resources (2000) further declared that the excessive removal of indigenous shrubs for fuel wood, medicinal and craft plants have also exacerbated the problem

of soil erosion. This has rendered the communities vulnerable and more dependent on agriculture for their livelihoods. However, most of the rural households are therefore faced with a problem of not only a limited land base but also a fast deteriorating due to soil erosion. Kingdom of Lesotho (1996) stated that soil fertility varies with zones. This is because lowland soils are generally of low fertility since they are poorly structured and have a low organic matter and poor holding capacity. In the foothills soils tend to be more fertile while in the mountains soils are more fertile than elsewhere. Morapeli (1990) said there is also a quantitative evidence of net annual depletion of soil fertility at a rate of 43Kg/ha of nitrogen, 2Kg/ha of phosphates and 46Kg/ha of potassium. Ironically, in the lowlands where most crop farming is mostly practised is where soil fertility is at its lowest. Therefore, the task of trying to produce optimum yields in line with the carrying capacity is a serious challenge.

2.2.10 Climatic variables

Climate change is of concern to agriculture because food production in developing countries varies by several percentage from year to year, largely because of weather conditions (FAO/WFP, 2007). According to FAO (1996), agriculture in Southern Africa is more sensitive to weather. However, Lal (2000) indicated that agricultural sensitivity to weather is the greatest challenge or limitation facing many developing countries, where technological buffers to drought, floods and temperatures (e.g. Irrigation, drainage and greenhouse production) are less advanced. Ultimately, due to lack of such technological defences, most small scale farmers succumb to the dictates of weather conditions resulting in food insecurities. Sometimes in the developing countries, the main physical factors affecting agricultural production such as soils and terrain are less suited to farming (Mokhothu, 2002; Ministry of Natural Resources, 2000).

However, Lesotho Meteorology (2010) stated that rainfall and temperature levels in the developing countries had great impact on crop growth. This because the climate is characterised by unusually high levels of variability and the irony here being that the mountains, which are otherwise unsuitable for crop farming, receive the highest rainfall while the lowlands receive insufficient rain during the growing season. FAO/WFP (2007) revealed that hailstorms and drought are also common and often result in poor crop production and food insecurity. For instance, drought was a major reason for crop failures in most of the developing countries. As a

result the country's state of dependency continues as more aid is sought, in terms of food money and technical assistance to ameliorate the food crisis.

Mokhothu (2002) indicated that the reduced and delayed precipitation will make the rangelands lose its nutritious grass species that are crucial in livestock production, which contributes about 55 to 65 percent of agricultural output and ultimately to food security. According to FAO/WFP (2007), climate also places critical constraints on crop production, especially in the mountain areas since, while the lowlands have about 111 frost risk days, the mountain areas experience about 276 days of frost risk. This renders higher risks to the people in the mountains especially when they grow frost prone crops. Thus, the choice of the crop, the cultivar, the ecological region and the planting date in the light of frost risks become crucial since they determine the potential yield and ultimately food security.

2.2.11 Pressures on land

Population growth has been outpacing food production in the developing countries (Mbata, 2001). According to Mphale *et al.*, (2002), animal pressure on land is high. This is as the density of population has increased from 53 persons per square kilometre in 1986 to 61 in 2000. Therefore, more people increasing, the more animals increase especially in rural areas. According to National Environmental Secretariat (NES) (1999), the people without land have also increased from 13% in 1970 to 55% in 1990. Nearly 60% of the population lives on 17% of the total area. Population pressures, according to Mphale *et al.*, (2002), have resulted in extension of agriculture into less productive marginal areas. For instance, cultivated land has increased from 317,900 ha to 406,500 ha in the past decades. Also, the mountain areas which were earlier used for grazing have been permanently inhabited. In the urban areas on the other hand, the population has more than doubled; however, according to Sechaba *et al.*, (2002), the spread of settlements seemed to be mainly confined to the agricultural areas and hills. The encroachment of settlements onto agricultural areas is a serious problem, which has far reaching implications for agricultural development and food security in the developing countries.

2.3 Overview of the Agricultural Mechanization programme

Mechanization refers to the broad development of agriculture in an area. On one hand, FAO (1997) stated that, farm mechanization involves the use of machines to till the soil and to harvest crops, resulting in an increase in yields. According to Richards (1985), productivity of the small scale farmers could be improved through the use of farm mechanization even though higher costs would be encountered. On the other hand, there is an economic argument that agricultural mechanization enhances agricultural productivity. This is as it increases productivity by increasing labour productivity and decreasing other production costs. According to Starkey *et al.*, (1995), productivity in South Africa increased greatly after the introduction of mechanization. This also resulted in the country exporting some of their produce (Maize and wheat) to other countries.

Nevertheless, some of the smallholder farmers are aware of the importance of farm mechanization in agricultural productivity in their lives but there are major constraints to its use among other things costs, acquiring of equipment and maintenance (Lal, 1995). According to Kingdom of Lesotho (1991), Government of Lesotho introduced this strategy through the country randomly to farmers to engage in productivity even though there was poor turnover due to the fact that the dissemination part of it was not good enough, even though some farmers managed well. The MOA (2010) supported the idea very well as they believed the programme would enhance productivity and rectify the problem of food insecurity.

Gono (2006) indicated that the experience of countries such as Asia and Latin America bear testimony to the huge benefits that can be reaped from farm mechanization.

Mechanization, using animal and tractor power, could significantly increase the productivity of human labour and improve the quality of life for the farmers (FAO, 2008). According to Richards (1985), there are three main power sources involved which are mainly human, animal and tractor from which manufacturing, distribution, repair, maintenance, and utilization of agricultural tools, implements and machinery are important part of mechanization.

The level, appropriate choice and subsequent proper use of mechanized inputs in agriculture have direct effects on achievable levels of agricultural production, the profitability of farming and the environment (Ruthenberg, 1985). Generally, in situations where agricultural land is not limiting like in Lesotho, the application of advanced tools and machines alone does not lead to increased yields (Moyo, 2003). However, FAO (1996) stated that productivity is only obtained when other inputs such as improved seeds, fertilizers and pesticides are made available at the right time. According to FAO (2000), if land is not a constraint, improved farm power could lead to increase in production by expanding the area to be cultivated.

In the past, agricultural mechanization in developing countries has been much criticized because it has failed to be effective, and was blamed for exacerbating rural unemployment and causing other adverse social effects (Rijk, 1999). This was largely the result from experiences during the 1960s until the early 1980s when large quantities of tractors were supplied to developing countries either as donations, or on very advantageous loan terms. In particular projects which were designed to provide tractor services through government agencies have had a miserable record (Malik, 1998). These projects proved not to be sustainable because of the intrinsic inefficiencies of government-run programmes. An overvalued foreign exchange rate and low real interest rates made agricultural machinery artificially cheap compared to labour and draft animals (Ruthenberg, 1985).

Mechanization has often become a burden to national budgets and the farming community rather than being a productive input (Moyo, 2003). This has especially been the case in centrally planned economies, where mechanization was heavily subsidized through the provision of government planned and operated machinery services (Miller *et al.*, 1994). Similar models of government supported mechanization have been tried in many developing countries and have in every case failed (FAO, 2000). The development of "appropriate" tools and equipment has also been a favourite subject for development strategies (Moyo, 2003). However, the major weakness of the projects was that they took place in isolation of research departments and other stakeholders (FAO, 2000). Like in Lesotho, the mechanization programme was a mandate of the central bank, which is a state institution. Further examples of misapplied mechanization programmes can be found in many technical co-operation projects, which were mostly planned

and implemented in an uncoordinated way (Squires, 1991). It is unfortunate that few mechanization projects have been successful (Moyo, 2003).

These experiences often combined with a very narrow perception and lack of knowledge about mechanization, namely the one sided promotion of tractors and other capital-intensive mechanical power technology, has caused the aid community to largely turn its back on mechanization (Widowson, 1987). At the same time, there are many examples where mechanization has been very successful, contributing to increased food production, productivity and advancement of rural economies. Examples being, privately owned mechanization in South Asia, single-axle tractors in Thailand, and various forms of farm mechanization in many parts of China (Scherr & Yadav, 1995).

It has been established that appropriate choice and proper use of mechanized inputs in agriculture have a significant effect on agricultural production and productivity, the profitability of farming, and on the environment (Lal, 1995). In most cases, the mere application of advanced tools, draft animals or machines does not by itself lead to increased yields, but is usually applied to reduce cost of production and to counteract labour shortfalls (Jafry, 2000). However, the benefits achievable by using advanced and improved inputs such as irrigation, better seed, fertilizer and pesticides cannot be fully realized without an increased application of farm mechanization (Richards, 1985). In situations where land is not a constraint and expansion of cultivated area is feasible, increases in farm power input have led to direct increase in production by simply increasing the land area or the number of animals that one person can handle (Chatizwa & Jones, 1997).

2.4 General impact of animal power on household

The section describes some of the impacts of animal traction on households, and these include; food security, economic impact, economic impact, social impact, impact on farming systems, impact on different ages and gender.

2.4.1 Impact on food security

According to Smith (1981) (quoted in Maxwell, 1996), there are many definitions of food security. Since the world food conference of 1974, definitions evolved from viewpoints ranging

from emphasis on national food security to an increase in supply to those calling for improved access to food (FAO, 1983). Definitions underwent another round of evolution after the 1996 world food summit, when the definition was broadly set as achieving food security “at the individual, household, national levels when all people, at all times, have physical and economic access to sufficient, safe and nutritious food preferences for an active and healthy life”(FAO, 1996).

According to FAO (1999), employment in off-farm and non-farm activities are significant as sources of farm households’ livelihoods which then enables households to modernize their production by giving them an opportunity to apply the necessary inputs, and reduce the risk of food shortage during periods of unexpected crop failures through food purchases.

A household’s wealth status forms the other important source of livelihood for farming households. According to Kang’ara *et al.*, (2001), livestock contributes to households’ economy in different ways. This may be as a source of supplementary food, means of transport, security, and means of coping during crop failures. The major products of livestock include draught power, meat, milk, eggs, manure which is used as fertilizer or fuel, feathers, fibres, hides, and horns. In addition to these products, livestock serve as an asset and may provide a reserve that can be converted to cash in times of need. A study by Kassa *et al.*, (2002) found out that households who own livestock have good food security status as well as sustainable farming.

However, Hofferth (2003) reported that subsistence farming is generally characterized by greater reliance on labour than commercial agriculture while also he declared that households with larger labour supplies are better positioned to increase the productivity of their land. This is as a result that availability of a relatively larger labour force, regardless of farm size, can be an advantage to those households who strive to achieve food security, provided that excess labour force is engaged in other income generating activities. A similar study by Juggins (1986); and Chen (1991) reported that labour availability is an important determinant of household productivity and food security.

Hofferth (2003) further argued that the higher the age of the household head, the more stable the economy of farm household. This is because older people have also relatively richer experience

of the social and physical environments as well as greater experience of farming activities. Moreover, older household heads are expected to have better access to land than younger heads, because younger men either have to wait for a land distribution, or have to share land with their families.

According to Starkey *et al.*, (1995), animal power may still work interchangeably with the use of a tractor. This is because animal power could be efficient and cost-effective for weeding, ploughing and on-farm transport where fields are small and remote. Nonetheless animal traction should be seriously considered as an option in all new agricultural development initiatives (such as new irrigation schemes).

Animals can still assist greatly by relieving humans of the burden of water transport by hand, head or wheelbarrow. According to Starkey *et al.*, (1995), animal power would still be of great significance. This is as numerous distribution systems would take some time to be installed in rural areas.

2.4.2 Economic Impact

Smallholder farmers obtain most of their income from their farming activities to meet their subsistence needs from which mechanization plays a significant role. This is because many of the rural households survive on land which is less than 3ha utmost (FAO, 1996). However remittances, pensions and other non-agricultural income have become very important to smallholder farmers. According to Kingdom of Lesotho (1991), children were responsible for looking after animals, but since the introduction of free primary education, there is more labour-intensive farming practices. According to Starkey *et al.*, (1995), there seemed to be many female-managed households. This is as men undertook work with draft animals and left old man and women for whom the inspanning would be difficult.

However, Starkey *et al.*, (1999) declared that draft animal power still involves large expenditure and high risk especially to smallholder farmers. This results from the fact that there is no clear credit policy established by the Government to enable smallholder farmers to get credit for animal traction.

In contrast, Starkey *et al.*, (1995) confirmed that tractors are expensive, extremely effective and economically viable in farms in excess of 100ha. Therefore most of the smallholder farms are less than 2ha which is well below the size at which tractor ownership could be economically justified. Starkey (1994) argued that tractors could be used for investment of non-agricultural income by business people. Tractors could also remain popular with planners, politicians, donors, and end-users but they provide short-term benefits to the smallholders.

Bartholomew *et al.*, (1994) and Fall *et al.*, (1977) emphasized a lack of necessity for dry season supplementary feeding when animals were to be used for a short period each year and suggested that supplementation should only be considered when the working period exceeds six weeks. If work is performed over longer periods, such as if animals are used for transport as well as cropping, and then supplementation can be beneficial as to maintain the live weight of the animal.

Donkey transport provided a source of income and employment to the local people. FAO (1996) supported that donkey operator could earn as much per day on trips by carrying some produce from the fields or some luggage from town or carry wood for other people from the forest.

Most of the tractors seemed to be contributing to scrap metal. According to Kilemwa (1993), about 67 are working tractors out of 152 available. This is because many of farmers have not benefited from their use in Tanzania. Their owners hire tractors out of cash. Where the tractor is working, it is used for the first ploughing while planting is done without the second ploughing. This is because of costs encountered. The area cultivated is in some cases expanded, though not necessarily so because the area correlates directly with the farmer's financial resources. Yield per unit area is mostly low as ploughing is done unsatisfactorily and weeds intensity and growth is accelerated on the field which is not harrowed. Delays in planting normally occur as farmers keep waiting to hire tractors as the season progresses.

2.4.3 Environmental Impact

Animal power is a renewable energy source that can be sustained in rural areas. However, its use in mixed farming systems encourages crop-livestock integration and sustainable farming practices (Simalanga *et al.*, 2004). According to FAO (1996), animals do not only produce

organic manure, they also provide transport for manure to the fields. FAO (1996) further stated that animal power can be used for a wide range of land management and erosion control systems in such a way that animal-drawn levellers can assist with water harvesting or the construction of water ponds while in hilly areas, animals could assist with contour ploughing and terracing. Live mulch using multipurpose green plants or leguminous shrubs provides animal feeds.

In drought-affected areas, overgrazing may become a problem, particularly around water points, but farmers can make increased use of donkeys, which survive drought better than cattle. This situation can also be remedied by the greater use of reproductive animals as this will allow farmers to obtain essential work from diminishing herds (Joubert, 1999).

According to Starkey (1994), pressure on land is making hillside agriculture more widespread with short fallow periods and increased deforestation. The risks of erosion are very serious. Animal traction can be used in hillside agriculture, provided there are appropriate conservation measures and appropriate implements.

Nengomasha *et al.*, (1999) declared that animals are regarded as an environmental hazard in some urban areas and this issue caused a conflict between local authorities and animal users. This is as a result that in Addis Ababa on a market day, some donkeys were reported of environmental pollution, despite the fact that the manure was collected and sold as fuel.

There is high rate of erosion in African countries. There is a higher loss of multitudes of soil which results in a decline in soil fertility; this exposes the soil to rain and wind. Chuma (1993) argued that minimal soil disturbance as by use of animal power combined with improved soil fertility and ground cover could contribute to improved erosion resistance.

Furthermore, Starkey *et al.*, (1995) stated that some agricultural authorities in South Africa claimed that animal traction should be discouraged due to pasture degradation and limited carrying capacity. Donkeys, in particular, have been blamed for overgrazing and environmental damage. According to the study, there was no clear evidence as to whether support or reject such contentions. Simalanga *et al.*, (2004) added that animal-drawn sledges have also been banned because of causing erosion.

2.4.4 Social impact

Mechanical power could be seen to reduce drudgery and increase speed of operations for both men and women. This is mainly noticed as animals enhance rural mobility and improve local marketing systems. Naturally motorized systems of tillage and transport can provide even more drudgery reduction. However, compared with these, animal power has the advantage to rural families of being available, timely and affordable. On the other hand, oxen have been the major draft animal, fulfilling diverse social and economic functions (Starkey *et al.*, 1995). However, FAO (1996) stated that cattle are mostly considered within the male domain, and in spanning of oxen have usually been performed by men and boys. Within traditional societies, horses also tend to be male-domain animals, but donkeys are much more gender-neutral.

According to Kilemwa (1993), animal or mechanical power is an essential component for all production processes in agriculture. This is as mechanization plays a large role in ensuring land and labour productivity. Yield is increased by expanding the area under cultivation and if treated separately from other production techniques such as fertilizing, could well increase yield per unit area by improving the quality of tillage. Starkey *et al.*, (1999) declared that the potential contribution of draft animal power to agricultural development cannot be over-emphasized. This is because most farmers are now aware of how draft animals can reduce their workloads and increase land productivity, whilst raising income, social status and prestige among themselves.

From a study conducted in Rukwa in Tanzania, Kilemwa (1993) stated that many farmers who do not own animals for ploughing would prefer to own them as they believe their neighbours' who own them, harvest more and have higher standard of living which is the prevailing situation in Lesotho. From this observation, it is safe to assume that the process of adoption of animal traction has been farmers' involvement first being induced by extension agents and projects.

2.4.5 Impact on farming systems

Animal traction is associated with the tendency to move from bush-fallow cultivation to permanent systems in which single crops are grown in cleared fields. This has been noted that animal traction can lead to intensification with larger farm areas (FAO, 1996). Farmers may well put an emphasis on those crops likely to yield cash revenues.

One of the more notable ways animal traction affects farming systems is through the integration of crop and livestock enterprises. According to FAO/WFP (2007), traditional separation of livestock rearing and crop production found in some African countries can become environmentally unsound as population and land pressures increase. According to FAO (1996), animal traction allows nutrients to be recycled and soil fertility to be maintained through the use of animal dung, green manure and composting techniques. It is also claimed that, farmers learn important animal husbandry techniques when they start working closely with draft animals. It may well be that the attitudes and skills learned in this way may be applied to other livestock enterprises, with benefits for the animals, farmers and rural economy.

2.4.6 Impact on different ages and genders

The social costs and benefits of animal traction vary considerably between people of different ages and genders in farm households. According to Joubert *et al.*, (2004), men and children usually train animals, work with them and herd them. This will later lead to easier work and area expansion. However, FAO (1996) stated that men are considered appropriate to cultivate land while women and children often have the task of weeding and harvesting. Allagnat and Koroma (1984) argued that children often look after animals leading to limited attendance at school. This might have a negative impact on those children. In Sierra Leone, it was noticed that children of owners of draft animals were not attending school. This is in spite of that draft owners might be wealthy to pay the fees.

In West Africa, most of the direct economic costs and benefits of animal traction are controlled by males. There are certainly examples of women owning draft animals and being given credit through banks or projects (Starkey *et al.*, 1988). When women have access to the use of draft animals it is often through informal exchange or hire arrangements.

However women access to animal draft power often results in less respect to men especially if women could have access to credits. On the other hand, adoption of animal traction tends to improve income differences between farmers in the villages. However the benefits are often shared through hire or loan arrangements depending on village relationships (Starkey *et al.*, 1998). According to Mbata (2001), the hiring-in farmers are unlikely to benefit from the draft

animals at the optimal time but then they do not have to bear the management costs and risks of owning the animals.

In some parts of West Africa, animal traction has been introduced through communal ownership, often encouraged by governments or aid agencies (Starkey *et al.*, 1988). While there have been examples of successful village associations for animal traction, many have experienced major social and organizational problems associated with conflicting interests for access during the crucial working hours and responsibility for maintaining the animals at other times (Kanu, 1988). With individual ownership, it is clear who is responsible for both the costs and the benefits of animal management. One of the costs is grazing supervision, and if this is not carried out with dedication the animal may suffer from insufficient food, accident or theft: alternatively growing crops can be eaten, causing much social conflict and expense. In one survey in Sierra Leone a quarter of farmers reported that they had to pay out significant sums in compensation as a result of the alleged misbehaviour of their work oxen (Corbel, 1988).

2.5 Mechanization as a Productivity Enhancing Technology.

Farm power is essential farm input. In Lesotho mechanization as an agricultural input proved that its operational costs exceeds the cost of other agricultural inputs (World vision, 2008). In many developing countries, agricultural production and food security are adversely affected because of insufficient use of farm power, low labour productivity. The need to improve agricultural labour productivity is therefore increasingly being recognized (Hassan, 2008).

The term mechanization is unfortunately often very narrowly perceived while its real purpose, namely, enhancing productivity of land and labour is often not well understood. According to FAO (2008), agricultural mechanization would be appropriate to termed Farm Power or Labour Productivity Enhancing Technology, to recognize not only the importance of manual labour and hand tools, draft animals, and mechanical power, but also other issues related to labour scarcity. However, as Lal (1995) stated, finding solutions to environmental problems in agriculture requires improved agricultural tools and machinery. Similarly, machines are required to assist with post-harvest loss reduction and on-farm processing. Thus it is now recognized that agricultural mechanization is crucial in the fight against hunger and poverty, and at the same time to address environmental and health concerns (Richards, 1985).

According to Viegas (1991), three principal purposes of mechanization are summarized as increase in labour productivity that is the introduction of machinery to substitute for labour is a common phenomenon associated with the release of labour for employment in other sectors of the economy. This facilitates cultivation of larger areas with the same labour force (Humphreys *et al.*, 1996). On increasing land productivity the purpose of mechanization is to produce more from the existing land. Machinery is therefore a complementary input, required to achieve higher land productivity. The introduction of irrigation equipment and planting machines has been used to achieve higher cropping intensities and better yields (Ruthenberg, 1985). Decreasing the cost of production, Humphreys (1996) cited that, a combination of the three objectives will be achieved and additional benefits to the user may be associated with a reduction in the drudgery of farm work and risk. These are subjective benefits and difficult to translate into cash. However Squires (1991) argues that frequently, mechanization increases an individual's workload, can be hazardous to health and may reduce the social interactions usually associated with farm work.

2.5.1 Mechanization for Reduction of Poverty and Land degradation

Smaller portion of land under cultivation is irrigated, hence, most of the land is rain fed. According to FAO/WFP (2007), the land use data for the last decade showed that total area under cultivation remained static. On the other hand, government emphasis is on bringing additional land under cultivation to increase production. This intensified pressure on existing resources and if measures are not taken resettlement areas are going to be subjected to massive land degradation. Mechanization is therefore, taken as a way of controlling land degradation as it is used in land designing and conservation works. The inter linkages of mechanization and other biophysical factors to control land degradation and poverty in developing nations are shown in figure 2.1

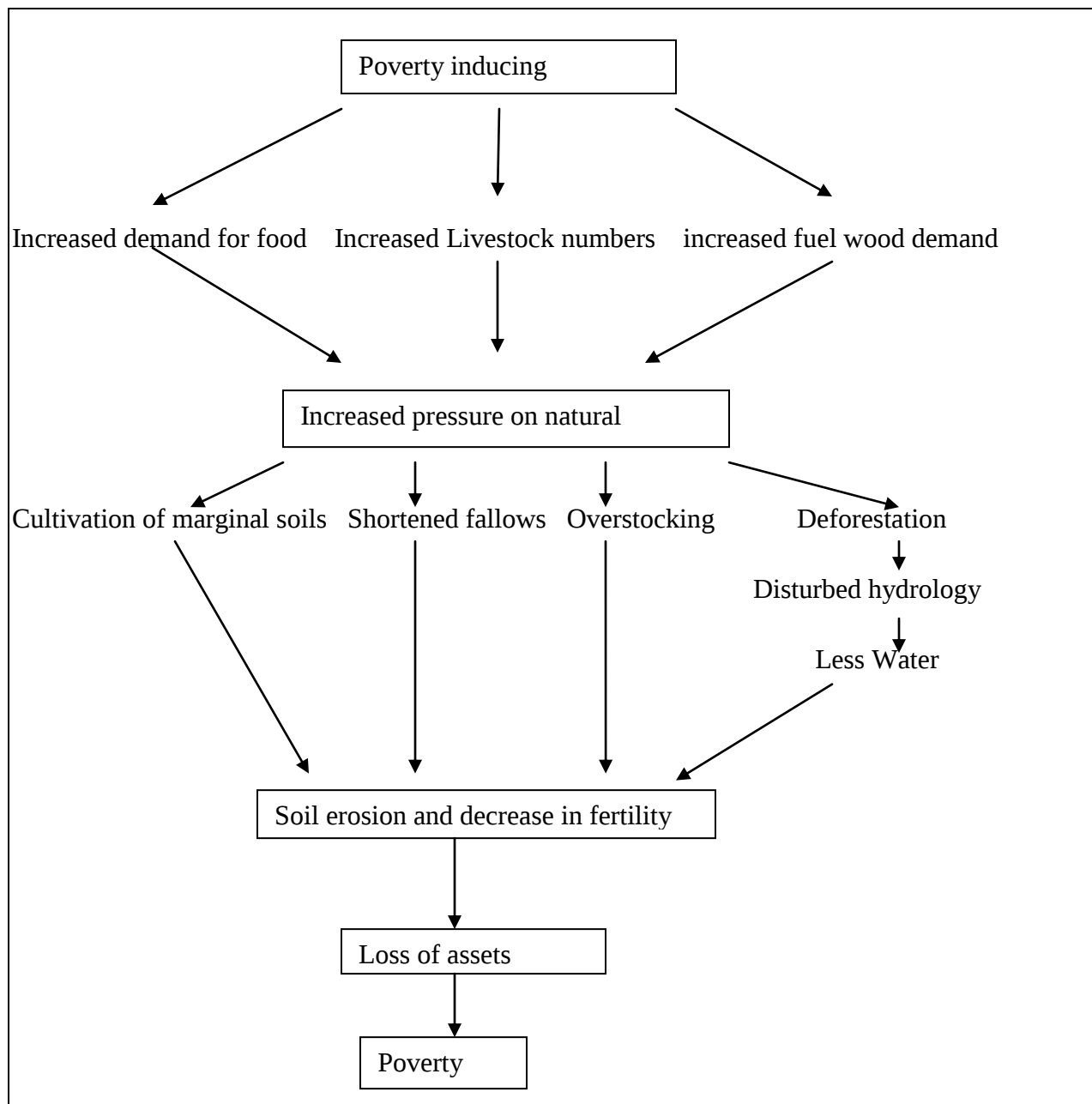


Figure 2.1: The biophysical consequences of mechanization on poverty processes
Source: Templeton & Scherr, (1996)

When rural households are faced with declining productivity as a result of land degradation rendering usage of machinery difficult, they either look to the improved or extended use of land, or embark on alternative livelihood strategies (Scherr & Yadav, 1995). Decisions will depend on perceptions of risk and the potential returns, as well as local tradition and culture. In examining the resources of rural households in sub-Saharan Africa, the predominant source of farm power

is labour, with better-resourced farmers using draught animal power and only the commercially oriented farmers using machinery (Twomlow *et al.*, 1999). In cases where labour is used to substitute machinery, particular attention must be paid to women and children who, in most smallholder farming systems, devote many more hours on agricultural production (Rijk, 1999). Households can as well invest in short-term yield enhancing or longer-term soil conserving technologies (Malik, 1998). Soil conservation technologies are inherently different from other crop improvement technologies such as fertilizers, pesticides and seeds.

2.5.2 Impact of mechanization on conditions of farm workers

Work conditions in developing countries for agricultural workers are not conducive to good health and proper living as labour substitute's machinery. Workers are frequently in contact with dangerous chemicals and the environment under which they work is not friendly. With appropriate mechanization drudgery of farm workers is mitigated. From a safety point of view technical departments have been developing technologies for safe working conditions at work place particularly while using agro-machinery and agro chemicals (Owen *et al.*, 2003). Governments in most African states have enacted safety laws like the Dangerous Machinery Act of (1972) for designing and manufacturing of machinery that is user friendly in Mali and Tanzania (Sims *et al.*, 1999). Efforts were made to improve working conditions of agricultural workers particularly female workers as these constitute the highest percentage of human labour force on farms (FAO, 2000).

2.6 The constraints to farm mechanization in the developing countries

This section dwells more on factors that affect the use of mechanization negatively. However, some of these factors if rectified properly household food security will be improved in the project areas.

2.6.1 Lack of information

Information is the key to making sound decisions. Some farmers are unaware of the availability of suitable machines, tools, or implements that could aid in their usually tedious work (Latin, 1985). They might be secluded from the technology by natural barriers and socio political

boundaries and sadly enough, some farmers are even lackadaisical and seemingly uninterested in mechanization as a new innovation.

2.6.2 Limited resource farmers

Most farmers are poor where majority are rural households (PCARRD, 2002). Limited resources among smallholder farmers remained a constraint in incurring some of the technologies. According to Kingdom of Lesotho (2008), government introduced block farming subsidies, which were offered by the government through the banks; but there was resistance from farmers in taking such credits. This fear could be a result of high interest rates or a guarantor. According to RASCP-TACMO (2002), many farmers prefer non-bank sources for support. This is because, there is less time to process the application, minimal documentary requirement and timely release of the loan.

2.6.3 Small farm size

Majority of the farms recorded in the developing countries are less than 3ha (FAO/WFP, 2007). This reduction in land size to small farms could be due to land conversion to satisfy the housing and recreational needs of the growing population. A small-sized farm is an issue to mechanization. This is because this is against the principle of economies of scale.

2.6.4 Lack of appropriate machinery

According to Salokhe (2003), there is a need to develop simple, manual equipment for various farm operations. This is as a result that most farming activities comprise of women workers. However Fernando *et al.*, (2010) stated that there is recognition for development of appropriate machinery for small-scale farmers which could be more rewarding but affordable. Amongo (2001) declared that the availability of quality machinery to smallholder farmers would expand area to be cultivated with quality work for higher returns. Second-hand imported machines may look attractive to farmers but may be a constraint when replacing worn-out parts. This is because parts are not available locally so they need to be ordered.

2.6.5 Lack of Extension services

Extension is the battle front of technology transfer (Koppel, 1994). The people involved in extension must not only be technically updated but must also possess good management and interpersonal skills. With so much on their shoulders, most of them might be lacking the capability to integrate the mechanization technology into the total farming system (Encanto, 2000). According to Mbata (2001), absence of reliable support services can be a major constraint to profitable employment of draft animals. As such, farmers employing draft animals need to be assured of a reliable source of harnesses and other animal traction equipment. The repair services need to be available at village level. Efforts have been directed to establish production units, and a supply network equipped with relevant repair skills.

2.6.6 Social constraints

In areas where animal traction is still a highly innovative technology like in the rural areas, it is common to hear someone argue that the technology is inappropriate (Mbata, 2001). According to Starkey (1984), another farmer watching a ploughing competition in Sierra Leone explained how amazed he was to hear farmers giving orders to animals in the local tribal language. It appeared as if the oxen would only have understood the language. This also illustrated the type of sociological or psychological constraint that may have to be overcome if animal traction is to diffuse into an area.

FAO (1996) stated that social traditions are obviously important, this results from the fact that many examples from different parts of Africa show how quickly animal traction can spread, if found to be profitable. However, Starkey (1984) further declared that in Zaire, two cooperating projects had broadly similar problems of farmers being totally unfamiliar with cattle husbandry and draft animal technology. This resulted in the slow rate of progress in both projects until farmers in one project started to benefit from increasing maize prices as traders carried grain to a growing town. According to Mbata (2001), adoption of animal traction would be higher in areas with a greater access to market opportunities.

Apart from social traditions, farmers may simply be unaware of animal traction options. For example, it has been claimed that farmers in the southern Sierra Leone may be unaware of technology that is suitable for employing oxen in rice swamps (Jarju, Sarr and Marong, 1988; Leaman, 1988). Nevertheless knowledge can spread very quickly, within areas where animal traction technology is technically and economically appropriate. An interesting example of this comes from the Gambia, where prior to 1955 there was virtually no use of draft animals for crop cultivation. Through a very structured extension programme based on ox-training centres, animal traction was successfully introduced into most Gambian villages. However, while the extension services were promoting the use of yoked pairs of oxen, an alternative, and technically very different, draft animal technology based on single-harnessed donkeys was diffusing informally from Senegal. By 1988 more donkeys than oxen were being used in the Gambia, as farmers adopted scarifying tines and seeders rather than the ridgers and ploughs first promoted by the extension services. Thus, through the two processes of formal extension and informal diffusion, major changes in farming technology were rapidly adopted, as mechanization became a normal part of farming systems in the Gambia (Starkey, 1988c).

Theft of mechanization parts in Southern Africa seemed to playing a negative impact to most of the smallholder farmers. According to Starkey *et al.*, (1995), one reason given for using donkeys was reduced risk of theft with donkeys. However, Corbel (1986) stated that in some countries tractors give prestige to their owners, but they may also cause jealousy and friction within communities. In some cases, this may lead to the loss of some parts through theft or witchcraft. According to FAO (2009), horses are prestigious, oxen are intermediate and owners of donkeys may be laughed at. This is as a result that farmers' distinct preferences for particular animals, harnessing systems, implements type and colours and cultivation practices may be founded in long standing technical assessments. In either case, sensitivity is required when dealing with such social constraints.

2.6.7 National policies

National development policies can represent either an impetus to animal traction, or these can act as a major constraint. Thus, some of the interventions at national level can greatly influence

decisions at farm-level. According to FAO (1996), uses of tractors are more encouraged than the use of animals in extreme cases in the Southern Africa. This is the case, where the policy declared that the forage consumed by working animals could be better used for milk production. According to Ministry of Agriculture (2009), animal traction has merely been neglected by most of the farmers in general. This is as farmers whether having animals or not, hires tractors for ploughing their land. According to FAO (1996), the neglect arose as a result of the government policies been negative towards animal traction.

In addition, Starkey (1986) declared that, even in several African countries, tractorization policies were actively pursued in the 1960s and 1970s by providing heavily subsidized tractor-hire services, governments made it economically undesirable to use draft animals. This also followed from the fact that mechanization is distributed through the world and animal traction was neglected as long as there were subsidized tractors and power tillers available. Only when the tractors had finally broken down, did farmers and ministry officials become interested in the animal traction option.

According to the Ministry of Agriculture (2010), there has been a major advance in the image of animal traction in recent years, but some senior officials and politicians still tend to think of it as an outmoded, old-fashioned technology. According to Kingdom of Lesotho (1991), animal traction has been neglected in the allocation of resources for the provision of national services such as credit, extension, research and training. Occasionally national policies may make it very difficult for the private sector to provide support for animal traction.

2.6.8 Capital and credit

It is well known that lack of capital or credit can be a critical constraint to agricultural development, and the adoption of animal traction can be highly dependent on the availability of these resources. The market cost of oxen, cultivation implements and carts in West Africa is high, relative to average farm incomes. In areas of low animal traction adoption, few crop farmers have both sufficient savings and also the confidence in animal traction to purchase animals and implements without assistance. In such cases, the provision of credit has often led to rapid adoption, as noted following credit schemes provided by cotton development or marketing

companies in Mali, Togo, Benin, Cameroun and Côte d'Ivoire. In such cases, there were packages of inputs besides credit, but the loans were considered to be particularly crucial. When there were major changes to the system for providing credit to small farmers in Senegal in the early 1980s, the market for new animal-drawn implements almost completely disappeared.

2.6.9 Environment and infrastructure

In forest areas, the presence of trees and stumps constitute a major constraint to mechanization. However, this constraint gradually disappears as population and land pressures increase and as the time required for land preparation and weeding under forest-fallow cultivations systems increases. A stage is reached where farmers find more worthwhile to remove the stumps and start ploughing with both animals and tractors (Pingali *et al.*, 1987). Similarly, increases in farm prices or access to new markets may be of great significance for farmers to overcome the environmental constraints. However, poor infrastructure on the other hand, is considered to be a major problem and concluded that repairs to bridges, the opening of new roads and the development of the crop marketing system would help overcome the existing constraints to mechanization (Starkey *et al.*, 1988).

Low production, especially in low income countries in the Southern Africa, may be regarded as a constraint to the use of mechanization. This is because small scale farmers will not be able to service their machinery or else work done will not be satisfactory and will lead to poor yields. Also, in more arid areas, the provision of water can be a constraint, and animals may have to walk long distances to water sources. High temperatures and large quantities of direct solar radiation may exacerbate water shortage, and cause animals to stop work as their body temperatures rise.

According to Starkey and Apetofia (1988) environmental constraints could be minimised if other conditions are favourable. For example, people wanting to show that animal traction is not universally applicable may refer to rural areas especially those in the mountainous areas. According to FAO (1996), draft animal power is integral components of the farming systems in very mountainous areas, and successfully plough tiny terraces on steep slopes. Even the constraints of mountains can be overcome if the returns are adequate.

2.6.10 Low producer prices

Farm gate prices offered to farmers, especially at harvest time are low. This further reduces farm incomes thus limiting investment capabilities (FAO, 1996). Mwinjilo (1991) observed that the use of draught animals substantially increases the financial burden on farmers, particularly during the early days of adoption. According to FAO/WFP (2007), the overall aggregate price increase in the animal draught power package and inputs used far exceeded crop price increases, leading to a reduction in gross margins. This made further investment in animal traction unattractive.

2.6.11 Low purchasing power of most small-scale farmers

A low level of crop production leads to low incomes which considerably limit the purchasing power of the majority of smallholder farmers, making investment in agricultural machinery and implements difficult (FAO, 2008).

2.7 Strategies for profitable agricultural productivity in rural areas.

Some of the factors which would be of great importance in improving agricultural productivity in rural areas are been discussed below.

2.7.1 Improvement on agricultural extension

Agricultural extension is a mechanism by which information on new technologies, more effective management options, and better farming practices can be transmitted to farmers (Owens *et al.*, 2003). Extension agents interact with farmers, providing information and aiding in developing their managerial skills (Birkhaeuser *et al.*, 1991). In addition, extension agents disseminate information on crops and livestock practices, optimal input use, and consult directly with farmers on specific production problems, thus facilitating a shift to more efficient methods of production. That is, agricultural extension not only accelerates the diffusion process and the adoption of new varieties and technologies but also improves the managerial ability of farmers and affects the efficient utilization of existing technologies by improving farmers' know-how.

2.7.2 Training of farmers and extension workers

The involvement of farmers is crucial if productivity and food security is to be achieved. The target group has been those farmers who already own draft animals or own tractors and equipment, but who are not using them, or who are using them improperly or inadequately. Creating awareness is achieved through animal traction or tractor demonstrations during the institutional open days, farmers' field days, ploughing competitions and agricultural shows (FAO, 1996). According to Kingdom of Lesotho (1991), this will stimulate productivity as majority of production comes from those smallholder farmers who are mostly using animals for production. Furthermore, cooperation with field extension officers and various interested non-governmental organizations and volunteer agencies has been instrumental in relaying the message. However, it has been noted that, this approach is better than attempting to impose ideas on uninterested farmers. It is better to let farmers understand the principles of animal and tractor power and then let them make decisions and take initiatives.

Additionally, particular attention is being given to pastoral tribes who are beginning to adapt themselves to settled life and crop cultivation. The use of animal traction in such cases is a part of the integrated approach to assisting such communities. Consequently, there is need for extension workers to receive training as well both government agencies and machinery manufacturing firms. It is further stated that extension workers should have enough amount of time to learn a new technology to be able to impart to smallholder farmers for improving productivity. According to Starkey *et al.*, (1995), more training to extension workers will lead to less scrap metals noticed in rural areas of machines and tractors due to the result of less maintenance by smallholders.

2.7.3 Development of animal-drawn equipment

The profitability of using animal traction can be greatly increased by investing in a whole package of suitable animal-drawn equipment. In most parts of Kenya, annual cropping is the norm and it is common practice to use animals only for land preparation. Subsequent operations only use manual labour, mainly because appropriate equipment for animal-powered operations is lacking (Meijer, 1985). A farmer using animal traction should be able to mechanize most of the

farm activities and so justify the keeping of draft animals. Secondary tillage operations like harrowing, planting and weeding of row crops should be carried out using animal power, and this can only be done when the farmer has access to the necessary equipment. Transport on the farm is another important activity that needs to employ animal powerfully (FAO, 1996). The Department of Agricultural Engineering in conjunction with the Ministry of Agriculture is working on a suitable package of animal-drawn equipment to enable the farmers to use draft animal power more profitably. The package includes ploughing, harrows, planters, cultivators and carts. The cooperation of light-engineering industries is being enlisted to mass-produce such equipment to ensure a reliable supply. The use of draft animals to drive mills is also being considered as an area where the animals could be used on a daily basis, thus increasing the profitability of their employment (Busquets, 1986).

2.7.4 Creation of farmers' organizations

Well developed farmers' organizations for smallholders, play an important role in achieving productivity. This is through empowerment of knowledge and skills to smallholder farmers to be able to solve their own problems. Technical support, facilitation of credit assistance, land clustering and consolidation will not work without cooperation among farmers. Also farmers' organization is the entry point of developmental programs by government and non-government organizations. Farmers will be able to facilitate the adoption of larger-scale mechanization rather than fitting the mechanization technologies to small farms (Lantin, 2003).

2.7.5 Custom of hiring farming operations

Hiring seemed to be one of the great resorts to many smallholder farmers in rural areas due to financial constraints faced by individual farmers. However, King (1985) identified some of the operations in the field such as land preparation, transport, harvesting and milling. According to King (1985), some payments to some of these services could be in the form of cash or even a certain proportion from the previous harvest. These service operations appear to be workable for promoting mechanization because it is based on a direct client-provider relationship governed by normal market forces. It is further stated that smallholders have power over the provider and can demand quality and value. As such, smallholders have the most power.

2.7.6 Focused research and development activities

Low cost technologies in the rural areas for smallholder farmers to improve productivity should be taken into account. According to FAO (2009), there was an increase of fuel and food prices in the developing countries which led to a decline in the areas planted in 2009/10 season, hence a lower production. Rodulfo *et al.*, (2004) elaborates that, development of technologies to lower costs in especially to some of the farming techniques such as cultivating machines, seeders, planters, sprayers needs well developed research to develop some of the techniques to lower the costs of fuel in particular.

2.7.7 Revitalizing Government Policies

Policies on tax for the importation of agricultural machinery and parts should be reviewed and all other materials and equipment for the manufacture of agricultural machinery as this would have an effect on mechanization (FAO, 2008). However, the government should try to make some arrangements with local companies to manufacture agricultural machinery locally as this would also lower some costs in the market. This will increase the rate of adoption of mechanization and farmers would benefit from the increased production as a result of technology improvement. In addition, farmers will be able to get information from local on some uses of the machinery and be able to replace worn-out parts without lot of stress. This would be of great help as farmers will be able to be familiar with their problems concerning the service of the machinery they use. Some of the spare parts should be standardized to make it easier to operate and maintain machinery (Rodulf *et al.*, 2004). Additionally, the government should try to implement policies regarding the imported, second-hand machinery in the market. According to Joubert *et al.*, (1999), most farmers in rural areas buy second-hand tractors that have reached their economic life and these farmers will use these kinds of tractors with high maintenance which will end up as scrap metal. These kinds of machinery increase the costs for the farmers.

2.8 Factors which results as production increases in rural areas

Food security is very important for the development of the country. This is because this improvement will also improve the standard of living in rural areas. Some of the important factors which will take place are discussed below.

2.8.1 Change in factor prices

Higher food production has an effect on the price of oil. According to Wielaard (2008), rapid high price of food increase of oil was experienced from 2007. On the other hand, Worth (2008) declared that the recent oil-price boom is helping to propel an extraordinary rise in the cost of food and other basic goods. Wielaard (2008), quoting Sheeran, the executive director of the World Food Program (WFP) indicated that with enough food, there will be low price of fuel. This in turn led to an increase in food commodities such as grain and transport as well. In contrast decreasing oil price does not enrich oil producers (Worth, 2008). According to IFAD (2001), petroleum prices and food prices are highly correlated, therefore, high food production will result in low gasoline and oil prices hence result in a decrease in transportation costs and production cost, thereby leading to a decline in food prices (MRCSCO, 2010). The rapid decline in petroleum prices exerted a downward pressure on food prices as fertilizer prices goes down as well as transport costs (IFAD, 2001). This decrease in transportation and production costs will also improve many of the poor global economies (Vaidya, 2008). According to MRCSCO (2010), rapid changes in the price of oil have placed great improvements on the world's super infrastructure thereby decreasing the costs for consumers.

2.8.2 Economic growth

With economic growth in some developing countries, people have made changes in diets and increased demand for food crops (Stancich, 2008). For example, meat consumption increased more than double in China and grew by 70% in Brazil and 20% in India over the last 15 years (Stancich, 2008). Such a shift from grain cereals to meat, is also leading to higher cereal prices (Martin, 2008).

2.8.3 Political stability

Decreasing food prices will result in very low riots and thereby contributing to political stability in the affected countries. Such political rests linked to low food prices have never occurred in a number of developing Countries. Decreasing food prices are therefore a critical component in political as well as developmental issues.

2.8.4 Environmental Management

It is the responsibility of each generation to conserve and replenish the nation's resources for the benefit of the future generations (Kingdom of Lesotho, 1991). Access to food would result in well developed environment and sustained resources. According to FAO (1996), through well managed production, resources will be maintained in such a way that some of the natural resources such as forest and grasses will not be misused hence there will be enough food for them. Even overgrazing of the land would be well managed as animals will have something to eat for survival and this will also result in expansion of resources such as land for grazing. This is because there will be enough food to supplement to both animals hence overgrazing of the land and misused resources will be minimised as a fact. This in turn will also assist in keeping the environment green with good vegetation cover, hence, leading to control of erosions, as there will be minimal disturbance of the top soil from harsh weather conditions of the atmosphere. According to Mbata (2001), animals will remain healthy for the whole year and will provide give good turnover for both draft power and production as well. Small scale farmers will not encounter any problems. This will result in availability of some scarce species used for study to be easily found and habitats of other species not to be destroyed.

2.8.6 Climate change

There is no single weather event that can be attributed to climate change; however, the meteorological adversity that is happening is linked with increased frequency in a global warming. Climate change has contributed greatly to the global food crisis (Hanson, 2007). Climate change has resulted in temperatures increasing, changing seasonal patterns and rising sea level (Harris, 2009).

There has been an increase in Earth's temperature making some places wetter and also drying out already arid farming regions close to the Equator (Hanson, 2007). Extreme weather conditions if experienced over a few days could destroy crops, especially during critical development stages (Stancich, 2008). Higher production could minimise temperatures for the benefit of the crops, increasing overall productivity in agriculture (Harris, 2009). According to Morgan (2009), there has been rapid warming in the tropics and subtropics which is likely to reduce crop yields. But with improve in productivity of crops from the fields, there would be

higher rate of vegetation with high rate of moisture in the atmosphere thereby lowering higher temperatures and low evaporation from plants and soils, lower higher rate of water requirements for the crops grown.

According to Harris (2009), growing seasons are changing, ecological niches are shifting, and rainfall is becoming more unpredictable and unreliable both in its timing and its volume as a result of climate change. This reduces value of traditional agricultural knowledge such as when to plant particular crops and puts greater uncertainty and risks on farmers. It then follows that climate change can results in decreased or increased agricultural production. The increase in agricultural production with a declining demand can lower prices in food markets (Hanson, 2007). Climate change has also driven up food prices, to a less direct role in the food crisis by fuelling apprehensions about the effects of greenhouse gas emissions. This has in turn, helped to drive up the production of more biofuels. Shah (2008) indicates that biofuels have increased food prices by 75% on a global scale.

2.9 The model adopted for the study

Different literature has been reviewed based on the model to be used for study on the technical efficiency of animal power on agricultural productivity. According to Chawatama, Ndlovu, Richardson, Mhlnga, and Dzama (2003), draught animal power simulator model was used to provide a decision support system for agricultural planners and the development agencies in the evaluation of different strategies of improving the efficiency of draught animal power use in crop production. On the other hand, Muchara (2011) adopted the stochastic Frontier Production Function Model in determining technical efficiency of cabbage, maize and cattle enterprises at farm level. Chisango (2010) also adopted the Cobb-Douglas model to establish the relationship between resource or machinery ownership and production efficiencies. However, Chisango (2010) further used stochastic frontier production function to predict the farm-level efficiencies using the estimated functions and to regress the predicted efficiencies upon farm-specific variables. Mucharanga (2009) also adopted Gross Margin model to compare the total income for the yields of crops such as maize and millet to the farmer, the study which was conducted in Mashona land in Zimbabwe. On the other hand, Tchale (2009) used the Stochastic Fronteir Production Function model in the study in Malawi to measure the efficiency of the small scale

farmers. It would be appropriate for the study to measure the efficiency of animal power in agriculture in the lowlands of Moleleke's district of Lesotho using Stochastic Frontier Production Model, gross margin analysis and multiple linear regression analysis.

2.10 Chapter Summary

This chapter offered different views from different offers regarding the impact of mechanisation on agricultural productivity- the case of the small scale farming. Smallholders seemed to have been affected by production constraints in the developing countries which included energy prices on food prices, climate conditions, health, low income sources, technical adoption and lack of technical knowhow, lack of capital, soils, climatic variables, pressures on land. However strategies were developed in the developing countries to rectify the problem of food insecurity from which some of the mechanization programmes were implemented. The implementation of mechanisation was limited by some of the constraints in the developing countries such as lack of information and limited resource farmers and others. As a result of poor implementation of mechanization in the developing countries, some of the factors which lead to the improvement on the use of mechanization in rural areas were considered which included the improvement of extension services etc. After the improvement in the use of mechanization which lead to an improvement in food security in rural areas, smallholders seemed to have enjoyed more, as there was a change in factor prices, economic growth, political stability etc. Lastly, Stochastic Frontier Production Model was identified as the most suitable model for analysis of data for the study. This was due from different authors who used the model before as the study seems to be familiar to their studies.

CHAPTER 3

DESCRIPTION OF THE STUDY AREA

3.1 Introduction

This chapter presents a description of the area of study. The comprehensive description covers aspects of the climate, vegetation, economic activities, type of power employed, land tenure system in place and soil types. The description of the study area is vital as it familiarizes one with the locality in which the study is located.

3.2 Geographical Location of the Study Area

Mohale's Hoek is one of the ten districts of Lesotho. It has an area of 3530 km² and a population of approximately 310,000 (Statistics, 2004). Mohale's Hoek is situated in the southern part of the country with only one urban area in the entire district. The district is divided into eight constituencies for administration and electoral purposes as follows: Hloahloeng, Ketane, Mekaling, Mohale's Hoek, Mpharane, Qaqatu, Qhalasi, and Taung (Bureau of Statistics, 2006). According to Kristy (2002), the four main vulnerability indicators or agro-ecological zones are Lowlands, Highlands, Foothills, and Senqu river valley. The study will mainly focus on the Lowland areas of the district. About four case studies will be selected in the Lowlands on the merits of the representative of some of the rural areas in one side of all the areas and also according to the objectives of the study. Some of the rural areas which will be enumerated are as follows: Ha Potsane; which is in the Eastern side of the town of Mohale's Hoek district about 1km, Ha'Mapotsane; which is in the western side of the town about 3km, Tsoloane; which is in Taung, which is in the Northern side of the town about 20km, Siloe; which is in the Northern site of the town about 30km. All of the rural areas are represented by the chiefs. The chief of the district of Mohale's Hoek is Bereng Letsie from the highland area in Phamong. Both Tsoloane and Siloe are under the paramount chief Moeketsi Monare, Ha Potsane is under the chief 'Makholu Moshoeshoe, and 'Mapotsane is under the chief Lerotholi. Figure 3.1 shows location of the lowlands of Mohale's Hoek district from the map of Lesotho where the study will be conducted. This is where most of the villages indicated are located in the part of the map coloured with yellow in Mohale's Hoek district.

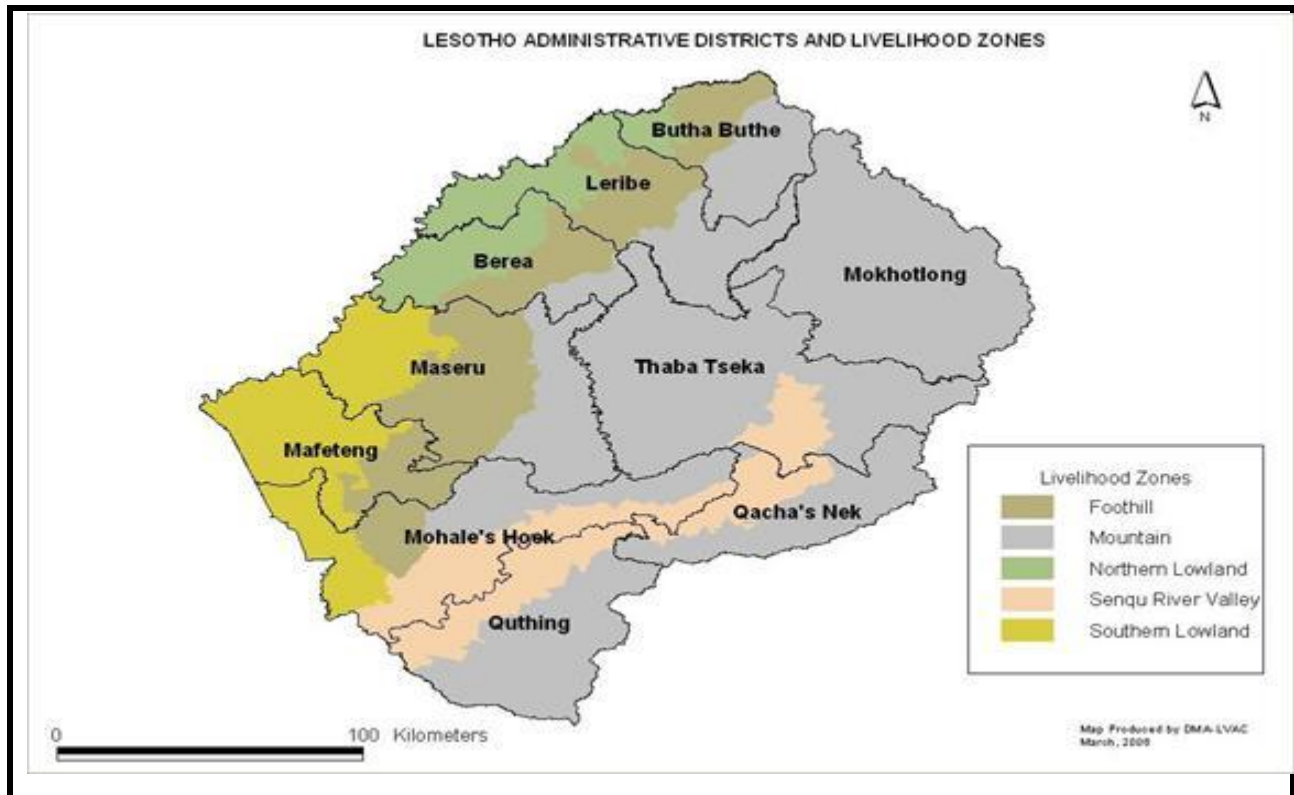


Figure 3.1: Map of Lesotho

Source: FAO/WFP, 2007

3.2.1 Vegetation of Mohale's Hoek

The vegetation type in the study area is characterized by natural vegetation such as *eragrostis curvula*, *themeda triandra*, aloes and shrubs (FAO, 1996). This vegetation is suitable for both large stock and small stock as they feed on grass and shrubs respectively. According to FAO (2005), the forests are found on mountain hills of these areas hence they are used for firewood during funeral ceremonies. The trees are covered by an extremely sparse, but yet resilient grass species. The forests have now been reduced drastically from their former size because of deforestation.

Bureau of Statistics (2006) stated that despite the rural electrification programme, firewood is still the most important source of domestic fuel in most communal areas of lowland of Mohale's Hoek district. This has led to rampant deforestation in the villages.

3.2.2 Climatic weather conditions of Mphahle's Hoek

Lesotho Meteorological Services (2010) declared that weather conditions vary greatly depending on the altitude. Summer is the hot, rainy season from October to April, with the hottest days in January and December, and the most rain falling between February to May and October to November. Days are sunny with afternoon electric thunderstorms, and temperatures range from around 86°F (30°C) in the lowlands with cooler temperatures as the altitude increases, averaging about 64°F (18°C) in the mountains. Snow falls mainly in winter from May to September, but can occur in the mountains at any time of year. Winter can be bitterly cold, particularly in the highlands, but days are usually clear and sunny. According to FAO/WFP (2007), wheat does well in such conditions in these areas but harvesting is difficult due to lack of combine harvesters in the country. Temperatures can fall to 20°F (-7°C) in the lowlands and 0°F (-18°C) in the highlands. At any time of year the weather can change very rapidly in the highlands from warm sunshine to mist, rain and freezing temperatures.

3.2.3 Population, population density and ethnic groups

According to Bureau of Statistics (2006), Lesotho has a total population of 1,872,721. Of the population, 23.74% lived in urban and 76.26% in rural areas in 2006. The country's capital, Maseru, accounts for around half of the total urban population. The sex distribution is 911,848 male and 960,873 female, or around 95 males for each 100 females. The country is estimated to have land area of 30355km.

The average population density in the country is around 61, 7 people per square kilometer. The density is lower in the highlands than in the western lowlands. Although the majority of the population 59.8% is between 15 and 64 years of age, Lesotho has a substantial youth population numbering around 35.3%. The annual population growth rate is estimated at 0.13% (FAO, 2005; Bureau of Statistics, 2006). The reason was the high mortality rate due to HIV/AIDS which seems to be taking its cause in the country.

The population of Mphahle's Hoek where the study is carried out is 206842, which comprises 11.04% of Lesotho's total population. In terms of ethnic groups in the country, an official record

suggests that 99.7% of the Lesotho's population is Sotho's. Other ethnic groups include Europeans, Chinese and Xhosas towards the southern part of the country. Some of the subgroups of Basotho include the Bakuena, Batlounge, Baphuthi, Bafokeng, Bataung, Batsoeneng, Matebele etc (FAO, 2005).

3.2.4 Land tenure

In Lesotho, land belongs to the Basotho nation and the King holds land for the trust of the people. The communal areas under study are like any other communal areas in Lesotho, from which land ownership is under customary land tenure system. Authority over land is exercised by chiefs with the help of the headmen who administer land on behalf of the King. Individuals have land rights to small arable and residential plots and enjoy rights to common resources such as grazing lands, mountains and any other land not assigned to individuals (Marake, Mokuku, Majoro & Mokitimi, 1998).

Land tenure systems or ownership affect agricultural productivity. This is because it influences productivity through security and investment in infrastructure. Williams (1972) stated that land tenure constitutes the rules and procedures governing the rights, duties and exposure of individuals and groups to use and control of the basic resources such as land and water.

Shortage of land is a common feature in the villages sampled, which is a characteristic of most communal areas in the lowlands of Maseru's Hoek district of Lesotho. According to Bureau of Statistics (2006), Lesotho's communal areas in both villages have population densities exceeding the available land resources. This is as a result of the continued land hunger in Lesotho's communal areas. The continued shortage of land in communal areas of these villages has led to the production of maize and sorghum in fields while animals occupy rangelands for grazing.

3.2.5 Farming systems

Crop production in the villages under study, namely 'Mapotsane, Ha potsane, Tsoloane and Siloe is rain-fed with no irrigation facilities (FAO, 1996). However FAO (1996) further stated that for dry land cropping, the region is suitable for drought tolerant crops such as sorghum, beans, pumpkins and maize. Maize and sorghum are major crops. Bureau of Statistics (2006) suggested

that farming activities in these areas are considered risky because of limited amount of rainfall, irregular farm output, marketing prices and unreliable yields. FAO (2006) indicated that the communities also practice animal husbandry as a supplementary activity. This is because cattle are the most prized possessions as they are used to pay the bride prize (*lobola*) and they are very important as a source of draught power. According to FAO (1991), cattle, goats, sheep, donkeys, horses, and poultry also provide manure to improve soil fertility. Winter cropping is practised in all villages. Crops involved are wheat and peas (FAO/WFP, 2007). Early summer maize known as green mealies is also planted around August / September mainly by fewer farmers in project areas. This is done in order to make sure that ploughing is timely to exploit the early rains and also sell it early before most farmers plough (Haque *et al.*, 1986). According to Mapfumo *et al.*, (2005), within these farming systems, there is a high degree of interdependence and interaction among crop and livestock activities. This is due to very low productivity of the communal grazing areas and farmers supplement their livestock feed during winter. FAO (1991) said that the activity of collecting maize stalks is done soon after harvesting of the last crop, the period between April and June. This is because livestock are herded during the rainy season but graze freely in croplands during the dry months of May to October, feeding mainly on crop residues. Therefore, crop residues compete between livestock feed and soil fertility management.

3.2.6 Animal and tractor power operation programmes in the study area

Some of the traditional agricultural implements are being used by farmers for different operations in the lowland of Mohale's Hoek district (MOA, 2009). MOA (2009) further indicated that very few farmers make use of improved implements such that there is a great variation in the production among farmers. World Vision (2009) declared that, in most areas, animal draught power accounted for about 80 to 90% of the cropped areas, tractor power accounted for between 10% to 15% and hand tillage 10%. World Vision further indicated that costs are so high for most farmers who practice tractor power for subsistence farming; hence large numbers of fields are left fallow for some time. However, FAO/WFP (2007) explained that very small proportion of the farmers have tractors, the rest rely on hired tractors, cattle and horses for tillage. Starkey *et al.*, (1995) declared that most farmers in rural areas buy and use second hand tractors that have reached the ends of their economic life with high expenses for the farmers, thereby end up as scrap metal. According to FAO/WFP (2007), most of the rural

households own livestock such as cattle, sheep, goats, horses, donkeys or chickens. Previous drought years and livestock theft reduced amount of livestock in rural areas. On the other hand, some of the late rains (April) made good recovery to livestock hence people are able to use their animals for draught power. Some people are able to cut some maize stalks after harvest as supplementary feeds for their animals during time of scarcity of livestock feeds.

3.2.7 Soil types

The soils in the study areas in the district of Mohale's Hoek are predominantly sandy and have a low moisture holding capacity, a low pH, and little organic matter or nitrogen and poor structure (Kamanga *et al.*, 2003). Haque *et al.*, (1986) said the soils are derived from granite with a pH of between 4.0 and 5.0. Haque *et al.*, (1986) further stated that these soils are infertile with low potential to support crop production under continuous cultivation. According to Hikwa *et al.*, (2001), the soils are specifically deficient in nitrogen, phosphorous and sulphur and the soil fertility continues to decline. This, amongst other factors, has resulted in maize yields declining and food security in these areas worsening. On the other hand, Kamanga *et al.*, (2003) suggested that soils in the homestead fields are moderately shallow, well drained and consists of brown sands and sandy loams. This is because of their proximity to the homestead labour, wood ash, composite and kraal manure.

The nature of the soils causes farming to be very difficult without the aid of manure (FAO, 1996). These shallow soils according to FAO (1996), especially in Mohale's Hoek, for farmers to get a good yield, they have to buy expensive inorganic fertilizers, usually Ammonium Nitrate (AN) and Compound D or farmers have to apply cattle manure. However, FAO (1996) further declared that for farmers to have adequate amounts of cattle manure to use in their fields they have to collect and deposit large amounts of leaf litter into their kraals. The Ministry of Agriculture (MOA), (2010) indicated that this activity is normally done in summer, in the period between August and October, and the activity is completed just before the first rains. It is usually done by women and children. MOA (2010) further stated that the soil types in the region favour cereal crops, mainly maize and sorghum, which can be produced with little input usage.

3.2.8 Overview of Agriculture in the area in 2009/10 season.

The limited arable areas in the lowlands of the district have good potential for crop production on their most productive communal lands, producing both food and cash crops (FAO, 1996). MOA (2010) stated that maize is the dominant crop, as it constitutes two thirds of the total cereal crops; however, most of their sources of income are obtained from beans, potatoes, sorghum, pumpkin and non-agricultural employment. Bureau of Statistics (2006) said most poor households still depend equally on their own crops, casual labour related to agriculture, construction, domestic work and self-employment. In general, crop production, livestock rearing or a combination constitutes the primary livelihoods in the rural areas. According to FAO/WFP (2007), there are gifts from relatives, remittances and social networks from an additional support mechanism in times of stress which play major part in the livelihood strategies. Table 3.1 indicates the total production of crops where maize is a dominant crop in terms of the area planted (MOAFS, 2010).

Table 3.1: Production (tonnes) of principal crops by district in 2009/10 season.

Districts	Wheat	Maize	Sorghum	Beans	Peas	Potatoe	Vegetable
Mokhotlong	705.3	999	5	826	160	38.3	28.5
Botha-Bothe	44.4	3200.4	503.6	465	23	43.1	20.4
Leribe	3000	6818.2	823.2	2072.6		167.2	17.5
Berea	409.5	30450	4350	8700	56		22.1
Maseru	638.1	3208.6	915.4	826.6	122.6	377.8	25.4
Thaba-Tseka	7020	11200	3020	900	1500	800	25.3
Mafeteng	348.5	1022	105.4	667.3	217.4	47.8	12.3
Mohale’ Hoek	297	10257.7	4462.9	1556.3	100.6		32.3
Quthing	144.1	511.6	69.3	336.4	12.5	15.5	70
Qacha’s Nek	362	4730	2400	362		12.4	25.6
Total	12968.9	72397.5	16655.1	16712	2192	1502.1	279.4

Source: MOAFS, 2010

3.2.9 Availability of Agricultural Inputs

The current famine situation in Lesotho led most people to consume all their food stocks including seeds (WFP, 2009). According to FAO (2009), the Government had to distribute seeds and fertilizers throughout the country of which the distribution was reported to be very slow and not everybody received inputs. This negatively affected future production prospects. FAO/WFP (2007) said the intervention marginalized the HIV/AIDS infected and affected households who because of their health status cannot engage in crop production. According to Ministry of Agriculture (2010), the intervention also neglected all other people engaged in other agricultural activities such as poultry, livestock, and others that were equally affected by the crisis.

Additionally some of the distributed seeds ended up being eaten thus showing more dramatically the high level of desperation.

3.2.10 Infrastructural facilities in the Areas

There is one main tarred road passing through all the sampled villages and linking them to the other towns in the country. The rural areas are linked to the main road by gravel roads and poor roads with potholes. Roads joining rural households are not well established. This is the main problem in rural areas as it is difficult to use motorized road transport these areas, such that most households use head portage for a larger part of their trips (Kingdom of Lesotho, 1991). WFP (2010) indicated that lack of funds, buildings for storages of produce from the fields are in a poor state, such that produce is stored for only a short period of time before being given to relatives if production is good in that year or disposed of through distress sales at very unfavourable prices. MOA (2010) stated that there is no irrigation systems developed in the fields to improve on production.

3.2.11 Marketing of produce in the areas

The area under study is nearer to the agricultural marketing authorities. Lack of marketing structures developed in these areas by the ones in charge, play major role in the low production from small scale farmers. According to Mbata (2001), well developed marketing systems in rural areas would enhance productivity of the small scale farmers. Some of the farmers abandon their farms to migrate to the mines because even when they produced enough, they are not able to sell their produce. According to FAO/WFP (2007), producer prices of most crops are controlled by the government, so the selling price is low compared to rapid increases of input prices.

3.2.12 Economic activities in the areas

Economic activity refers to any type of work undertaken by an individual to earn a living (Bureau of Statistics, 2006). Most of the people (70%) are rural households of which some are extremely poor (FAO/WFP, 2007). These households lack income and jobs and face the serious constraints of severe degradation of the natural resource base. There is a high level of inequality in income distribution (IFAD, 2001).

The area has limited production with about 80% of households involved in agriculture from which most are involved in subsistence farming and informal activities (bars, spaza shops). The poor production and lack of commercial farming have been attributed to a lack of ownership security and high degree of resource degradation (Rowntree, 2005).

Some of the younger people are employed in the industrial sector mainly in the textile industries, while others work as street vendors. Although the numbers are now much lower Basotho still migrate to work in South African mines. Since the country is surrounded by South Africa, this affects the economy of Lesotho negatively, as most of the goods are imported from South Africa (FAO/WFP, 2007). Bureau of Statistics (2006) indicated that the livelihood sources have been limited due to lack of formal and informal employment opportunities and this has led to high dependence levels in the area, particularly in the rural areas of Maseru's Hoek. However, Hill and Nel (2000) declared that people rely on food aid and migrant labour remittances for survival and this has led to rural areas of Maseru's Hoek being considered low income areas.

3.3 Chapter Summary

In this chapter, the villages of Potsane, 'Mapotsane, Tsoloane and Siloe have been described in terms of a wide range of physical and socioeconomic characteristics. The region is considered a semi arid region and has low agricultural potential. The areas receive unreliable rainfall of 724.4mm especially in 2009/10 season with lowest temperatures in July at -1.0⁰c. Even though maize is the dominant crop in these areas, there is declining soil fertility and drought which led to very low production. These also led to an increasing food insecurity situation in these areas, necessitating the recommendation for immediate improvements in the production technologies to increase production.

CHAPTER 4

METHODOLOGY

4.1 Introduction

This chapter describes the procedures used for the selection of the study area, both in respect of the choice of the district and the specific communities in which the collection of the data was carried out. The model for the study is also described in this chapter. Following that, the chapter outlines the nature of the data and provides detailed descriptions of all the variables. Further, the chapter will describe the mode of measurement or calibration of the variables and the expected relationships with the dependent variables in all cases. Subsequently, a description of the analytical framework and the steps adopted for data collection will be discussed. Then the chapter will present the methods of data analysis.

4.2 Site Selection

The success of the research relied on the cooperation between the researcher and extension workers from the Ministry of Agriculture and Food Security. The Ministry has maintained close working relations with the rural communities of Mohale's Hoek over the years and provided important information relevant to the study. Good relations with the communities were encouraged in order to carry out the research project successfully. The researcher visited local communities of Mohale's Hoek namely, 'Mapotsane, Potsane, Tsoloane and Siloe in order to present and discuss the research problem, objectives, and importance of the research project to the local authorities. After the discussions, the authorities including the chiefs and extension workers of the respective areas were well informed on all aspects of the project and were therefore in a position to inform their people and provide the required support and cooperation for the research.

4.3 The Model

The present section is devoted to a description of the different analytical procedures employed in this study for purposes of predicting the behaviour of the farmers in respect of adoption of animal power in smallholder farming and the implications for productivity.

4.3.1 Gross Margin Model

When acquiring new technology, it is important to consider the economic value of the new product. As a rule of thumb, an enterprise with higher or positive gross margin is deemed viable. Hence, gross margin was used to assess the viability of draught animal power and tractor power in the production of maize. According to Barnard and Nix (1999), gross margin of a farmer enterprise is its output less the variable costs attributed to it. Erickson, Akridge and Barnard (2002) define gross margin as the money that is available to cover the operating expenses and still leave a profit. However, this study employs the definition preferred by Vsagie and Ghebtsadik (2005), that define gross margin as the difference between the gross income derived from each enterprise (maize production activities) minus the total variable costs. In maize production, the variable costs consist primarily of expenses of seeds, fertilizers, sprays, contract work and casual labour hired. These are aggregated to obtain the total variable costs. The enterprise output is the total of the production of the enterprise.

In physical terms and in value terms, the physical output is the total physical production measured in tones. That is not yield which measures productivity. Then the value of production refers to the physical production at current market prices. This is the basis for calculating the gross income or gross revenue.

A simple mathematical expression of the relationship between the gross income and the expenditures on the set of variable inputs to be presented as:

$$GI = (P \times Y \times A) \dots \dots \dots (1)$$

where;

GI = Gross Income measured in monetary value (US\$)

P = Prevailing market price measured in monetary value (US\$)

Y = Yield of the produced commodity measured in metric tonnes per hectare (t/ha)

A = Area under production measured in hectares (ha)

The following calculation presents the total of all variable costs of an enterprise of maize which will be subtracted from the gross income to obtain the gross margin of an enterprise (Erickson *et al* 2002).

$$TVC = \sum_{x=1}^n (x_1, x_2 \dots \dots \dots x_n) \dots \dots \dots (2)$$

where;

TVC = Total variable costs measured in monetary value (US\$)

X₁ = First variable costs to be during the production phase

X_n = the last variable cost to be used during the production phase

The following calculation presents the calculation of the gross margin of an enterprise where Total variable costs are subtracted from the gross income (Erickson *et al* 2002).

$$GM = (GI - TVC) \dots \dots \dots (3)$$

where;

GM = Gross Margin measured in monetary value (US\$)

GI = Gross income measured in monetary (US\$)

TVC = Total variable costs measured in monetary (US\$)

In order to capture the type of power with the highest gross margin in the production of maize, data production from each farmer was used. In addition, equations 1 to 3 indicate the steps taken to derive actual gross margin for each farming unit. Table 4.3 illustrates the format for summarizing the results of gross margin analysis for a typical agricultural enterprise.

Table 4. 1: Format for summarising results of gross margin analysis for agricultural Enterprise.

Item	Unit	Quantity	Price (R/Unit)	Amount (R/Ha)
INCOME: (Gross value of production)				
Sales of maize in 50kg bags	Tonnes			
Maize consumed	Tonnes			
Maize stored for livestock	Tonnes			
GROSS INCOME				
VARIABLE COSTS:				
Pre-harvest:				
Seed: Maize seed	Kg			
Fertilisers: (Lime, LAN 28%)	Kg			
Mixture 2-3-2 (22) + 0.5% Zn	Kg			
Manure	Kg			
Pest & disease control:				
Kombat	Litre			
Gaucho	Litre			
Atrazine	Litre			
Fire insurance	Rand			
Tractor Hire	Hour			
Contract work: Planting	Day			
Harvest:				
Packing material: 50kg bags	Bag			
Contract: maize harvesting	Day			
Marketing costs: 5%	Rand			
TOTAL VARIABLE COST				
GROSS MARGIN				

Source: Survey, 2010

4.3.2 The Multiple linear regression model

Economic theory predicts direct relationships between a vast array of socio-economic and community variables and the willingness or otherwise of economic actors to participate in the process of exchange. It is therefore possible to fit a simple linear regression model.

$$Y = f(x_1, x_2, \dots, x_n) \dots \dots \dots (4)$$

where;

Y is the dependent variable representing some measure of market participation for the particular enterprise, while the X 's are explanatory variables.

Following conversion, the model can be specified as:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \dots \beta_n X_n + \mu_i \dots (5)$$

where:

β_0 = the intercept or constant term

$\beta_1, \beta_2, \dots, \beta_n$ = slope or regression coefficient

$X_1, X_2, \dots, X_n$ = explanatory or independent variables

μ_i = error or disturbance term.

The model was estimated to identify the impact of animal traction on agricultural productivity. Given the rather large number of variables enumerated, the likelihood of correlation among independent or predictor variables is high. For this reason, the test of multicollinearity was applied. Assuming two variables, X_1 and X_2 , collinearity is suggested if:

$$X_1 = \lambda X_2 \dots (6)$$

However, the equation (5) demands that a more robust function be developed to cater for the several predictor variables in the model. This can be presented as:

$$\lambda_1 X_{1i} + \lambda_2 X_{2i} + \dots \lambda_k X_{ki} = 0 \dots (7)$$

where λ_i are constants and X_i are the exploratory variables that might be linearly correlated.

The speed with which variances of an estimator is inflated by the presence of multicollinearity. A formal detection tolerance or the variance inflation factor (VIF) for multicollinearity as illustrated by Gujarati (2003) can be as follows:

$$VIF = \frac{1}{\text{tolerance}}$$

where tolerance = 1- R²

Tolerance of less than 0.21 or 0.10 and / or VIF of 5 or 10 and above indicates multicollinearity of variables. Where multi-collinearity was detected on the basis of the value of the VIF, the highly collinear variable, that is those with very high VIF, were detected from the model.

Finally, a test was conducted to detect any possible serial correlation indicated by the size of the Durbin-Watson (DW) statistic by establishing that:

$$\mu_i = \rho \mu_{i-1} + \varepsilon_i \dots \dots \dots (8)$$

4.3.3 Diagnostic tests to detect:

1. Serial correlation:

Durbin-Watson statistics (DW) can be used for assuming ε_i in (5) is evenly distributed.

The DW statistics is calculated as followed:

$$DW = \frac{\sum_{t=2}^n (\hat{u}_t - \hat{u}_{t-1})^2}{\sum_{t=1}^n \hat{u}_t^2}$$

Test shows the DW statistic and $\hat{\rho}$ from (6) are linked as:

$$DW \approx 2(1 - \hat{\rho})$$

The DW test is usually used for testing the following null and alternative hypothesis:

$$H_0 : \rho = 0$$

$$H_1 : \rho > 0.$$

From the equation (4), $\hat{\rho} \approx 0$ corresponds to that $DW \approx 2$, and $\hat{\rho} > 0$ corresponds to that $DW < 2$.

We test this null hypothesis as follows:

- ❖ Choose a significance level, say 5%, and with the number of observations and the number of regressors, find two sets of critical values: d_L (for lower) and d_U (for upper).
- ❖ Make a decision:
 - If $DW < d_L$, we reject H_0 against $H_1 : \rho > 0$.
 - If $DW > d_U$, we fail to reject H_0 .
 - If $d_L \leq DW \leq d_U$, the test is inconclusive.

The only advantage of the DW statistics over the t-test from (6) is that an exact sampling distribution for DW can be computed. Given that the DW statistics requires the normal distribution of e_t and a wide inconclusive region, $d_L \leq DW \leq d_U$, the disadvantage of the DW test is substantial.

2. Heteroskedasticity:

To test for the presence of heteroskedasticity in time series regression, the same method for cross-sectional applications could be used. This test requires that error terms V_t be serially uncorrelated. Heteroskedasticity is calculated as follows:

$$\hat{U}_t^2 = \delta_0 + \delta_1 X_{t1} + \dots + \delta_k X_{tk} + V_t \dots \dots \dots (9)$$

The null hypothesis is $H_0 : \delta_0 = 0, \delta_1 = 0, \dots \dots \delta_k = 0$.

Then the decision can be made using F statistics.

4.3.4 Stochastic Frontier Model

The original specification, involved a production function specified for cross-sectional data which had an error term with two components, one to account for random effects and another to account for technical inefficiencies. The Cobb-Douglas Model, one of the widely used Stochastic Frontier methods was employed in this research to establish the relationship between resource/machinery ownership and production efficiencies. To estimate a Cobb-Douglas production function, one has to log all input and output data before creating the data file for the

programme use. The Cobb Douglas production function was assumed to be in version 2.0, Data had therefore to be supplied in original units since the program would obtain the logs of the data supplied.

The principal aim of using the Stochastic Frontier Production Function was to address the set objectives and research questions as stated in chapter one. The stochastic frontiers were used to predict the technical efficiency of animal traction power on maize yield using the estimated functions and to regress the predicted efficiencies upon farm-specific variables, highlighted above in an attempt to identify some of the reasons for differences in predicted efficiencies.

The model used solves two general parameters, and the error components can be formulated as

$$Y_{it} = X_{it}\beta + (V_{it} - U_{it}) \dots \dots \dots (10)$$

Where Y_{it} is the (logged) or assumed obtained output obtained by the farmer in the t-th or stipulated time period; X_{it} is a (kx1) vector of (transformation of the) input quantities of the i-th firm/farm in the t-th time period; β is a (kx1) vector of unknown parameters or variables; and V_{it} are assumed to be iid $N(0, \sigma_v^2)$ random errors, and $U_{it} = U_i \exp(-\beta(t-T))$, where U_i are assumed to be iid as truncations at zero of the $N(\beta_i, \sigma_u^2)$.

If $h > 0$, the inefficiency term, U_{it} , is always decreasing with time, whereas $h < 0$ implies that U_{it} is always increasing with time. That could be one of the main problems when using this model, hence technical efficiency is forced to be a monotonic function of time.

The second model included in the frontier package is the technical efficiency (TE) effects model (Battese and Coelli, 1995). It can be expressed as:

$$Y_{it} = X_{it} \beta + (V_{it} - U_{it}) \dots \dots \dots (11)$$

where Y_{it} , X_{it} , β and V_{it} are as defined earlier and $U_{it} \sim N(m_{it}, s_u^2)$, where $m_{it} = Z_{it}d$, Z_{it} is the vector of firm/farm's-specific variables which may influence efficiency.

FRONTIER offers also the solution of the model of Stevenson (1980) which is a particular case of the previous model that can be obtained for the cases in which T is equal to 1 (for cross-sectional data).

There are two approaches to estimating the inefficiency models. These may be estimated with either a one step or a two step process. For the two-step procedure the production frontier is first estimated and the technical efficiency of each firm/farm is derived. These are subsequently regressed against a set of variables, Z_{it} , which are hypothesized to influence the firms'/ farms' efficiency. A problem with the two-stage procedure is the inconsistency in the assumptions about the distribution of the inefficiencies. In the first stage, the inefficiencies are assumed to be independently and identically distributed (iid) in order to estimate their values. However, in the second stage, the estimated inefficiencies are assumed to be a function of a number of firm/farm's specific factors, and hence are not identically distributed unless all the coefficients of the factors are simultaneously equal to zero (Coelli, Rao and Battese, 1998).

The production possibility frontier for a given set of inputs is illustrated in Figure 3.6,1 (i.e. an output-orientation). If the inputs employed by the firm/farm were used efficiently, the output of the firm/farm, producing at point A, can be expanded to point B. Hence, the output oriented measure of technical efficiency ($TE_O(y,x)$), can be given by OA/OB . This is only equivalent to the input-oriented measure of technical efficiency under conditions of constant returns to scale. While point B is technically efficient, in the sense that it lies on the production possibility frontier, higher revenue could be achieved by producing at point C (the point where the marginal rate of transformation is equal to the price ratio p_2/p_1). In this case, more of y_1 should be produced and less of y_2 in order to maximize revenue. To achieve the same level of revenue as at point C while maintaining the same input and output combination, output of the firm would need to be expanded to point D. Hence, the revenue efficiency ($RE(y,x,p)$) is given by OA/OD . Output locative efficiency ($AE_O(y,w,w)$) is given by $RE(y,x,w)/TE_I(y,x)$, or OB/OD as shown in Figure 4.1 and Figure 4.2 (Kumbhaker and Lovell 2000).

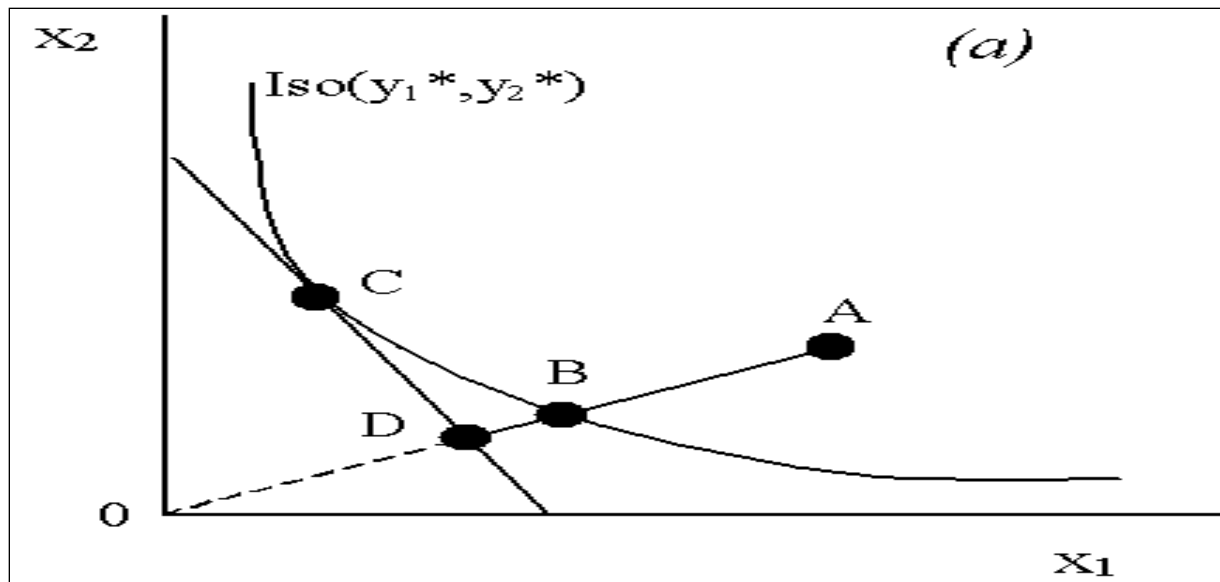


Figure 4.1: Input (a) and output (b) oriented efficiency measures

Source: Kumbhaker and Lovell (2000)

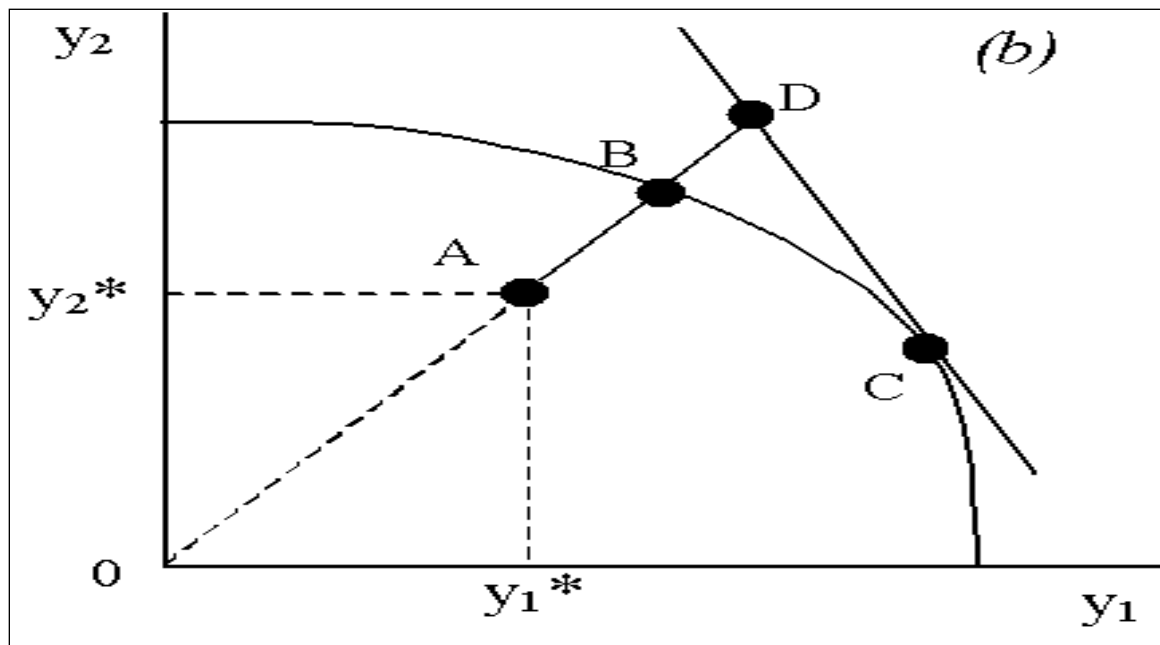


Figure 4.2: Input (a) and output (b) oriented efficiency measures

Source: Kumbhaker and Lovell (2000)

4.3.5 Application of the Cobb Douglas Production function

In economics, the Cobb-Douglas functional form is widely used to represent the relationship of an output to inputs. It was proposed by Knut Wicksell (1851 - 1926), and tested against statistical evidence by Charles Cobb and Paul Douglas in 1928. They considered a simplified view of the economy in which production output is determined by the amount of labour involved and the amount of capital invested such as mechanizing the agriculture sector. While there are many other factors affecting economic performance, their model proved to be remarkably accurate.

Cobb-Douglas production function shows physical output as labor and capital inputs; that is:

$$Q = AL^a K^b \dots\dots\dots(12)$$

where Q is output, A, α , b are constants, and L and K are labor and capital, respectively.

Capital can be interchanged with labor without affecting output.

$$P(L, K) = bLaKb \dots\dots\dots(13)$$

where:

- P = total production (the monetary value of all the produce or goods produced in a year)
- L = labor input (the total number of person-hours worked in a year)
- K = capital input (the monetary worth of all machinery, equipment, and buildings)
- b = total factor productivity
- The a and b are the output elasticities of labour and capital, respectively. These values are constants determined by available technology.

Output elasticity measures the responsiveness of output to a change in levels of either labour or capital used in production, *ceteris paribus*. For example if $b = 0.15$, a 1% increase in capital/machinery and equipment would lead to approximately a 0.15% increase in output. Furthermore if $a + b = 1$, the production function has constant returns to scale, that is if L and K are increasing by 20% the P is also increasing by 20%. The function is homogenous of the degree, $a + b$, if $a + b > 1$ there are increasing returns to scale; $a + b = 1$ indicates constant returns to scale and $a + b < 1$ indicates diminishing returns to scale.

According to Battese and Coelli (1988) the productive efficiency of a firm/farm after long term capital investment is witnessed in the long run. In the short run returns decrease at an increasing rate, reach a constant level and start to increase but at a decreasing rate. So the argument is that it might be early to anticipate very positive upward curves in the output production as a result of mechanizing the agricultural sector in Zimbabwe. Positive upward curves may be witnessed in the long run. The figures above show the behaviour of a firm/farm in the short and long run after a long term capital investment Coelli (1988).

4.3.6 Short run - capital fixed - decreasing returns to scale

We usually assume that capital is fixed in the short run. Suppose the firm/farm is to operate efficiently (using the cost minimizing combination of inputs) producing product in the 25 - 35 unit range (using the decreasing returns Cobb Douglas production function). It might set its capital $K = 35.56$, which is the amount of capital associated with producing $q = 30$ units of product.

4.4. The key variables considered for the model

Sixteen variables were involved in the productivity of maize yield and also influence household food security. These include gender, age, household size, education, income generating activities, cost if hired, equipment not obtained, tractor costs, labour costs, animal costs, area of maize, quantity of seeds, quantity of fertilizer, amount consumed, diesel costs, size of land. Table 4.1 summarizes variables specified by stochastic frontier production model with maize yield as the dependent variable and their expected signs.

Table 4.1: Summary of the variables specified in the model

Variables	Variable definition	Expected sign
Gender	Gender of the household head. Dummy variable= 1 if farmer is male; 2 if female.	+
Age	Age of the household head in years.	+
Household size	Actual number.	-
Income generating activities	Activities for generating income by the household head. Dummy variable = 1 if the farmer has access; 2 if farmer does not.	-
Income	Actual income of the household head in Rands.	+
Cost if hired	Actual cost in Rands.	+
Size of land	Actual size of the land in hectares.	+
Equipment not available	Equipment availability to the household head. Dummy variable = 1 if farmer has; 2 if farmer does not have.	+
Tractor cost	Costs of tractor for ploughing by the household head in Rands.	-
Diesel cost	Costs of diesel fuel in Rands of the household head.	+
Animal cost	Costs incurred by the household head in the use of animals for production in Rands.	-
Area of maize	Size of the land of the household head for producing maize in hectares.	+
Seeds (kg)	Quantity of seeds used by the household head in kilograms during sowing of all the fields in 2009/10 season.	+
Fertilizer (kg)	Quantity of fertilizer used by the household head during ploughing in kilograms. If the farmer did not use = 0.	+
Amount consumed	Quantity of maize and sorghum consumed in kilograms.	-
Education	The level of education the farmer has attended school is measured in years the farmer has been at school.	+

Source: Field Survey, 2010

4.2: Description of the variables collected

4.3.1 Household size

This is measured by the total number who lives in the household which will have implications for household labour for farm work depending on the age structure of the household. It can also influence the dependency ratio. However a larger household may mean increased farm labour, which enhances labour availability for farm production. Increased production also increases the chances of market access.

4.3.2 Gender of household head

This indicates whether a household is a male headed or female headed household. A male headed household have high chances of obtaining higher yields because males are able to look after their animals and the inspanning is not a problem.

4.3.3 Marital status

Whether the household head is married, single, divorced, widowed. The married household head will be able to reduce food insecurity in their families because they have higher chances of family labour. Increased family labour means increased production for the benefit of the family.

4.3.4 Educational status

Total number of years the head has been at school. This variable is related to the knowledge of the farmer about the importance of improved practices in farming and how well the farmer can interpret technical information and apply these in farming operations. The farmers who are not educated are likely to obtain low yields because of low rate of skills to apply in farming operations.

4.3.5 Age of the household head

This is expressed in number of years of the household head. It is also related to the extent of farming experience as well as the level of capitalization that is possible, with older farmers being more experienced and more likely to have accumulated greater wealth that can be available for investing in agricultural production.

4.3.6 Power used

Whether or not household head used animal or tractor in some or all of the farming activities and whether or not power used is owned, hired or borrowed. However, farmers owning any type of power used are able to obtain more yields because they are able use at any time and without any payments incurred.

4.3.7 Land size (Ha)

This is the size of the land used for ploughing in hectares. Bringing more land under cultivation will, in and of itself, boost the household's gross farm output, even if productivity is not increasing. However, one would expect higher output if there is utilization of available land, and lower output otherwise. From the higher production, the farmer stands a better chance of more surplus which could be marketed easily.

4.3.8 Fertilizer quantity (kg)

This variable is expressed as the quantity of fertilizers used in kilograms. The expectation is that enhanced fertilizer consumption would lead to higher production and productivity. Conversely, a farm unit that is too constrained to afford adequate amounts of fertilizer will most probably experience lower productivity which will translate to lower physical output and ultimately less marketable surplus. Low production will increase the rate of food insecurity.

4.3.9 Household labour

This is referred as the household members who assist with farm labour. It is expected that larger families will have more household labour that can be potentially deployed for farm work than smaller sized families. However, a larger household may enhance farm production under the kind of labour-intensive farming systems that prevail in communal agriculture.

4.3.10 Purchased seeds

This measures whether or not farmers are able to use certified seeds and quality varieties for high production. Farmers who are able to buy seeds on yearly basis are likely to obtain higher yields. Farmers using seeds from previous harvest are likely to obtain low yields because the seeds no longer protected from pests in the storerooms.

4.3.11 Manure application

Whether or not farmers are able to use manure in their fields. Farmers using manures in their fields are likely to get higher yields. This is because production is improved by replacing nutrients from the soil.

4.3.12 Support services

Whether or not a farmer is able to receive any support from the department of agriculture concerning production. Farmers which have access to support services are likely to realize higher production.

4.3.13 Market access

Whether or not farmers are able to sell their produce. Sufficient access to market is likely to improve the productivity of the small scale farmers because there is a guarantee that surplus produce would be sold. This is because the farmer who has access to markets, is able to produce at a higher level than farmers producing for consumption only. The ones producing only for consumption are less likely to alleviate or reduce poverty through income earning as there is likely to be none.

4.3.14 Extension contact

Whether or not a farmer is able to consult extension workers at any stage of production to receive guidance on farm operations and to deal with emerging farm problems. Farmers who are able to consult extension workers are likely to benefit as they may get helpful information from extension workers.

4.3.15 Employment status

Whether a farmer is employed full-time farmer, part-time farmer, retired (pensioner). This is because farmers who are employed are able to finance their farming operations by buying improved inputs or be able to buy required equipment to be used as a result of their steadier income stream.

4.3.16 Distance to Markets (km)

This is expressed as the distance travelled by the farmer to buy inputs or sell produce in km. The greater the distance to the market, the higher the problems in terms of the availability of transport and transport costs. Farmers who are located far away from the market area, are likely to lack market access if they do not possess their means to transport their produce. Therefore, farmers who are far away from the market area, are likely to produce at a higher costs.

4.3.17 Production constraints

This variable is measured by availability of inputs, costs encountered for maintenance or servicing of power owned, costs during production or ploughing late. The increased production constraints are likely to lower the production level of the farmer and contributes to food insecurity

4.3.18 Farmer organizations membership

Whether or not farmer is a member of any organization. Farmers who are members of the organization will be able to obtain skills and information regarding production hence they will also get information on marketing. Farmers exposed to information is able to obtain higher yields and access to surplus.

4.3.19 Crop yield (Kg/ha)

This variable measures the amount of crop output (maize and sorghum) in kg/ha. The higher yields from both crops will lead to access to surplus and good access to markets. Higher yields will also lead to reduction of food insecurity

4.3.20 Technical information

This variable measures the information which a farmer needs to improve production and marketing of farm produce. Farmers with less information are likely to produce less due to low level of information regarding production and marketing opportunities.

4.3.21 Farm Equipment

This measures the availability or absence of equipment used for farm production such as ploughs, planters, disc harrows etc. Farmers who lack equipment are likely to produce less or not at all as they will obtain equipment later than their better-endowed neighbours

4.3.22 Off-farm income

This variable measures whether household has other off-farm and non-farm activities that generate income. Off-farm income can help in lowering technical constraints since the farm has alternative capital inputs. According to Mashatola and Darroch (2003), farmers who lack off-farm income are likely to be affected by finance-related technical constraints than those who have. Therefore, there is a positive relationship between off-farm income and market access.

4.3.23 Farming experience

This variable measures the number of years a farmer has been in farming. Therefore, the less the number of years the farmer is involved in farming, the higher the probability of being technically constrained because certain farming techniques require that the farmer possesses some degree of experience.

4.3.24 Other income generating activities

This measures whether a farmer is having some of the income generating activities which can assist in buying of inputs for farming. Other generating activities can help in lowering technical constraints since the farm has alternative capital inputs. So there is positive correlation between other income generating activities and the market access.

4.3.25 Average monthly income of the household head

This variable measures how much the household is earning on monthly basis. Household head that has access to average monthly income will be able to invest in farming and can get higher yields. Farmers with higher monthly income will adopt improved techniques hence obtain higher yields. Therefore, there is positive correlation between average monthly income of the household head and market access.

4.5 Methods of data collection

The study used both primary and secondary data. Secondary data were useful for background information and for the researcher to get a better understanding of the study area. The main sources of secondary data were the previous studies conducted in the study area and the data provided by the Ministry of Agriculture. Primary data were obtained from farmers and extension workers in the areas sampled namely; 'Mapotsane, Potsane, Tsoloane and Siloe in the lowlands of Mohale's Hoek district of Lesotho.

4.5.1 Transect walk

The researcher and a group of farmers, local leadership of the communal areas and extension workers in the Ministry of Agriculture took on a transect walk. Through the walk the researcher got an overview of the area and made general observations. It was during this walk that the researcher saw physically the animals, kraals, tractors, some equipments and field areas. The researcher also interacts with some household heads in the areas. The extension workers and the village heads who were to be used as enumerators helped in identifying issues relating to land use, cultivated crops, cultivation patterns and the mechanization programmes in the area.

4.5.2 Sampling framework and purpose

Forty farmers were sampled randomly in each of the sampled villages. However, due to limited number of farmers who utilise tractor power and animal power in some villages, the total sample size declined from hundred and sixty to one hundred and eighteen. Lists of households/farmers supplied by the chiefs were used. The primary sampling unit in the survey was the ward (a unit into which a district, a city or town is subdivided for administration and election purposes). The choice of the sampling unit in the project areas was based on the fact that ward boundaries are still intact.

4.5.3 Sampling methods

The sampling frame comprised of 118 farmers and 4 extension workers drawn from the lowland area of Mohale's Hoek district. Farmers were classified into four groups:

Group 1: farmers with cattle and use them for ploughing

Group 2: farmers with tractor and cattle and use them for ploughing

Group 3: farmers with tractor only and use it for ploughing.

Group 4: farmers without cattle and tractor and hire when ploughing

Classification was based on the data on farmers using animals and tractors and without power for the production of both maize and sorghum cereal crops. Stratified sampling was used where farmers were clustered according to geographical location because the villages sampled consisted of many villages and the sample had to be representatives of the whole lowland of the district of Mohale's Hoek. After grouping, the farmer's location was identified and simple random sampling was used to represent each target group in each selected village. Although simple random sampling is tiresome and not usually the most convenient sampling method (Babbie, 1973), it was the most convenient in this study because it gave every farmer an equal chance of being selected.

4.5.4 Household interviews and administering of questionnaires

Questionnaires consisting of both open and close ended questions were used for data collection in this study. Information was gathered on demographics, land, assets, capital, challenges, extension services, markets, organizations and institutional support services. These questionnaires were delivered by the researcher and the two enumerators to the respondents giving them oral and written instructions. The face-to-face interviews were conducted in the respondents' dwellings and lasted for an hour at most. These interviews ensured that all questions were clear and understood by the respondents and allowed further probing when particular answers were encountered until point of clarity was reached. The research team ensured that all questions were attended during the interviews. The questionnaire used for collection of data which included as appendix 1 The questions were written in simple English but the interviews were conducted in Sesotho and English. The research team convinced the respondents that information they provided was private and confidential. The exercise was done at the lowlands area of Mohale's Hoek and 118 households were interviewed with four extension workers from the Ministry of Agriculture.

Unstructured interviews were conducted with extension workers from the Ministry of Agriculture and food security in Mohale's Hoek district. The purpose of these interviews was to

find out from extension workers some of the agricultural practices and type of power used mainly and productivity levels that are engaged by small scale farmers in the lowlands of Mohale's Hoek. Extension workers were selected by their departments based on their knowledge in terms of the information that was needed by the study.

4.5.5 Focus groups

In the first month of the study, the researcher conducted workshops with farmers producing maize and sorghum and using animals and tractors and those who hire when ploughing in the project areas sampled. In these workshops, focus groups were used to explore the views of the farmers at village level on their attitudes towards the type of power used, crops produced, and production practices employed. Focus groups according to (Kitzinger, 1995) are organized group discussions with groups discussing given topics.

The farmers were organized into different groups based on the power used. Four groups were formed as indicated above during sampling procedure. Farmers were also grouped according to their type of power ownership, crop and livestock production systems.

The focus groups actually helped farmers to explore and clarify their views through interacting in ways that would not have been possible in household interviews. Focus groups were helpful in bringing out several attitudes, beliefs, reactions and feelings.

4.6 Analytical Framework:

The objective of the study is to determine the impact of animal traction on agricultural productivity. Farmers' Gross Margins for the crop namely maize over a period of one season. Yield levels for the maize crop have been established from both animal and tractor powers used. Thereafter a linear regression analysis was performed to determine the impact of animal traction alone with other explanatory variables on the output of survey farmers.

In addition, the survey households were divided into two groups based on the nature of the power source they employed. A dummy variable was introduced to indicate the use and non-use of motorised power. Those with motorised power such as tractor were scaled one and zero

otherwise (i.e. Then the independent sample t-test was applied to test for the equality of means in the cases of maize and sorghum production).

Further non-parametric tests were conducted to explore the extent of group differences in the survey data based on the type of power used. Making use of the explore option in Statistical Package For Social Sciences, it was possible to calculate and display the group means, median values, variances, interquartile ranges, kurtosis, among other statistics.

4.13 Chapter Summary

The data collection was conducted in four villages in the lowlands of Molepolole district of Lesotho namely: Molepolole, 'Molepolole, Molepolole, and Molepolole. Data was collected from 118 farmers and 4 extension workers from the Ministry of Agriculture using the structured questionnaires which contained a few open-ended questions. Face to face interviews were employed to collect data from the respondents. Descriptive statistics were employed to access the household characteristics of sampled households, farming systems and challenges facing small scale farmers. Some models were employed by the study were viewed in this chapter where Gross Margin Analysis was conducted for the animal power and tractor power yield levels for the production of maize to compare the two types of power. Some of the diagnostic tests to detect serial correlation and heteroskedacity and t-tests approach and the multi-linear regression model were employed for analysis of data. However the Stochastic Frontier Production Model was performed for the production efficiencies. The chapter then dwelled more on the key variables for the study and their descriptions.

CHAPTER 5

PRESENTATION OF RESULTS

5.1 Introduction

The overall objective of the study is to determine the impact of animal power on agricultural productivity in the district of Mphahle's Hoek. Specifically the study aimed to identify the impact on productivity of two principal crops namely, maize and sorghum. This chapter presents the results of the analyses of the survey data linked directly to the objectives and research questions. The chapter begins with a presentation of the demographic information and socio-economic characteristics of the survey households. This is followed by a discussion of the farming systems, highlighting its challenges and opportunities. Lastly, the impact of animal power on agricultural productivity is presented by the interpretation of three separate analytical procedures, namely a gross margin analysis, a multiple-linear regression model and the stochastic frontier model which additionally tests the technical efficiency of the farming system with respect to the type of animal power employed.

5.2 Demographic information and socio-economic characteristics

This section discusses the households' demographic features in respect to gender, age, marital status, household size, and educational status, average income, farming experience and employment status. These aspects are important because according to Makhura (2001), the household head coordinates the main household activities and the head's decisions are mostly influenced by such factors. As stated earlier this study was conducted in the Lowlands of Mphahle's Hoek district of Lesotho. The results of the analysis of demographic data are presented in table 5.1.

Table 5.1: Summary statistics of demographic variables

Variables	Total farmers	Min	Max	Mean	Std. Deviation
Gender	118	54	64	1.53	0.501
Age	118	23	92	56.50	14.095
Marital status	118	1	3	2.25	0.492
Household size	118	1	13	5.46	2.297
Educational status	118	0	16	5.78	3.511
Employment status	118	1	6	2.37	1.338
Farming experience	118	1	50	16	10

Source: Field survey data (2010)

5.2.1 Gender of household heads

The gender of household heads has been presented on Table 5.1. The gender has been categorised into male and females. The results indicated that there were 54 males farmers and 64 females sampled in the study. Table 5.2 presented the gender distribution in four villages sampled, namely; ‘Mapotsane, Potsane, Tsoloane and Siloe. From the sampled villages, females dominated as household heads. Efforts were made to improve working conditions of agricultural workers particularly female workers as these constituted the highest percentage of human labour force on fields (FAO, 2000). Some of the farming activities performed by women included weeding, harvesting, irrigation and cooking. According to King (1985), some of these farming activities improve productivity if done very well by the farmers, highlighting the importance of skills and experience as crucial inputs in smallholder development.

Table 5.2: Gender distribution in sampled villages.

Villages	Tsoloane (N=28)		Potsane (N==30)		Siloe (N=30)		Mapotsane (N=30)	
	Number (N)	Percent (%)	Number (N)	Percent (%)	Number (N)	Percent (%)	Number (N)	Percent (%)
Females	13	46.4%	17	56.7%	16	53.3%	18	60%
Males	15	53.6%	13	43.3%	14	46.7%	12	40%
Total	28	100.00	30	100.00	30	100.00	30	100.00

Source: Survey, 2010**5.2.2 Age of the household heads.**

The ages of household heads are presented on Table 5.1. The age of farmers sampled in the areas range from 23 to 92 which indicated that there were young, and old farmers involved in farming in the project areas. The results further showed that older farmers and middle aged farmers are involved more in farming in the project area than the younger farmers below the age of thirty years (Figure 5.1). The observation showed that younger farmers spent much of their time on off-farm activities which were their main sources of income. Schooling was probably another reason younger persons were less frequently observed in farming. According to Hofferth (2003), age of the household head is a very important factor in agricultural productivity as it determines farming experience. This is because the higher the age of the farmer the more productive the farmer due to more experience acquired from farming. On the other hand, young people are not able to acquire land on their own and are more likely to obtain land through older people.

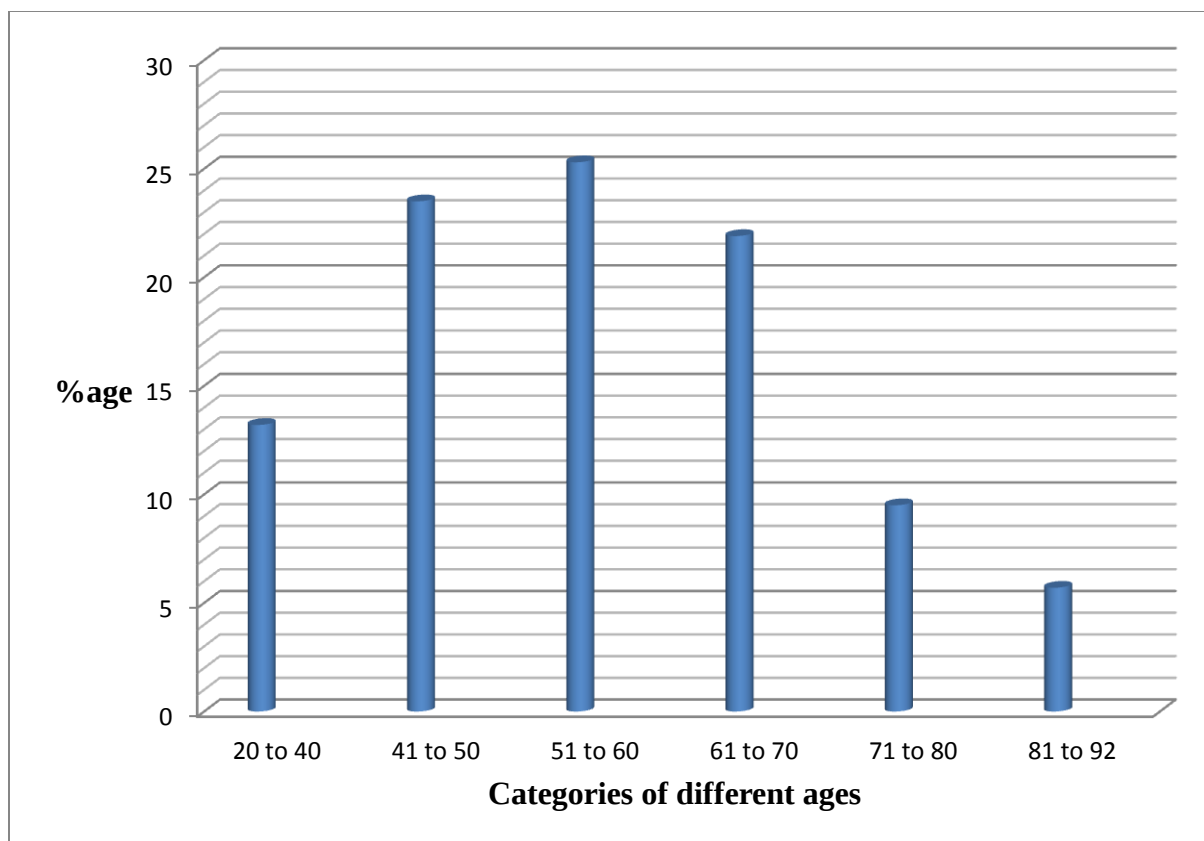


Figure 5.1: Average age range of the household heads

Source: Survey, 2010

The most productive ages in the project areas ranged from 51 to 70 which constituted 25.3%, followed by the ranges of 41 to 50 with 23.5% and 61 to 70 constituting 21.9% of the sample. On overall basis, the dominant age range was 51-60 years, which constituted 25.3% of the total respondents in those villages. The age range which had the least number of respondents in all villages was that above the age of 80 years. According to Joubert *et al.*, (2004), the higher the age of the household head in rural areas, the more experienced the farmer. According to Mbata (2001), the entry of younger farmers into the sector would lead to an increase in food insecurity due to limited farming experience.

5.2.3. The marital status of household heads

The marital status of the respondents is divided into four categories namely married, single, widowed and divorced. Most of the household heads were married and widowed (Table 5.1). Figure 5.2 presents the distribution of marital status of the household heads in the project areas.

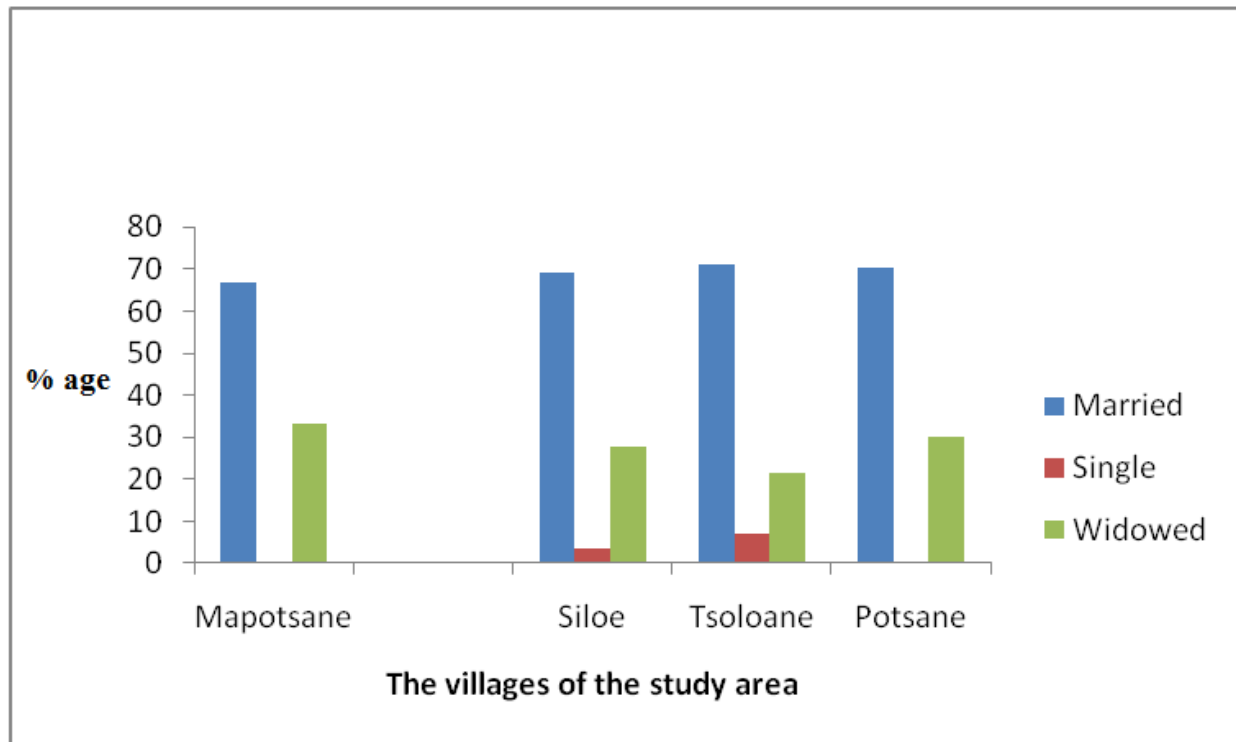


Figure 5.2: Marital status of household heads in sampled villages.

Source: Survey, 2010

The statistics above showed that most farmers were married compared to the other groups, and this is similar to all the villages that were used as case studies. Research so far has shown that, married farmers were always eager to reduce food insecurity in their families through adoption of new techniques in their fields (Mphale *et al.*, 2002). Consequently, the household heads are able to work and also to finance farming activities. In addition, spouses act as family labour. Single and widowed farmers are probably facing high food insecurity problems because they are on their own, and they fail especially in terms of limited resources. According to the Ministry of Agriculture (2010), most smallholder farmers were unable to adopt some of the new techniques for higher productivity.

5.2.4 Distribution of the household size in the sampled villages.

The range of household sizes, minimum and maximum, for the entire sample is presented in Table 5.1. The results indicated that the household sizes ranged from one to thirteen members per household. This indicates that in some of the households, there are more members that assist with family labour during farming. According to Hages *et al.*, (1997), a larger family size means that there is enough farm labour from youth, middle aged and elderly members. However, this also depends on other factors such as household resources like draught power. This confirms that labour can be readily available for farming activities during production of both maize and sorghum with lower costs. However, Paddy (2003) declared that larger families tend to put pressure on consumption than labour as it contributes to production.

Table 5.3 presents the distribution of household sizes in sampled villages. The mean household sizes for Tsoloane, Siloe, Potsane, and Mapotsane were 4.8, 5.3, 6, and 5.7 respectively. The study reveals that in Tsoloane, the household sizes ranged from 1-10 members. This can be attributed to the fact that the members who were able to assist with family labour were those in households with 3-4 members (i.e. about 17.9%) followed by those with 6 members, constituting about 14.3%. In Siloe, the sizes of the households ranged from 1-13 with the highest number with 6 members which carried 26% followed by those with 5 members with 23.3%. In Potsane, the households sampled for the study ranged in size from 2-11. In Mapotsane, the range of the household sizes was 2-9 from which the households with the highest appearances were those with 7 members per household, which represented 23.3%, followed by those with 5 members which represented 16.7%.

Table 5.3: Distribution of household size in the sampled villages.

Villages	Variable	Std. Deviation	Minimum	Maximum	Mean
Tsoloane	Household size	2.3	1	10	4.8
Siloe	Household size	2.4	1	13	5.3
Potsane	Household size	2.3	2	11	6
Mapotsane	Household size	1.3	2	9	5.7

Source: Survey, 2010

In the case of labour, the findings infer that both maize and sorghum producing households did not seem to have much problems with obtaining farm labour.

5.2.5 Educational status of household heads

The educational status of household heads is presented in Table 5.1. The result showed that most farmers in the project areas were not educated. This probably explains the low production of maize and sorghum because a good management skill to efficiently manage both animals and tractor power depends on level of literacy. Educational levels influence adoption of new innovation by farmers. It is generally believed that education enables one to acquire and process relevant information effectively. In the sampled households, educational level was determined by the number of years of schooling completed by the household heads. Figure 5.3 presents the distribution of educational status of household heads. It is clear from the figure that most farmers did not reach the highest level of education.

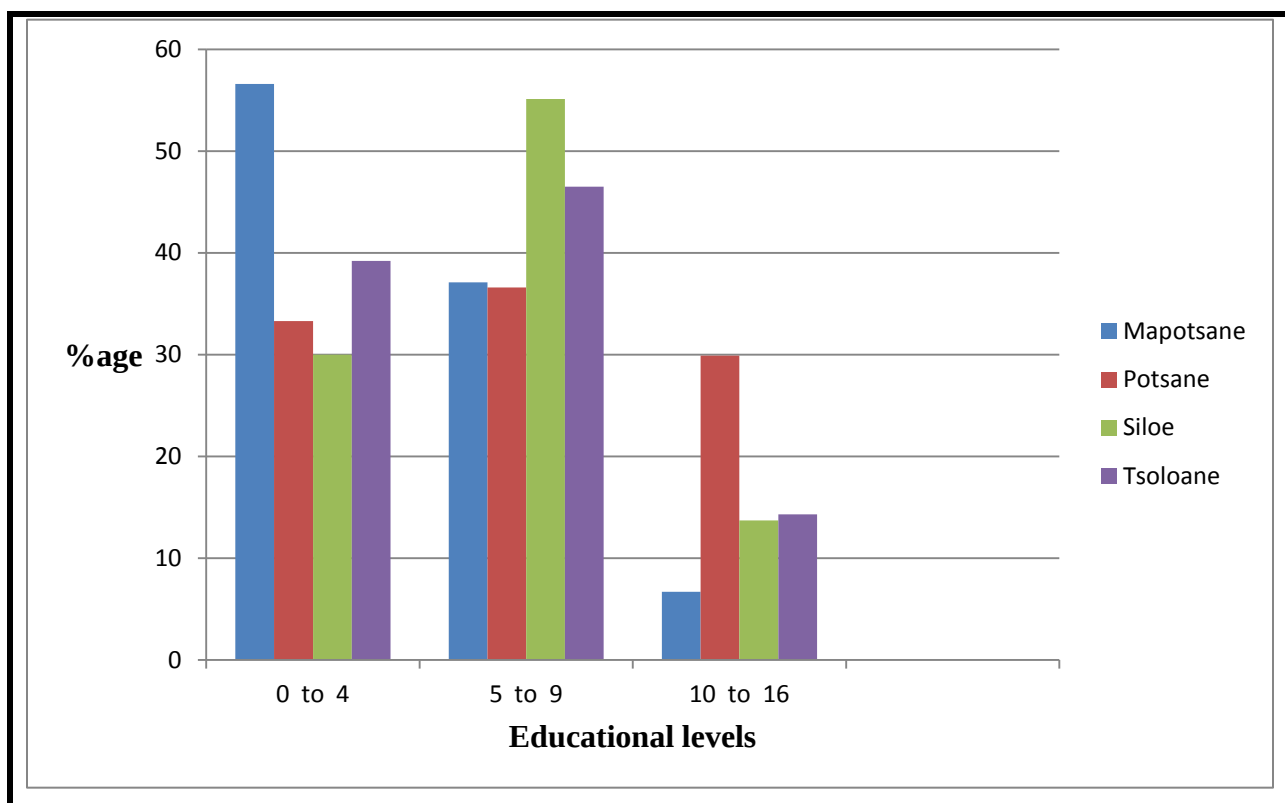


Figure 5.3: Educational levels of household heads

Source: Survey, 2010

From Figure 5.3, the results indicated that in Mapotsane there was the highest rate of farmers who had not gone to school: 56% in comparison to those who had studied up to standard four. The lowest rate recorded, that is 6.7%, are in relation to those who studied up to standard ten and above (including Degree level). In Potsane, 36.6% of the respondents studied between standard five and standard nine, and this represented the highest percentage. The lowest statistics represented those between standard ten and degree level. In Siloe, the highest levels of study were those who studied from standard five until standard nine. The lowest rates were those who studied from standard ten to the level of degree. In Tsoloane, the highest rates were obtained from those who studied from standard five to standard nine. The lowest rates were those who studied from standard ten to degree level. From the study, there was a great variation between the villages in terms of levels of education. In the sampled households, educational level was determined by the number of years of schooling completed by household heads.

5.2.6 Farming experience of the household heads

Farming experience of the farmers is determined by the number of years a farmer has been engaged in farming. Table 5.1 indicated the farming experience distribution in the sampled areas of the study. The results showed that there were farmers with a maximum of fifty years and others with a minimum of one year. This indicated that there were farmers with a lot of experience which can maintain high production of maize and sorghum. According to Joubert *et al.*, (2004), the more experience the farmer has, the higher the production from the fields and more the access to land for the benefit of the younger people.

5.3 Farming systems and socio-economic characteristics

This section addressed the first specific objective of this research, namely the description of the farming systems in which the challenges and opportunities are highlighted. In order to achieve this objective, data on cropping patterns, livestock production systems, assets or resource ownership and pattern used and challenges faced by the farmers in the farming system has been discussed.

5.3.1 Cropping patterns

The following section contains Table 5.4 which entails the statistics of cropping patterns which will be discussed throughout the section. Variables included members that assisted with labour, land acquired, systems adopted, size of land, application of manure, maize yield, sorghum yield, amount consumed, seeds (kg), fertilizers (kg), seeds cost, fertilizer cost, coping strategies, cultivation of the land on yearly basis.

Table 5.4: Statistical data for the cropping patterns and livestock systems.

	N	Min	Max	Mean	Std.Dev	Kurtosis	
	Statistics	Statistics	Statistics	Statistics	Statistics	Statistics	Std. Error
Members assist with labour	118	1	7	2.25	1.228	1.961	.442
Size of land(ha)	118	.400	15.4000	2.24127	2.0321306	15.982	.442
Maize yield (kg)	118	.000	7400	.812542	1.2111019	8.802	.442
Sorghum yield(kg)	118	0	8400	5569.87	1085.279	25.476	.442
Amount consumed(kg)	118	0	4440	1082.50	946.428	3.194	.442
Seeds (kg)	118	10	500	24.131	48.4166	82.481	.442
Fertilizer (kg)	118	0	800	53.08	117.773	15.881	.442
Seeds cost (R)	118	0	5000	310.97	508.056	62.987	.442
Fertilizer costs (R)	118	0	2000	128..66	280.169	18.033	.442

Source: Field Survey, 2010**5.3.1.1 Land size and activities**

Table 5.4 presents the average size of the land from the project areas. This is the land that was ploughed during the 2009/10 and the land size ranged from 0.4 ha to 15.4 ha. However some farmers used smaller pieces of land while others used bigger areas. The researcher presumed that farmers using for instance 15 ha of land are likely to produce more as a result of acquiring machinery than those with areas of 0.4 ha. Nonetheless, Table 5.5 presents the distribution of land size into different farming activities performed from the land and the type of power used for each activity.

Table 5.5: Farming activities, power and size of land.

Farming activities	Power used	Number of farmers (%)	Size of land (ha)
Ploughing	Animals		81.97
	Tractor	61.86	182.5
Cultivation	Animals	84.75	224.33
	Tractor	5.93	19.82
Planting	Animals	78.81	206.17
	Tractor	9.32	29.7
Discing	0	0	0
	0	0	0

Source: Survey, 2010

From the Table 5.5, the tractor dominated during the ploughing stage. That is, the land ploughed by tractor is 182.5 ha which means 61.86% of farmers were involved in use of tractor for ploughing, compared to 81.97 ha of land ploughed with the use of animals with 38.14% farmers involved. For other activities such as cultivation, planting and discing, the use of a tractor declined while the use of the animal power increased. For instance, during the cultivation stage, 84.75% farmers were involved in the use of animal power to cultivate 224.33 ha, 5.93% used the tractor to cultivate 19.82 ha of land. Simalanga *et al.*, (2004) stated animal power as the cheapest source of power. From Table 5.5, most farmers do not disc their land after ploughing, hence, they just sow their seeds only. According to Owen (2003), the finer seedbed have higher chances of causing erosion since the particles of the soil would be very small and therefore less able to retain rainwater. However, in the sampled areas, planting is mostly done by animals. This is because 206.17 ha were planted using animals while 29.7 ha used tractors. It was noted that there were 11.86% farmers who did not cultivate their land. According to King (1985), planting is important as it allows farmers to plough a larger area; as such, it can be easier for a farmer to

cultivate in between the rows of the plants as one of the important management strategies for weeding to obtain high production of both maize and sorghum.

5.3.2 Acquisition of land by the household head

The results demonstrate that those with the smallest pieces of land acquired their land through resettlement, while most got it through inheritance. Table 5.6 shows the distribution of land, how it was acquired and the land tenure system used in the project areas.

Table 5 6: Land acquisition by the household head

Land tenure systems used	How land was acquired by the farmer			Total
	Bought	Resettled	Inherited	
Communal	9	12	97	118

Source: Survey, 2010

The land tenure system in Lesotho is communal. According to Marake *et al.*, (1998), authority over land is exercised by chiefs with the help of the headmen who administer land on behalf of the King. Individuals have land rights to small arable and residential plots and enjoy rights to common resources such as grazing lands, mountains and any other land not assigned to individuals. Most household heads seem to have obtained their land through inheritance (Table, 5.6). However 9 households bought the land, while 12 were resettled. It was noted that farmers owning land are able to produce for household food security with lower costs and also have power to choose crops to be grown.

5.3.1.3 Ploughing of the land

Table 5.4 presented data on the ploughing of the land by farmers on year-to-year basis. The results showed that most farmers were unable to plough their land every year. The reason for this was that the farmers in the project areas lacked most resources such as the type of power to use, income and inputs (FAO/WFP, 2007). According to Mphale *et al.*, (2002), the drought conditions in 1992 resulted in farmers losing most of their livestock. However, Figure 5.4 represents the distribution of farmers who were able to plough their land every year and those

who were not. According to Mphale *et al.*, (1992), it is expected that farmers ploughing their land every year will always have something to eat than those who do not.

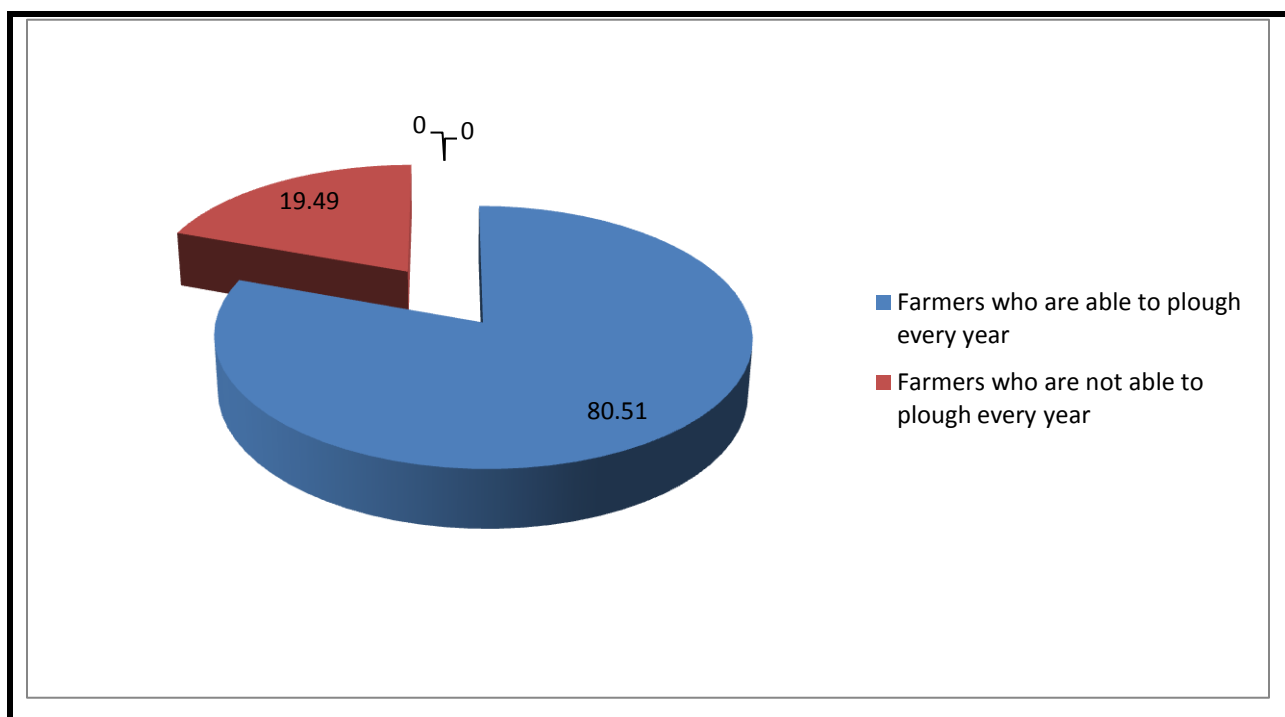


Figure 5.4: Farmers who are able to plough their land every year including 2009/10 season.

Source: Survey, 2010

From Figure 5.4., it is shown that 80.5% farmers ploughed their land on a yearly basis while about 20% did not. It seems that those farmers who were able to plough every year had more food than those who did not plough every year. In some instances, those with ownership of power and equipment used them in the fields. This situation can be linked to the average number of years in handling animals. Available information shows that on average, households had been keeping and managing animals for about 11.6 years with the range of 1 to 50 years. This suggests that these farmers are experienced in the use of animal traction in agriculture. It is also clear that they are not commonly found engaged in non-farm activities. However, farmers who are not able to plough their land every year have high chances of experiencing increased household food insecurity and be counted nationally as part of the statistics of the ultra-poor in Lesotho. According to Marake *et al.*,(1998), land is mainly given to an individual if there is guarantee that he/she would use it effectively. Therefore, low rate of production from the land

would result in the land being taken back by the government and allocated to those who can use the land productively.

5.3.1.4 Gender and farming systems adopted by the household head

Table 5.7 presents farmers who practice monoculture and those who practice mixed farming. Monoculture has the capacity to generate higher yields if farmers have sufficient resources, such as inputs especially fertilizer and improved seeds. According to the Ministry of Agriculture (2010), most farmers were not able to respond to new practices due to lack of resources, so farmers should practice crop rotation which will not require high amount of fertilizer application. Table 5.7 shows the distribution of the gender in relation to different farming systems which were used in Tsoloane, Potsane, Siloe and Mapotsane.

Table 5.7: Types of farming systems adopted in relation to gender of the household

Systems adopted	Monoculture	Mixed farming	Crop rotation	Total
Gender of household: male	26	6	23	55
Female	35	6	22	63
Total	61	12	45	118

Source: Survey, 2010

Monoculture is practised mostly in Mapotsane, Potsane, Siloe and Tsoloane. Crop rotation follows monoculture in the sampled villages. That is, 26 male household heads practise monoculture, and 23 male household heads practise crop rotation compared to 35 female household heads who practise monoculture and 22 female household heads who practise crop rotation in all sampled villages. Thus, the number of farmers practising monoculture was higher than for crop rotation. Since monoculture was the most practised type of farming, it needed more application of nutrients in the form of fertilizers to replace the used nutrients from the soil. There is limited application of fertilizers in most of the villages and this led to low yields due to the use of the same farming system where only one crop is grown on an annual basis.

5.3.1.5 Crops produced and yield levels

Crops that were produced in the project areas include maize and sorghum. Among the crops, maize is a staple food and sorghum is a substitute. These crops also perform better as most farmers practice dry land farming in Lesotho (FAO/WFP, 2007). Both crops played an important role in rural households. Both crops contributed to household food security. Table 5.8 presents crops produced, size and yields. It is important to note that a surplus if experienced could be sold to meet other needs in the household.

Table 5.8: Summary of the crops produced, size of land and yields.

Crops Grown	Number of farmers (%)	Average Area (Ha)	Range of land (Ha)	Average Yields (kg/ha)	Average Yield range (kg/ha)	Total Yield (kg/ha)
Maize	90.68	1.464	0 – 8	1043	0 - 9240	123130
Sorghum	55.93	0.813	0 – 7.4	569.9	0 - 8400	67245

Source: Survey, 2010

From Table 5.8, maize is mostly planted compared to sorghum. For instance, about 90.7% of the farmers planted maize in the 2009/2010 season. Also maize has an average land area of 1.464 ha with a range of 0 - 8 ha while sorghum hectareage averaged 0.813 ha with a range of 0 – 7.4 ha. In terms of physical production, the average yield of maize was 1043 kg/ha while that of sorghum was 569.9 kg/ha. This confirms the relative superiority and importance of maize over sorghum in these areas. According to FAO/WFP (2007), maize is grown on a larger portion of land than other crops, such as sorghum. This is because maize is the staple food of Basotho. Nevertheless, sorghum is still one of the important products in the country because it is mostly used for mealie meal, traditional beer, and *mahleu* (a form of traditional porridge). In addition, sorghum has very strong root systems, as a result, it can tolerate drought more than other crops, including maize. Although Lesotho climatic weather conditions are highly variable, both sorghum and maize are still preferred to other crops. This is also substantiated by the fact that, in prevailing climatic weather conditions, both are performing well in the local soils. However, the total yields fall below requirement and mean that there is a lot of starvation as both crops give very low

production relative to the population. According to WFP (2010), Lesotho faces crisis of food insecurity.

5.3.1.6 Costs and amount of crops consumed

Table 5.4 presented the amount of crops consumed by each household. The results showed that some farmers got nothing while others consumed about 4440 kg of both maize and sorghum. However, Table 5.8 shows the total costs and total amount of crops consumed by the households of both maize and sorghum in the project area.

Table 5.9: Crops grown and total amount of crops sold and consumed in the project area.

Crops Grown	Amount consumed (kg)	Amount sold (kg)	Average sold (kg)	Average consumed (kg)	Total amount of both (kg)
Maize and Sorghum	127735	59284	502	1082.5	268904

Source: Survey, 2010

From Table 5.8, maize and sorghum were the most consumed products compared to those sold. This is evidenced by 127735 kg that was consumed in the project areas, compared to just 59284 kg which was sold in the 2009/10 season. Although there was so much consumption, the statistics also demonstrated that there was very low productivity in the same year, but at the same time, there was little access to markets. According to FAO/WFP (2007), insufficient access to markets by smallholder farmers in these areas results in farmers producing at a subsistence level especially in the cases of maize and sorghum. The total amount of both maize and sorghum produced was 268904 kg, which is very small compared to the increasing population shown by the Lesotho Bureau of Statistics (2006). The low rate of production entailed that there were chances of high food insecurity in the project areas.

5.3.1.7 The levels of yield during 2009/10 season.

Table 5.4 presented the yields of both maize and sorghum. Generally, maize gave higher yields than sorghum. However Figure 5.5 showed that the yields in Lesotho in 2009/10 season were low throughout the whole country. According to Lesotho Meteorology (2010), the amount of

rain fall in 2010 was high (at 724mm), but it came very late and this contributed to failure by many farmers to plough as the rains were heavy and persistent.

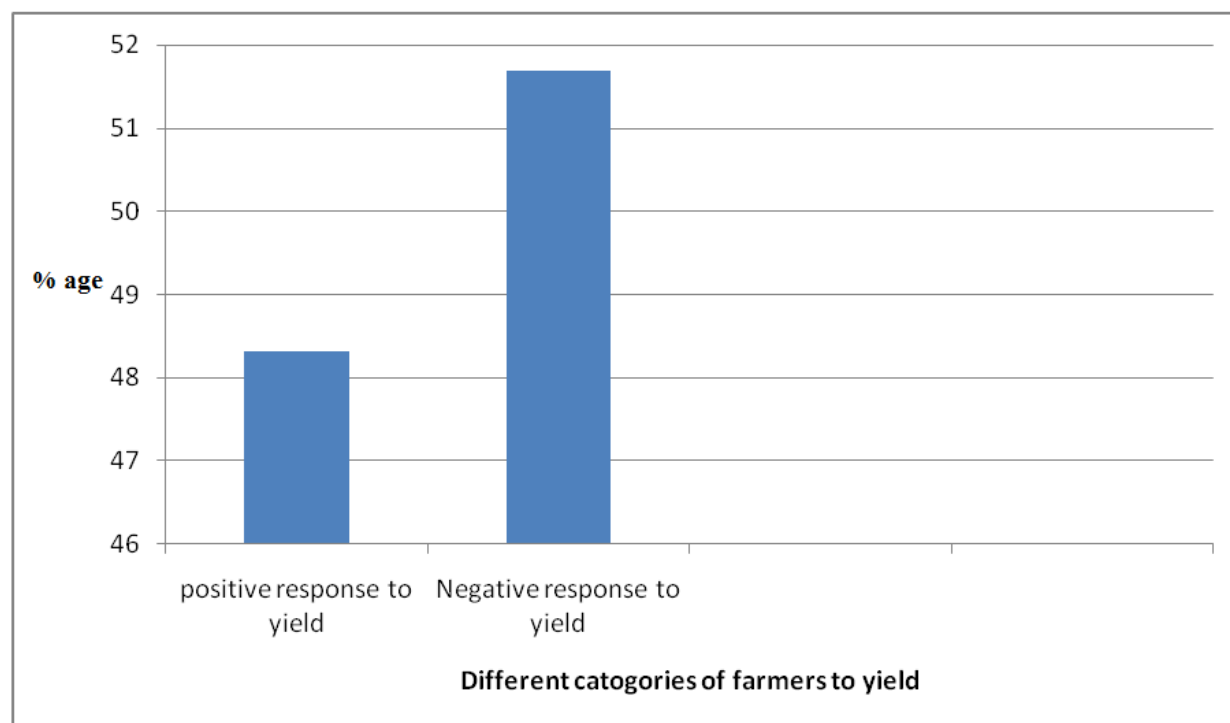


Figure 5.5: Yield levels during 2009/10 season

Source: Field survey, 2010

According to Figure 5.5, 48.31% farmers had good yields while 51.69% had low yields. However, the yields were still very low compared to the past years. According to WFP (2010), Lesotho faced very low production in the 2009/10 season than most of the countries in the region and this led to a high rate of food insecurity in 2010, creating the need for significant humanitarian assistance which would be of help to the majority of the rural households.

5.3.1.8 Inputs used during 2009/10 season.

This section describes the inputs that were used in the production of maize and sorghum. The bulk of these inputs consisted of fertilizers and seeds as shown in Table 5.4.

(a) Seeds used during 2009/10 season

According to Table 5.4, the quantities of seeds used during the 2009/10 season ranged from 10 kg to 500 kg. This is because some farmers ploughed larger areas while others ploughed smaller

areas. The average quantities of seeds used was 24.13 kg. Table 5.10 presents the average quantities used by each farmer in the 2009/10 season. Of course, some farmers used more seeds than other farmers, because some farmers engaged in block farming where a higher acreage was cultivated.

Table 5.10: Quantities seeds used per season by different farmers

Total number	Mean	Std.dev	Minimum	Maximum
118	24.13	48.42	10	500

Source: Survey, 2010

According to Table 5.10, different use of seeds were dependent on the size of the land obtained and availability of resources. This is as a result that land differs for each farmer. However the higher land ploughed indicated higher production which will also lead to improvement of food security of the farmers (Mbata, 2001).

(b) Fertilizers used during 2009/10 season.

As revealed by Table 5.4, the quantities of fertilizers used ranged from zero to eight hundred kilograms with an average of 53.1 kg. The results were based on the fact that some farmers used fertilizers while others ploughed without any application of fertilizers (Ministry of Agriculture, 2010). However Table 5.11 presented the use of fertilizers in 2009/2010 season.

Table 5.11: Fertilizer usage during the 2009/10 season.

Number of farmers	Mean	Stddev	Minimum	Maximum
118	53.1	117.8	0	800

Source: Survey, 2010

Based on the result in Table 5.11, sampled farmers who used fertilizers to improve production were expected to have an improved food security status and those who were unable to use fertilizers to an increasing rate of food insecurity. This is also due to high rainfall during the 2009/10 season which gave an advantage for animal and tractor power users (Lesotho Meteorology, 2010).

(c) Costs of inputs used.

Table 5.4 presents the costs of inputs, that is, fertilizers and seeds used. The results indicate that some farmers did not buy seeds while others bought seeds. Some of the farmers who ploughed larger areas of land used as much as R5000 each. In the case of fertilizers, some farmers did not use fertilizers while others bought fertilizers which cost them R2000. Table 5.12 presented the summary of the inputs used during the 2009/10 season. Inputs such as certified seeds and fertilizers improved the productivity of the crops. Farmers who did not use certified seeds and fertilizers got low yield.

Table 5.12: Costs, total and average of inputs used during 2009/10 season.

Inputs used	Number of farmers (%)	Total amount of inputs (kg)	Average range of costs (R)	Average costs (R)	Total costs (R)
Seeds	100	2847.5	0 – 5000	311	36695
Fertilizers	31.36	6263	0 -2000	128.7	15182

Source: Survey, 2010

Table 5.12 presented that most farmers used seeds and few used fertilizers. This is because 100% used seeds while 31.36% used fertilizers and 68.64% were not able to access fertilizers. As a result, 2847.5 kg was the quantity of seeds used in the 2009/10 season while 6263 kg was the amount of fertilizers used by farmers in the sampled villages in the lowlands of Molepolole district of Lesotho. According to FAO/WFP (2007) most of the households are poor. This is as there is uneven distribution of income in the country mainly between the rural and urban areas which also made most of the households not able to adopt some of the productive practises to increase production. This is from the fact that there are those from both seeds and fertilizers with the range of zero which showed that they are not incurring any costs meaning that they may also be taking most of their seeds from the stored harvest which may have been affected by pests as some of their storerooms are in poor condition. Average costs for seeds are higher than those of fertilizers and the total costs are very high for both showing that most of the farmers are likely to encounter problems when producing crops. This is also declared by FAO/WFP (2007) that most

of fields are not cultivated especially in rural areas where most production is taking place due to high costs of inputs.

5.3.1.9 The coping strategies due to low production.

Coping strategies are conditions considered as a means of solving a certain problem. The results show that most farmers resorted to coping strategies, such as buying food, and/or other family members provided for them during times of hunger. A few households reduced their number of meals or borrowed from relatives. Figure 5.6 provided a summary of the coping strategies that farmers engaged in, as a result of food shortage.

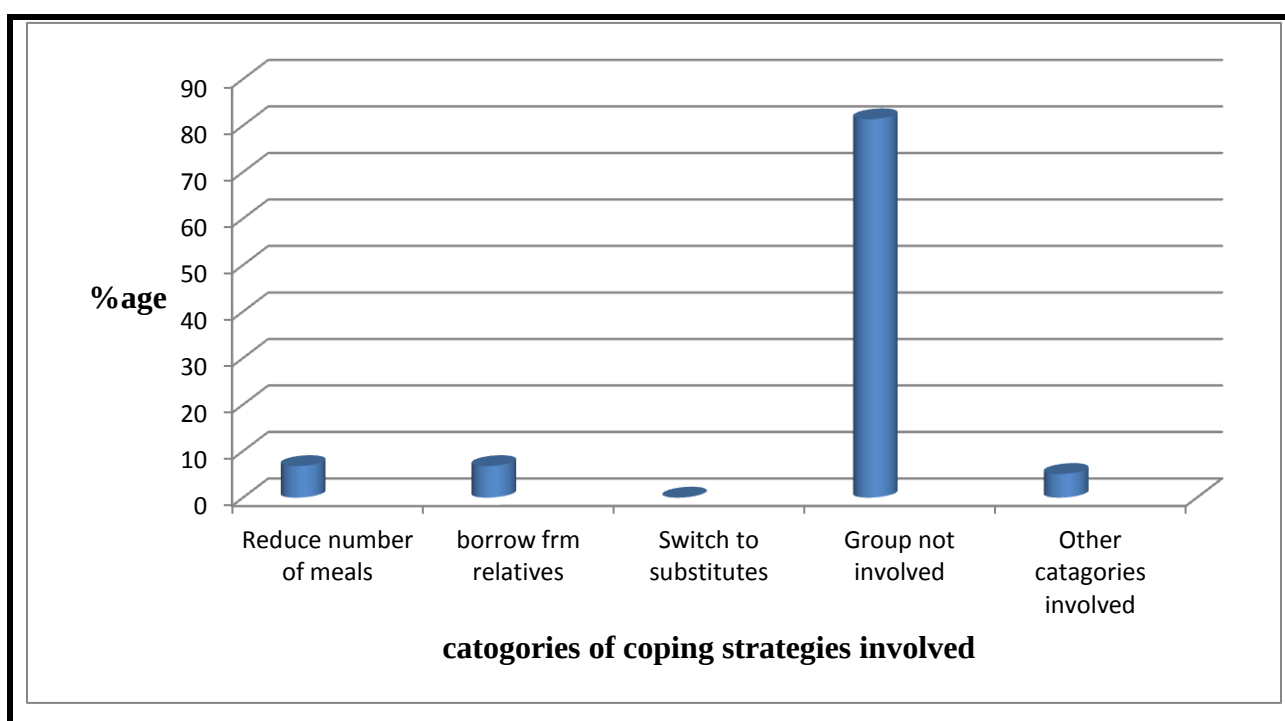


Figure 5. 6: Coping strategies engaged as a result of shortage of food.

Source: Survey, 2010

From Figure 5.6, 81.36% were able to have food to eat. This was as a result of some of the farming activities they were involved in. About 6.78% were able to reduce the number of meals in a day to solve their problem of food and other groups borrowed from relatives and friends to subsidize food respectively. According to Starkey *et al.*, (1995), farmers owning some of the resources such as animals, tractors, or equipment to be used for farming activities, are likely to

have food to eat due to the fact that they may be able to hire such equipment to other farmers or be able to utilize early rains compared to those without any resource.

5.3.1.10 Households who assist with family labour

Table 5.4 indicated that members who assisted with family labor ranged from 1 to 7 members in some households with an average of 2.25. However, Figure 5.7 demonstrated sampled farmers in the villages who are able to assist with family labour in the fields. The more members who assist with farming activities, the higher the chances of production. This results from the opinion that, the yields increased due to some of the farming activities such as weeding that were done at the right time.

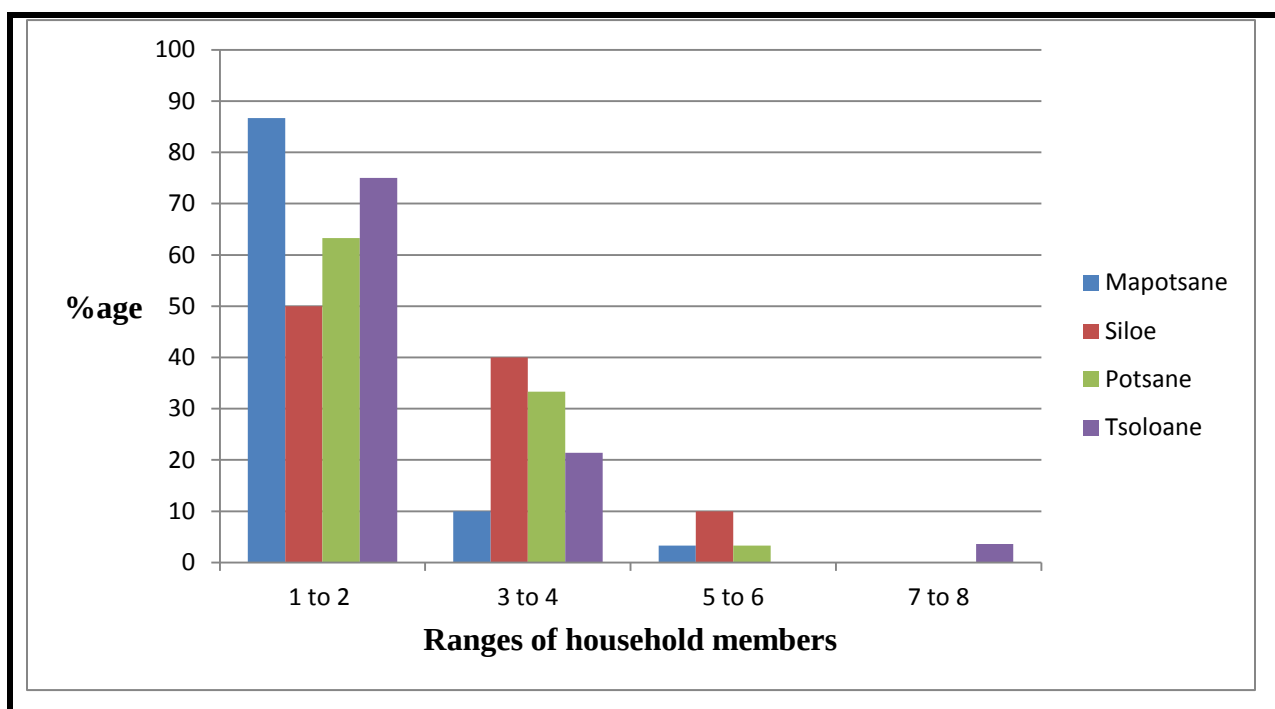


Figure 5.7: Members that are able to assist with family labour

Source: Survey, 2010

In Mapotsane, farmers who were able to assist with labour ranged from 1 to 5 and this constitutes 85%, and only 10% are able to provide labour at the range of three to four members per household to improve production. In Siloe, family labour distribution ranged from 1 to 6 from which the highest percentage of assistance came from labour provided by 1 to 2 members per household which is 50% and the lowest provision of members is in the range of 5 members per

household which carried 3.3%. In Potsane, family labour ranged from 1 to 5 where the highest family labour came from the range of 1 to 2 members which carried 63.3% per household and the lowest range of members is found in five to six members per household which carried 3.3%. In Tsoloane, households who provided labour ranged from 1 to 7 members. This is as a result that 39.3% is provided to those who are able to provide a family labour of two members utmost. From all the four villages sampled, family labour is not a problem. There is always a member in all the areas who is able to assist with some of the farming activities (Figure 5.11). Labour for maize and sorghum producing farmers is not a problem since there were enough people to assist with labour. However, the main issue in these areas is resources such as capital.

5.3.1.11 Application of manures in the fields

Figure 5.8 represented the farmers' application of manure in their fields for higher yields that represent household food security. Manure is applied in the form of fertilizers to replace lost nutrients from the soil; therefore, high production will be maintained by the farmers.

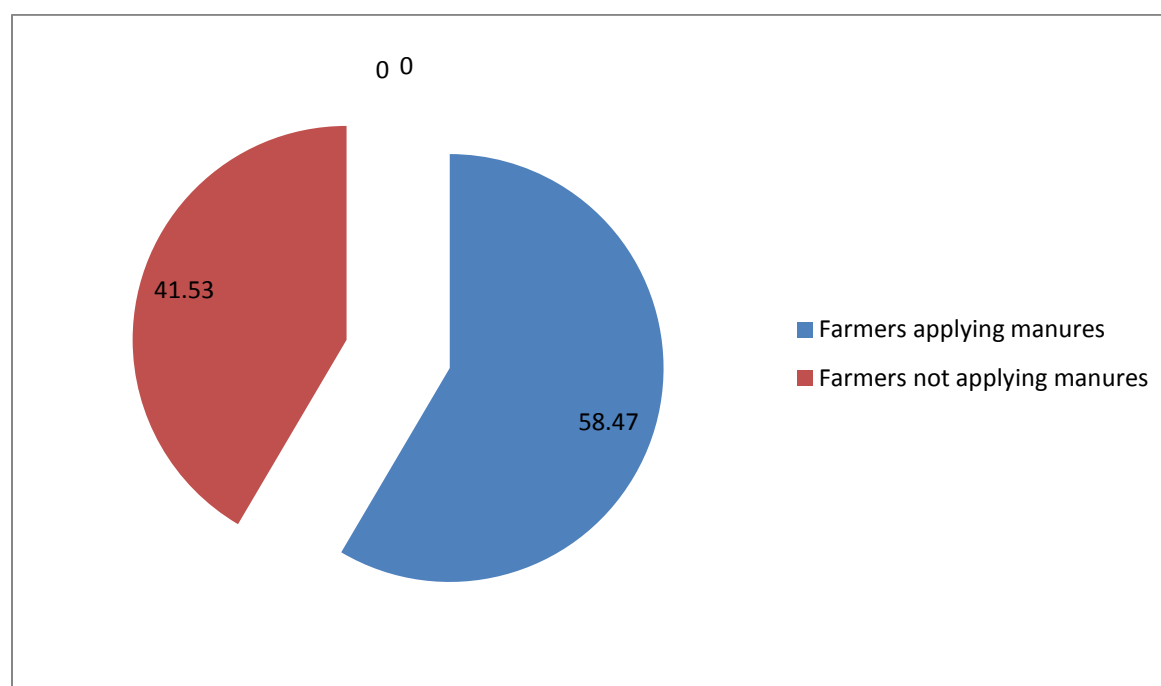


Figure 5.8: Total number of farmers who were able to apply manures in their fields in 2009/10 season.

Source: Survey, 2010

From Figure 5.8, most farmers were able to apply manure in their fields. There were 58.47% farmers who applied manure in their fields from the sampled villages compared to 41.53% that did not. According to FAO/WFP (2007), application of manure replaces the used nutrients from the soil and leads improved production. It is also expected that low nutrients from the soil would not obtain higher production and the farmers will get low production. Most farmers were aware of the importance of fertilizers during crop production, but most were restrained by lack or low income at household level. This contributed to high rate of food insecurity, especially to those farmers who adopted monoculture which needs replacement of nutrients from the soil to improve soil fertility.

5.3.2 Livestock production systems

The section focused on livestock production systems where some variables on livestock production will be looked at in this part. Most of the discussions will be based on Table 5.13 which will be considered for statistics of the variables to be followed below. The variables include training of farmers and type of power.

Table 5.13: Statistics of variables for livestock production systems.

Variable (N=118)	Description	Number of people
Farmer Training on animal traction	Received Training	27
	Not trained	91
Type of Power	Animals	62
	Tractor	56

Source: Field survey, 2010.

(a) Types of power adopted by household heads and the status

Table 5.13 discusses types of power used by farmers whilst, Table 5.14 presented the distribution of the type and status of power in the project areas. From the statistics, animal power is mostly used than tractor power. Animal power is the cheapest type of power for the conditions of the smallholder farmers in the lowlands of Mohale's Hoek district. However, farmers owning both tractor and animal power produce at a lower cost, as they are able to plough bigger areas of land

with tractors whilst other activities such as planting, cultivation would be done using animal power. But farmers without any type of power would have problems when farming.

Table 5.14: Summary of the type and status of power used.

		Type of power		
		Tractor	animal	Total
Status of power	Own	16	27	43
	Borrowed	0	2	2
	Hired	40	33	73
Total		56	62	118

Source: Survey, 2010

From table 5.14, sixteen farmers owned tractors and twenty seven owned animals. Only two farmers borrowed animals. Tractors are hired by forty household heads while thirty three household heads hire animals. Most farmers hire both tractor and animals for farming where most hire tractors. This showed that some farmers in the project areas are producing at a higher cost. According to Joubert *et al.*, (2004), tractors are only efficient at fields exiting four hectares and are capital intensive. In addition, there are few tractors available in rural areas. FAO/WFP (2007) further declared that there seemed to be a declining quantity and quality of livestock in rural areas of Lesotho and results in less area to be cultivated, hence low production for the rural households.

(b) The dominant animal power used in the project area.

Table 5.13 indicated that cows were the mostly used type of animal power. Figure 5.9 outlines the summary of animal draft power used and the percentages. Animal power is the cheapest source of power which could easily be managed by the farmers even though sometimes some farmers fail to manage them. Animals if well managed improve the household food security. This is as animals graze on natural grazing land in the project areas.

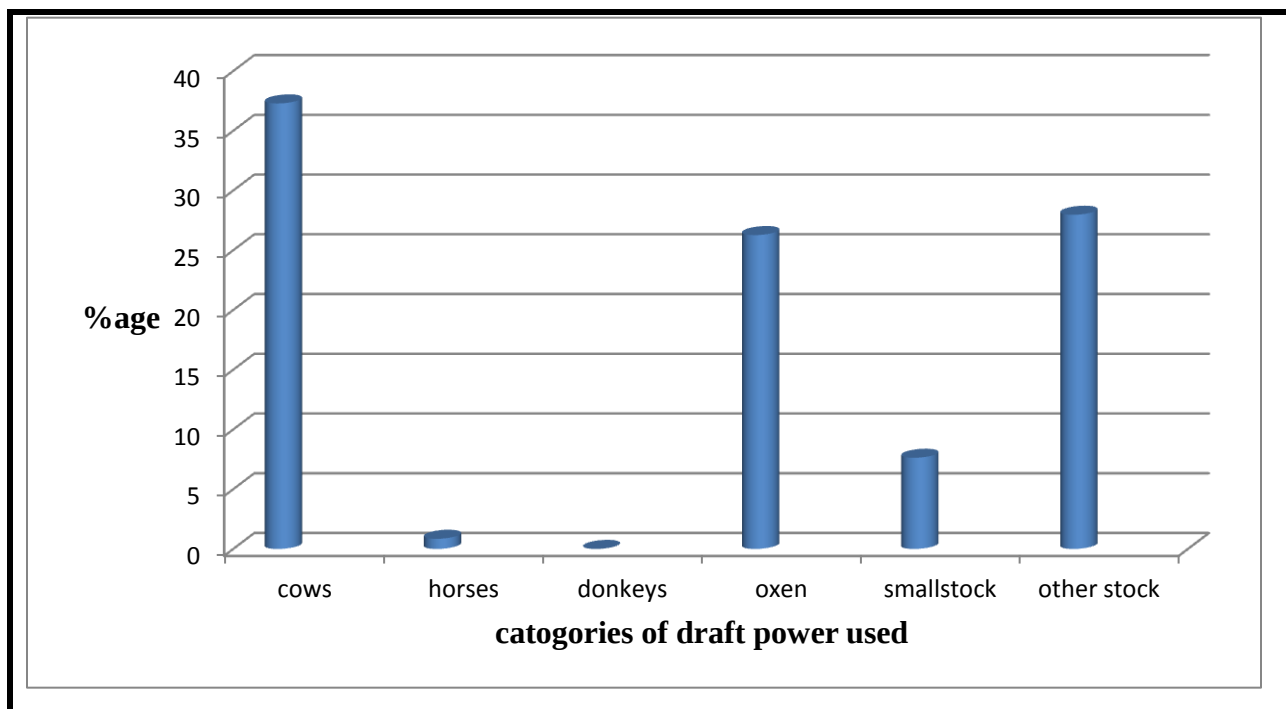


Figure 5.9: Summary of animal draft power used by farmers.

Source: Survey, 2010

From Figure 5.9, there are 37.29% farmers who use cows for farming. This is followed by farmers who use both oxen, and cows for farming purposes and these constitute 27.97%. The least used type of draft power is horses with 0.85%. From these statistics, cows are used more for farming compared to other types of draft power such as oxen, horses, and donkeys in all the four villages sampled. However, most oxen are sold out during funerals and celebrations, so oxen are always very scarce. According to Starkey *et al.*, (1995), horses and donkeys are easy to manage because horses can only be used alone and donkeys on the other hand can survive drought weather conditions than most of the other draft power and also have strong power. This is also compared from the weather conditions that sometimes prevailed in Lesotho.

According to FAO/WFP (2007), most of the draft power used was sometimes not in good condition hence, farmers had to hire a tractor for ploughing and only draft power for planting and cultivation. The small stock obtained 0.85% and seemed to be in limited use as most of the farmers in these areas prefer them for selling. This is because most small stock in these areas is not in good condition due to poor feeding conditions and poor management skills. Nonetheless, most farmers are not able to sell their draft animals regularly. According to FAO/WFP (2007)

drought weather conditions which prevail in these areas prevent good management of livestock and this results in poor looking animals and this limits the selling of animals. This is evidenced by the fact that 80.51% of the farmers did not sell their animals in 2009/10 season while 19.49% sold their livestock mainly the small stock or large stock in rare cases.

(c) Training of farmers for ploughing

Table 5.13, presented the training of farmers in the project areas. The results showed that most farmers need training. This is as most of the farmers did not receive any kind of training so there is low production and poor management of resources. Figure 5.10 demonstrates the number of farmers who were trained and not trained for use of power. Training of farmers is one of the important activities as most farmers would be able to produce at a higher rate.

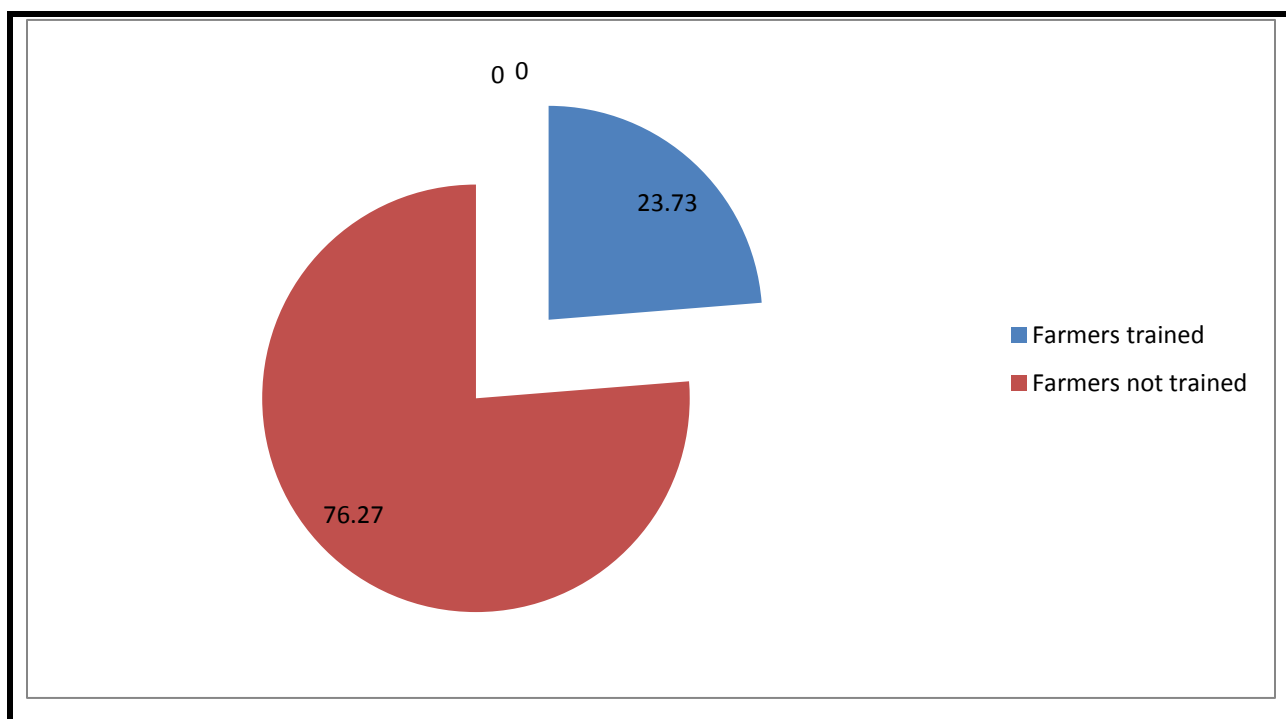


Figure 5.10: Farmers who were trained and not trained in 2009/10 season

Source; Survey, 2010

From Figure 5.10, 76.27% of the farmers were not trained for the production of both maize and sorghum. Most used experience from their parents when they were going to the fields while still young. On the other hand 23.73% were trained and these were able to get more yields with well managed machinery. According to Starkey *et al.*, (1995), training is important as it enables one

to be able to work at a higher level with good turnover from the field. Training could be done through workshops, seminars or field demonstrations where most farmers acquire new innovation from the extension agents to improve on productivity. From these results, it is apparent that farmers who were trained are likely to obtain high yields than those who did not train; and these are more secure due to improved information for productivity.

5.3.3. Assets / resources ownership and use patterns.

The section contains the Table 5.14 which shows the variables on resources ownership and use patterns which will be used for discussions in the following chapters.

Table 5.15: Statistics of variables for assets or resource ownership and use patterns.

	N	Min	Max	Mean	Std.Dev	Kurtosis	Std. Error
Income	118	1.000	20000.000	1326.606	2684.452	27.587	.442
Income generating activities	118	0	194000	2507.80	17894.32	114.910	.442
Equipment obtained	118	1	2	1.80	.404	.232	.442
Time in farming	118	1	50	16.53	10.906	.042	.442
Workshop attendance	118	1	2	1.58	.496	-1.935	.442
Record keeping	118	1	3	2.92	.360	20.083	.442
Service for extension	118	1	3	2.86	.432	10.575	.442
Extension availability	118	1	3	1.99	.801	-1.436	.442
Organization in marketing	118	1	2	1.86	.353	2.254	.442
Membership of organization	118	1	2	1.90	.304	5.215	.442
Rating of extension	118	1	3	2.29	.868	-1.413	.442
Skills obtained	118	1	5	4.39	1.261	1.908	.442
Train needed	118	1	6	3.41	1.262	-.052	.442
Farmer knowledge	118	1	3	2.02	.640	-.512	.442

Source: Survey, 2010**(a) Average incomes of the household head**

The income levels from Table 5.14 showed that in the project areas, some farmers did not get any income while others obtained an average income of R20000.00 in a month. Figure 5.11 presented the summary of the average incomes of the household heads in the sampled villages. According to Chisango (2009), income generation is very important in farming. This is because there are some costs involved in farming. Such costs may include inputs such as improved seeds,

fertilizers, labour, equipments, and tractor costs. As such, farmers who lack an income would result into failure. So the higher the amount of income a farmer spends in farming, the more production the farmer will get.

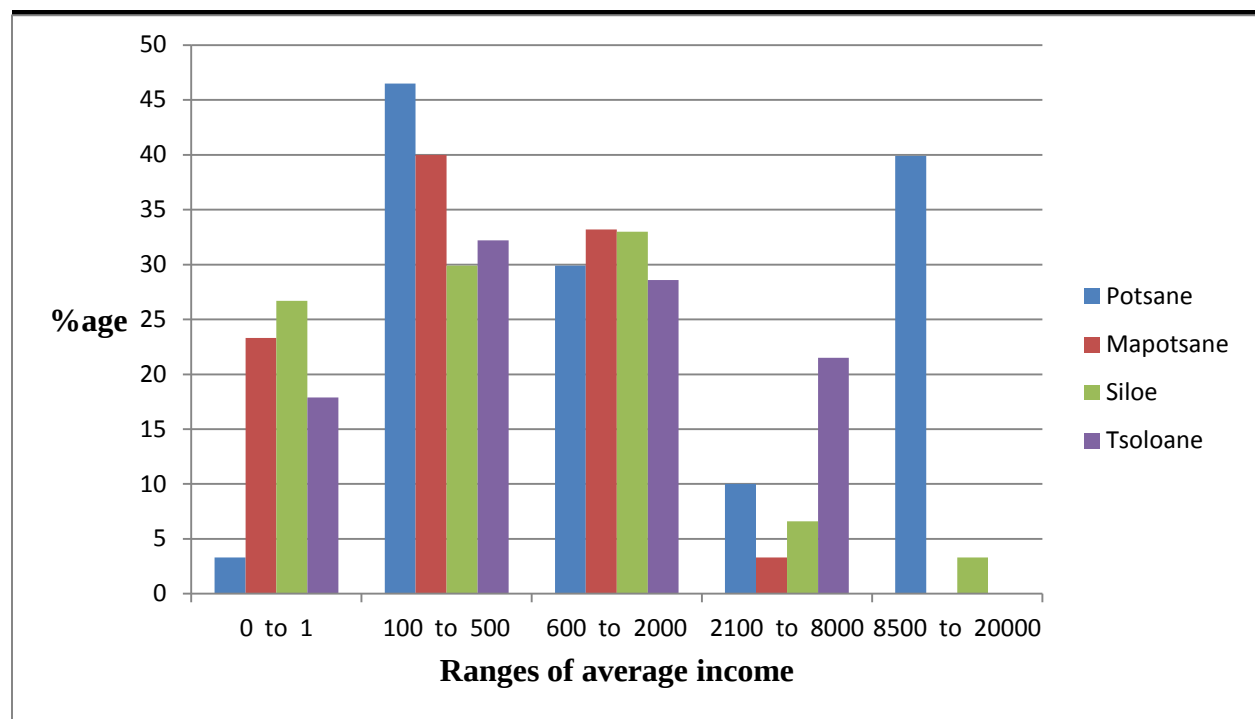


Figure 5.11: Average incomes of the household heads in sampled villages

Source: Survey, 2010

From Figure 5.15, farmers are receiving very low income while most are getting R100.00 to R2000.00. Also very few get R8500 to R20000. This showed that farmers in the lowlands of Mohale's Hoek are constraint mainly by lack of income at the household level.

According to Sechaba (1999), low income is a limiting resource in Lesotho as a whole. This is as a result of the fact that most households lack an income in the country and this contributed to the high rate of poverty. Also some of the maize and sorghum producers were affected as farmers were not able to use improved practices. According to FAO (2008), farmers are not able to improve their production in Lesotho because of limited resources. As a result, most Basothos while still working in the mines in the past years, were able to buy supplements for their animals and some of their improved inputs to increase yield but at the moment encounters problems after been retrenched from the mines. According to Kingdom of Lesotho (1991), most of the

production in the country is on the shoulders of the government to provide for the poor farmers at the subsistence level.

(b) Some of the income generating activities of the household heads

Table 5.14 presented statistics of income generating activities in the project areas. The results indicated that some farmers did not get anything from income generating activities while others obtained an income of R194000.00 (layers project). Figure 5.12 presented the summary of the other income generating activities of the household heads in the sampled villages. Income generating activities are those activities which assist in farming with cash after the sale of the products from the projects have been sold. Farmers practising some of these activities are able to get cash to assist in farming for some of the inputs and equipments. However there is higher return from the fields because of well established practises done by the farmers due to availability of income.

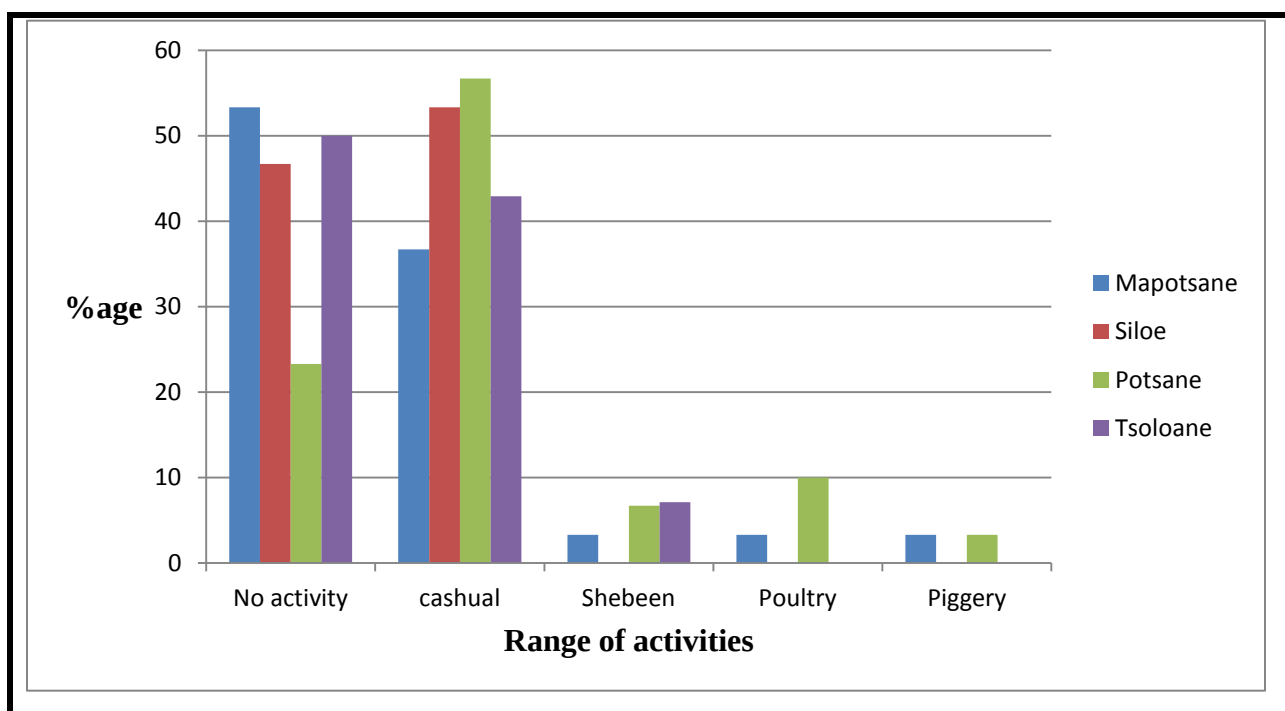


Figure 5.12: Income generating activities of the household heads.

Source: Survey, 2010

Some of the income generating activities in the lowlands of Mohale's Hoek include casual labour, shebeen, poultry, shops, and piggery. Most of the sampled farmers seemed to be involved

more on casual labour, shebeen, poultry and piggery in the project areas (Figure 5.12). According to Bureau of Statistics (2006), income generating activities are those activities which are done to earn an income to be able to meet other needs. Therefore, some farmers in the study carried some of the generating activities to meet other needs such as school fees, farming, clothing and food. This is because an income mostly comes in the form of cash. In Mapotsane, those that are not carrying any activity obtained 53.3%. There are some income generating activities that are carried out by farmers though at a lower scale and these are represented by 3.3%. These activities include, running a shebeen, poultry, and piggery while those involved in casual labour obtained 36.7%. In Siloe, most of the farmers sampled were not carrying out any of the income generating activities for assisting in farming activities. Most of them were involved in casual labour which obtained 53.3%. On the other hand, in Potsane, majority of the farmers sampled were casuals who obtained 56.7% and those that do not have access to any of the activities obtained 23.3%. The lowest rates were those which carried 3.3% dealing with piggery. In Tsoloane, those without any income generating activities obtained 50% while casuals obtained 42.9%. The lowest group were those which were involved in piggery. Bureau of Statistics (2006) further stated that income generating activities assist in the reduction of poverty in rural areas. This is through application of improved farming systems as cash is needed. According to World Vision (2008), there are income generating activities such as piggery or poultry provided to those rural households which are not able to provide for themselves. However World Vision identified some villages throughout the country but the criterion used was a problem as other poorer members will still be left out. It may be due to limited resources.

(c) Availability of equipment

Table 5.14 demonstrated availability of equipment for use in the field. As shown, most farmers did not have equipment. However Figure 5.13 presents the results of the total number of farmers had farming equipment and those who did not have. Resources such as equipment play major role in farming, as such, lack of may lead to failure.

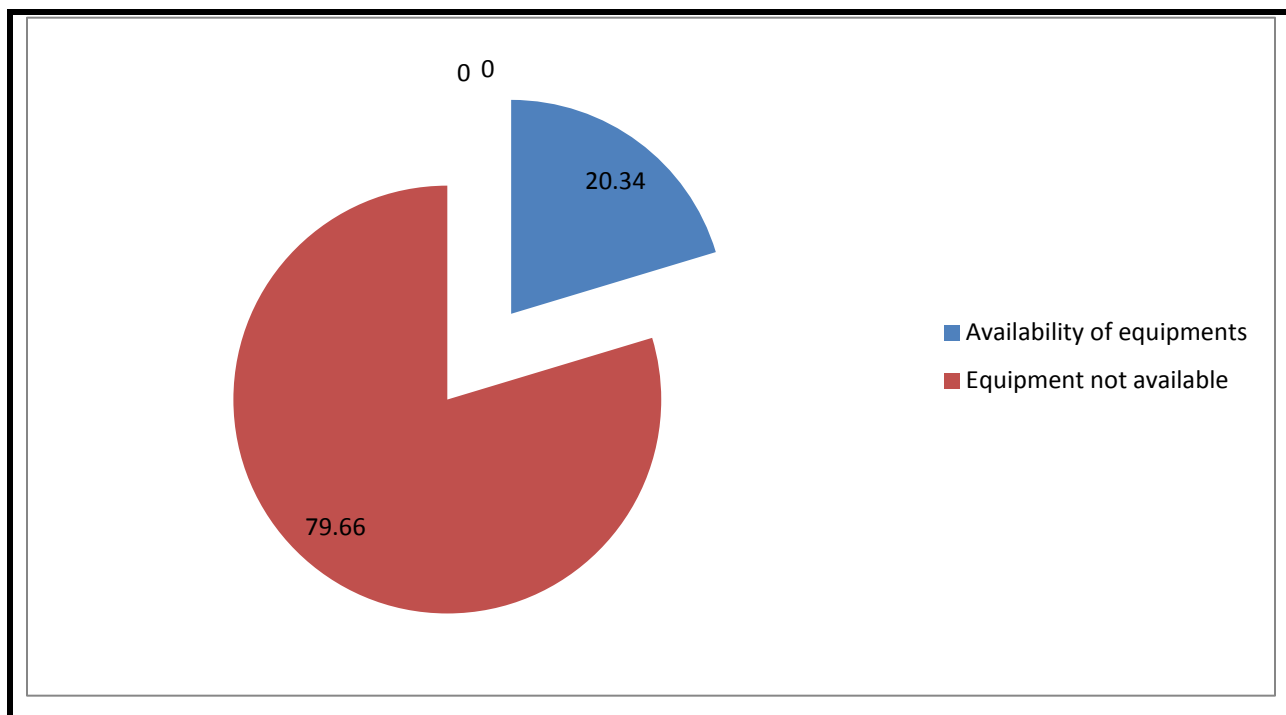


Figure 5.13: Equipment ownership by farmers.

Source: survey, 2010

From Figure 5.13, 79.66% presented farmers who did not have equipment compared to only 20.34% who had. This means yield will be affected as most farmers will have to hire or borrow before carrying out the farming activities. This may lead to late ploughing or not ploughing at all due to the time factor or even opted for short season crops that do not give high yields. Such farmers may fail to utilise early rains. These equipment included ploughs, scotch card, planter, disc harrows, sprayers and others. According to Starkey *et al.*, (1995), the availability of resources determines the food security status of a rural household. This is because, farmers with animals in rural areas are always having some food in their store rooms compared to those without animals. However those without equipments are likely to produce less. This is because they may have to hire and sometimes they lack funds to do so.

(d) Farming experience of farmers and knowledge

Experience plays an important role in farming. The farmer who is mostly experienced in farming, is able to produce higher yields. However Table 5.16 described the farming experience. Good farming experience by any farmer resulted in higher yields from the farmer. This is as the

farmer was able to use his experience in production. Even though some farmers will be facing very low yields in some years while experienced farmers will always have something to harvest.

Table 5.16: Summary of the farming experience of the farmers in years.

Number of farmers	Mean	St. Dev	SE Mean	Median	Minimum	Maximum
118	16.53	10.91	1.00	15	1	50

Source: Survey, 2010

The average farming experience is 16.53 years with 15 years being the median. The range of experience is one to fifty years (Table 5.16). According to Joubert *et al.*, (2004), the experience in farming is important to a farmer as it improves productivity of the farmer and access to ownership of the land compared to low experience. From the study, there were more farmers with a lot of experience but were limited by resources as most were subsistence farmers.

(e) The rate of farming knowledge

Table 5.14 presented the different levels of farming knowledge. Farming knowledge ranged from poor to good with an average of 2.02 which showed that the knowledge of farmers in the project areas was average. Figure 5.14 described the rate of farming knowledge and whether the knowledge is through experience or education. The farmers producing at a higher rate every year even when there is drought are rated high in terms of knowledge in farming.

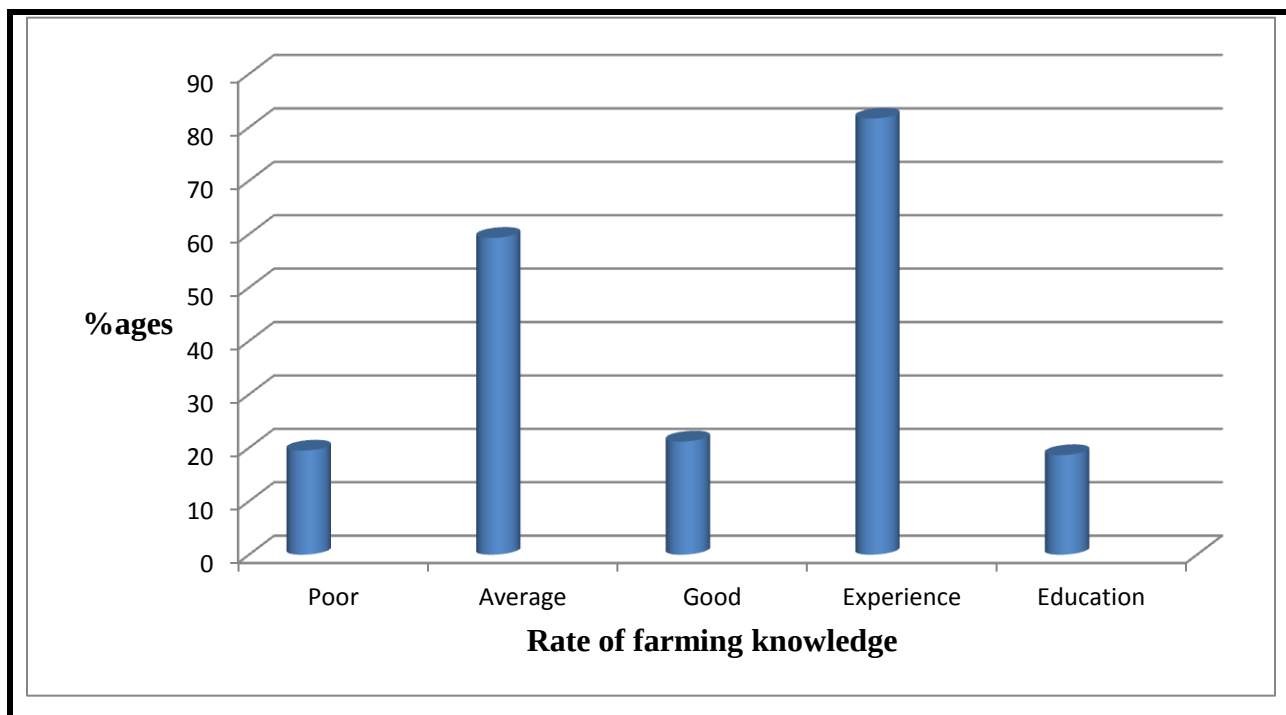


Figure 5.14: The rate of farming knowledge within farmers in the sampled villages.
Source: Survey, 2010

Most of the farmers who were involved in the study had an average farming knowledge followed by those with good farming knowledge. This is because about 59.32% of the farmers declared to have average farming knowledge compared to 21.19% of those who showed to have good farming knowledge (Figure 5.14). It is also expected that those with good farming knowledge will produce more than those with average farming knowledge. The last group were those with 19.49% who were considered with low rate of farming knowledge of the farmer. However, most of these farmers acquired farming knowledge through experience compared to those that acquired through education. This is shown by 81.36% of the farmers who acquired farming knowledge through experience while 18.64% acquired farming knowledge through education (Figure 5.14). According to Joubert *et al.*, (2004), experience is the best teacher. This is as it improves production and a farmer will always supply at a higher rate compared with the less experienced.

(f) The skills obtained and training needed

Appropriate farming skills by farmers would lead to good production. This is because some of the skills obtained would work interchangeably with one another; hence this would lead to

success in productivity. The results showed that skills were averaged at 4.39 % meaning that farmers in the project areas lacked most of the skills (Table, 5.14). The Figure 5.15 described the summary of the skills obtained by the farmers in villages sampled.

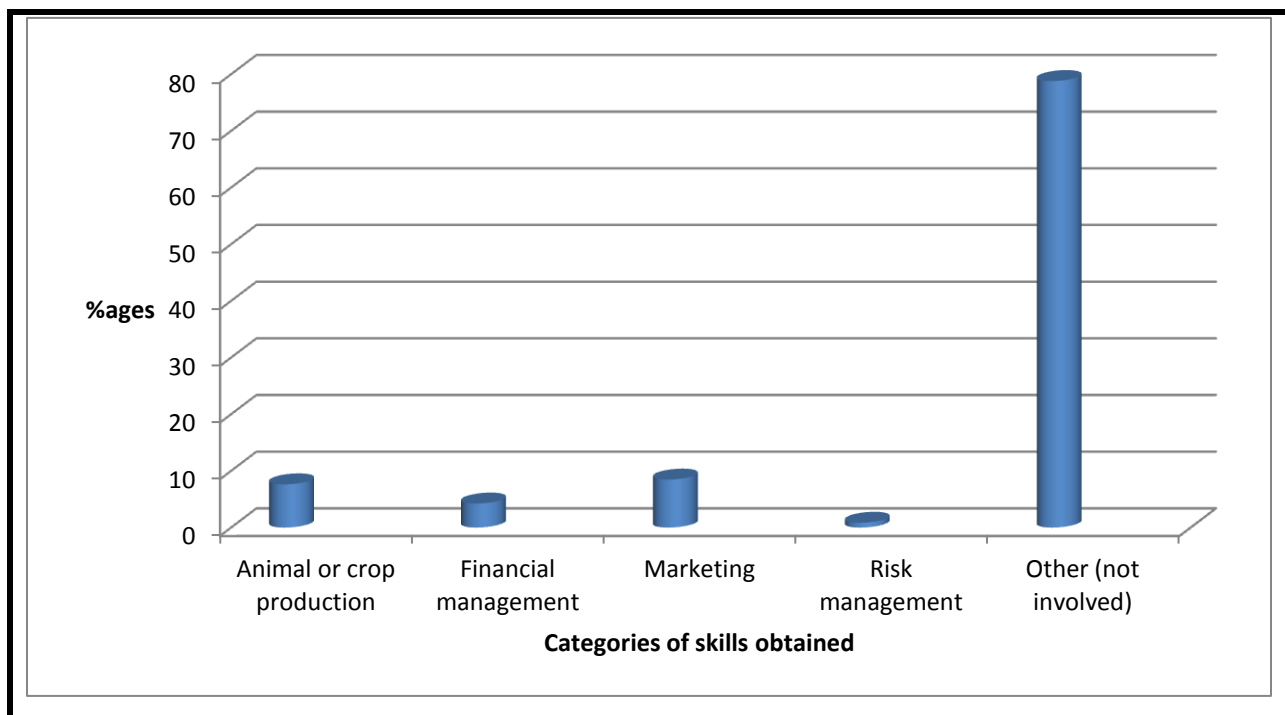


Figure 5.15: Skills obtained by the farmers in villages sampled.

Source: Survey, 2010

Most of the household heads in the sampled villages lack some of the skills that are necessary for production, while very few households had skills. About 78.81% household heads had no skills whilst 8.47% household heads showed skills in marketing, and at times a member of the family possessed these skills (Figure 5.15). According to Mbata (2001), access to markets would enhance productivity of the farmer as the farmer will be able to find market and be equipped with information necessary for cultivation. There were about 7.63% household heads that proved to have skills in animal and/or crop production. These skills are important as they improve the quality of use of animals for production of crops. Few had skills in risk management. This is shown by 0.85% household heads that had risk management skills. Household heads who obtained some of these skills were expected to have good production and well managed resources.

(g) The specific training needed

The farmers' training plays an important role for improved production. Most of the household heads in all areas seemed to be lacking training in marketing, budgeting, and record keeping. As such, farmers need training on marketing, budgeting and record keeping. Figure 5.16 showed the summary of the training needed by household heads in their farms in all sampled villages. However well trained small scale farmers would result in quality of work done and management of resources.

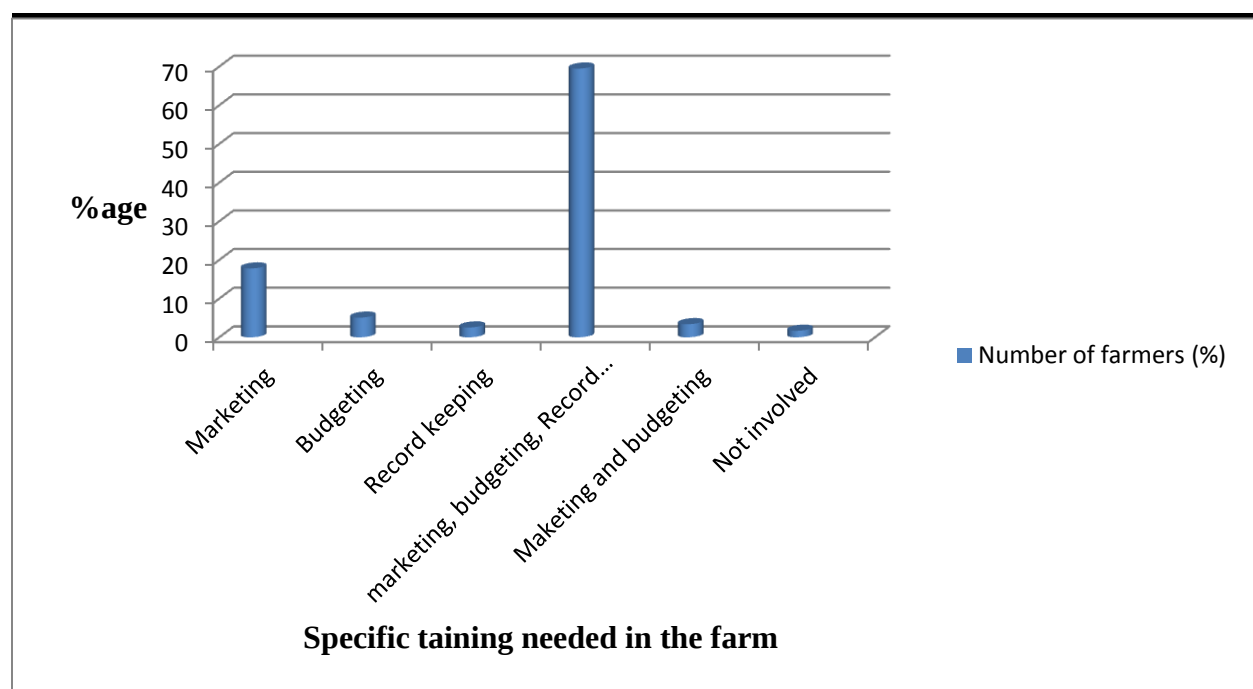


Figure 5.16: Training needed by the household heads in their farms.

Source: Survey, 2010

From Figure 5.16, 69.49% of these farmers showed to be lacking skills in marketing, budgeting and record keeping. According to Ministry of Agriculture (2010), some of the small scale farmers were unable to improve on their productivity as they were unable to keep their resources and manage them very well. This is because the information on marketing, budgeting, and record keeping enhances their productivity (Figure 5.16).

(h) The workshop attendance and types of records kept.

Creating awareness is achieved through animal traction or tractor demonstrations during the institutional open days, farmers' field days, ploughing competitions and agricultural shows. The results indicated that most of the farmers did not attend workshops. This is shown by the mean of 1.58% (Table, 5.14). Figure 5.17 described the summary of workshops attendance by farmers in both villages sampled in 2009/10 season.

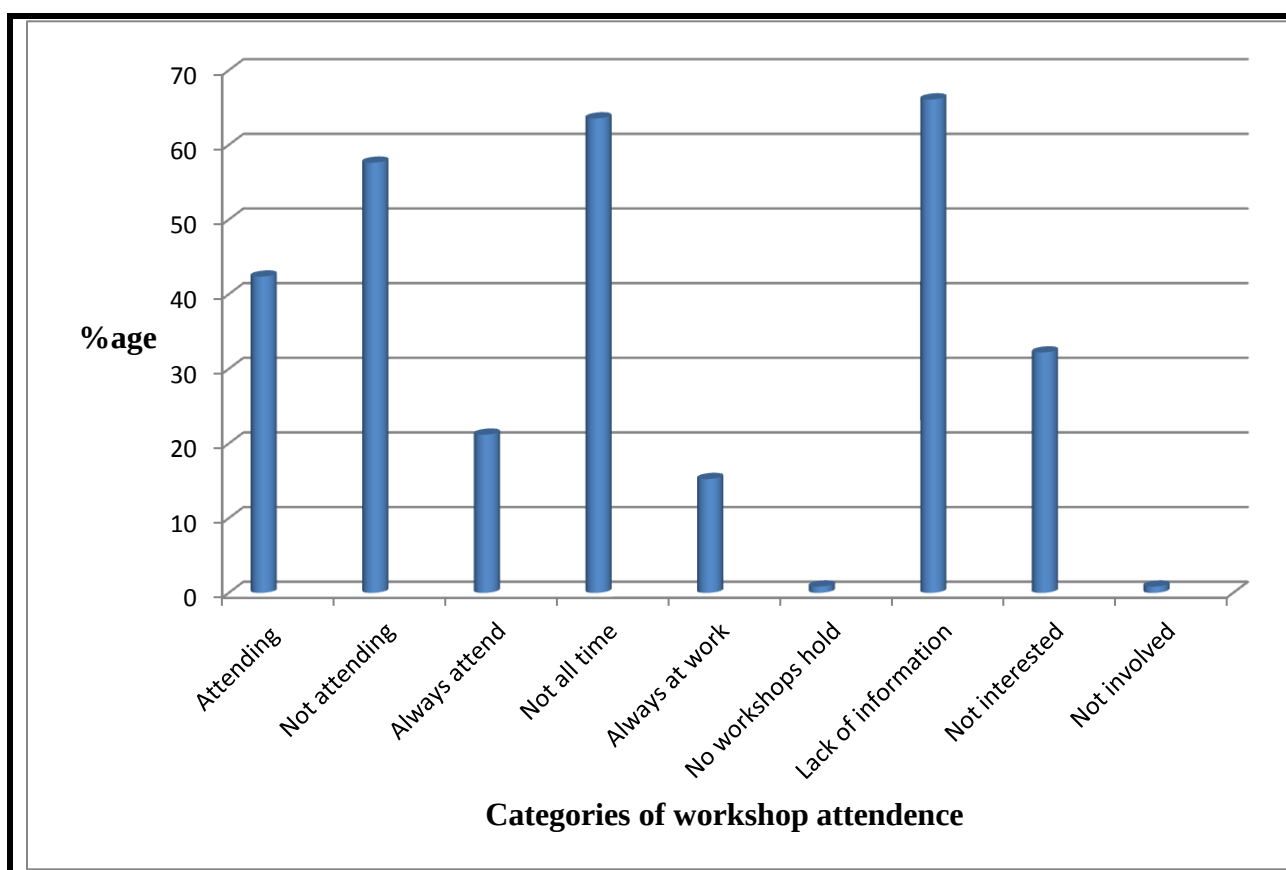


Figure 5. 17: Workshop attendance by farmers in the sampled villages.
Source: Survey, 2010

Most of the workshops were not well attended in all villages. This is because about 57.63% of the household heads didn't attend workshops very well while about 42.37% attended workshops. However, most seemed to be not attending at all times while others attending at all times. The result above showed that 63.56% household heads were not attending workshops at all times while 15% didn't attend and 21.19% attended (Figure 5.21). Nonetheless, household heads who attended workshops at all times were likely to produce at a higher level compared to those who didn't attend workshops in these villages. However, some of the reasons for not attending

workshops included, being at work, no workshops available in their areas, lack of information. The most common reason cited by most heads was that there were no available workshops in their own areas and 66.10% household heads stated this. According to FAO (1996), the involvement of farmers is crucial if productivity and food security is to be achieved. Because of low production in the project areas, the target group has been those farmers who already own draft animals or own tractors and equipment, but who are not using them, or who are using them improperly or inadequately. According to Kingdom of Lesotho (1991), this will stimulate productivity as majority of production comes from those smallholder farmers who are mostly using animals for production. Also cooperation with field extension officers and various interested non-governmental organizations and volunteer agencies has been instrumental in relaying the message. This is better than attempting to impose ideas on uninterested farmers. It has been noted that it is better to let farmers understand the principles of animal and tractor power and then let them make decisions and take initiatives.

(i) Records kept by farmers

Record keeping is important for the productivity of the farmer. Figure 5.18 described the records kept with their percentages by the household heads in 2009/10 season.

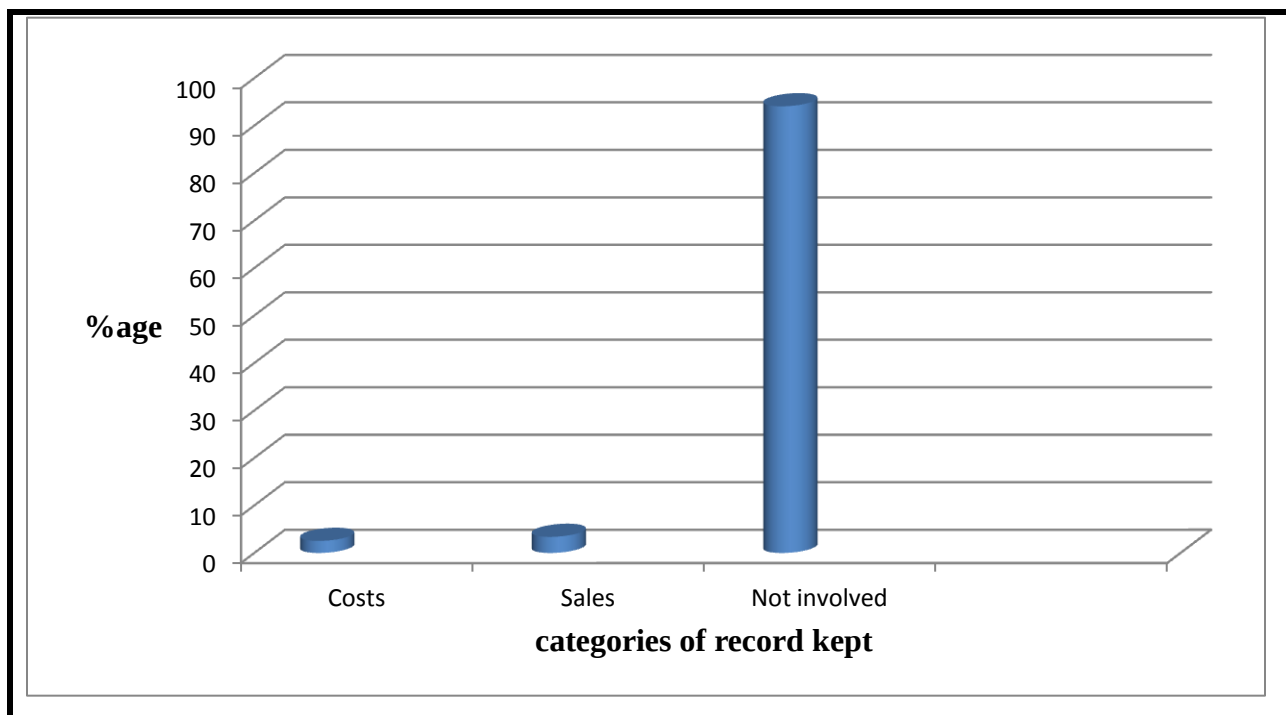


Figure 5.18: Records kept by farmers in both villages sampled.

Source: Survey, 2010

The households seemed to not been keeping records whether selling or producing something or even any of their costs involved. However it was advantageous for the researcher to arrive immediately after have harvested their crops. This made it easier to get what has been sold at that time as it was still early. From Figure 5.18, 94.07% of the household heads declared that there were not involved in keeping of records of either costs or sale made. According to King (1985), keeping of records is very important as it enables one to view whether is making any progress or not during the previous season. Therefore, the farmer will be stimulated to work hard to improve on the poor results.

(j) Services provided by extension services

Table 5.14 provided the extension service provided through extension service. The results indicated that the extension services were not available for farmers. Figure 5.19 demonstrated the services provided by extension officers. According to Owen *et al.*, (2003) extension is very important in empowering farmers with skill and knowledge on production. However, proper extension services would establish strong farmers.

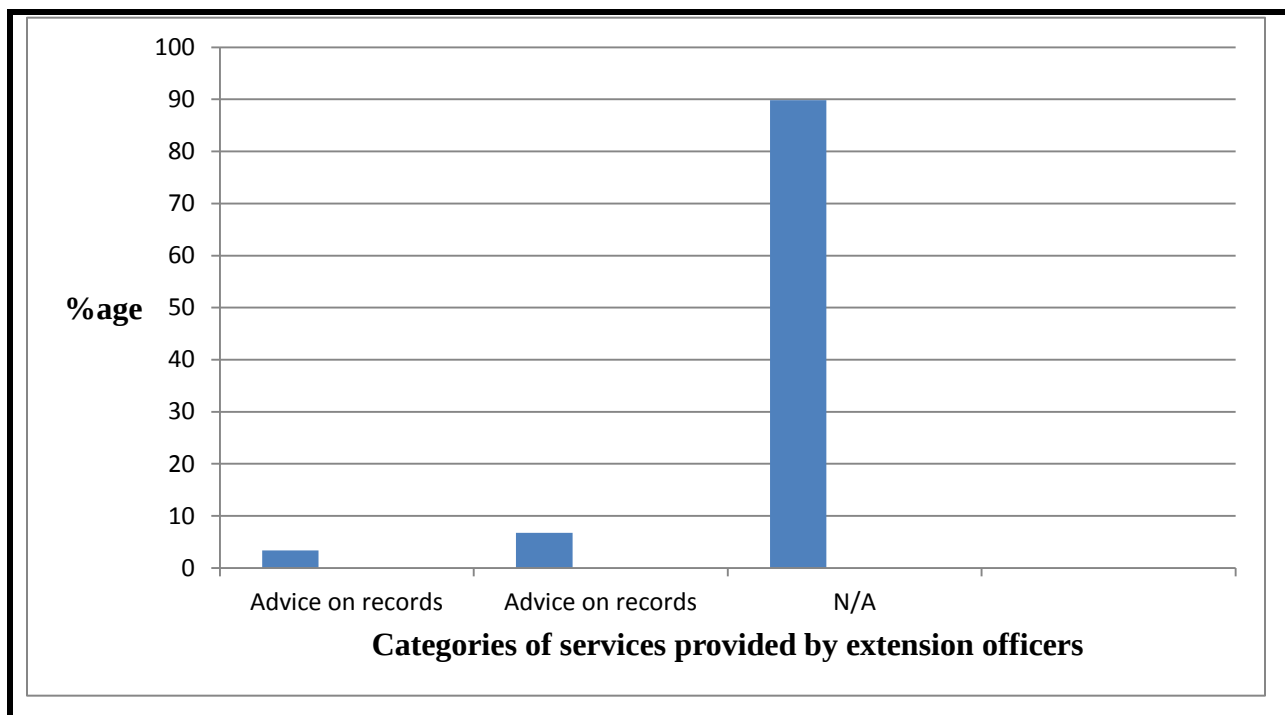


Figure 5.19: Services provided by extension officers.

Source: Survey, 2010

From villages sampled, 89.83% household heads stated that they were not aware of any services provided by extension officers in their region. This is also followed by the fact that only 3.39% of the farmers stated to have had some advice on marketing and only 6.78% of farmers used to have receive advice on records keeping. The results clearly showed that extension services were not available to small scale farmers in the lowland region of Mohale's Hoek district of Lesotho (Figure 5.25). According to Machete (2004), the availability of extension officers with their services to small scale farmers would be of great help to farmers and would be knowledgeable with information which would improve productivity of these farmers.

(k) Membership of any organizations

Technical support, facilitation of credit assistance, land clustering and consolidation will not work without cooperation among farmers. Table 5.14 described the membership of organizations in the project areas. Most farmers did not attend any organizations. However Table 5.17 explained the membership of any organizations, members, names of organizations, and reasons for not attending.

Table 5.17: Membership of organizations in the project areas.

Membership of any organization.	Number of farmers (%).	Name of any organizations.	Reasons of not joining.
A member	10.17	IphepengLihoai	Non
Not a member	89.83	Non	Does not exist

Sources: Survey, 2010

From Table 5.17, household heads who were members of the organizations in the sampled villages during the 2009/10 season were 10.17% while those who didn't join any organization were presented by 89.83%. The name of the organization which exists is Iphepeng Lihoai while other households stated that it no longer exists. However, Lantin (2003) stated that well developed farmers' organizations for smallholders play an important role in achieving productivity. This is through empowerment of knowledge and skills to smallholder farmers to be able to solve their own problems. farmers' organization is the entry point of developmental programs by government and non-governmental organizations. Farmers will be able to facilitate the adoption of larger-scale mechanization rather than fitting the mechanization technologies to small farms.

(l) The role of organizations in marketing

Organizations are important tools for farmers to attend as they provide information concerning production in general especially marketing as it is one of the most serious problems farmers face. Table 5.14 explained the role of organizations in marketing. The results indicated that most farmers were not aware of any role played by organizations in marketing. This is because farmers lacked information on organizations. Figure 5.20 demonstrated the role played by organizations in marketing during the 2009/10 season.

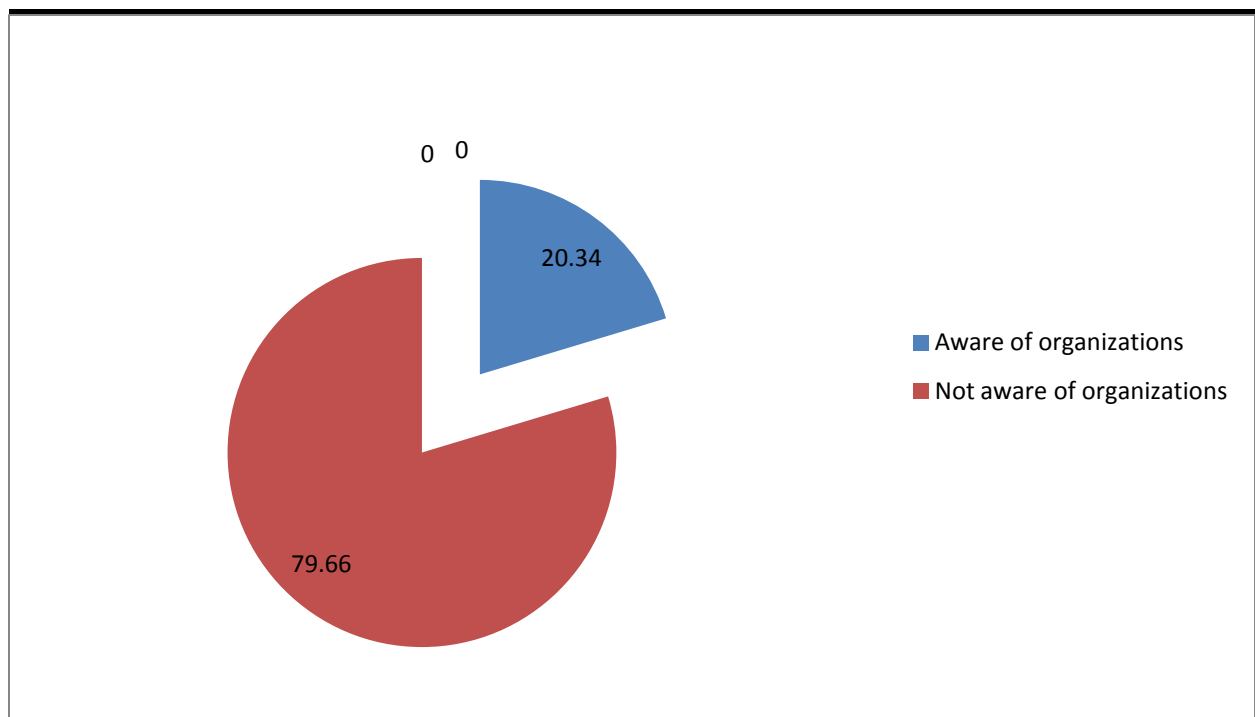


Figure 5.20: Roles played by organizations in marketing.

Source: Survey, 2010

Most sampled household heads in the lowlands of Mohale's Hoek district seemed to have not been aware of the role played by organizations in marketing. About 79.66% farmers declared to have not been aware of the role of organizations in marketing while only 20.34% seemed to be aware (Figure 5.26). According to Mbata (2001), lack of access to marketing in Lesotho in especially cereal crops such as maize and sorghum leads to low productivity of such crops. However, this contributed to farmers producing at a subsistence level and therefore an increase in the rate of poverty in the region. Most farmers produce for eating in most cases, so even if sold something, it will be their duty to get through selling their produce. This resulted from lack of organizations in the areas and even if one is available it does not last due to some fights or eating of money or sometimes as a result of power. However, Lantin (2003) stated that well developed farmers' organizations for smallholders play an important role in achieving productivity. This is through empowerment of knowledge and skills to smallholder farmers to be able to solve their own problems. Technical support, facilitation of credit assistance, land clustering and consolidation will not work without cooperation among farmers. Also farmers'

organization is the entry point of developmental programs by government and non-government organizations.

5.3.4 Challenges and opportunities faced by the farmers in the farming system

The section on challenges and opportunities are presented in Table 5.18 which summarized the variables which should be discussed in the following chapters. The variables included; challenges of lack of equipment, support from agric, distance travelled, problems in conducting extension workers, marketing strategies and marketing problems.

Table 5.18: Challenges and opportunities in the project area.

	N	Min	Max	Mean	Std. Dev	Kurtosis	Std. Error
Challenges of lack of equipment	118	1	7	2.76	1.495	-.783	.442
Support from Agric	118	0	2	1.06	..271	9.496	.442
Distance travelled	118	0	45	8.53	9.654	-.235	.442
Problems in conducting extension	118	1	3	2.86	.412	10.033	.442
Marketing strategies	118	1	5	3.813	1.8114	-1.196	.442
Marketing problems	118	1	5	2.28	1.116	.769	.442

Source: Field survey, 2010.

(a) Challenges of lack of equipment and strategies of dealing with the challenges.

Table 5.18 explained the challenges of lack of equipment. However Figure 5.21 presented how farmers deal with the challenge of lack of equipment in their farming. Equipment is an important resource which might cause failure to a certain farmer if not available. This is the reason most farmers sometimes are not coping in farming because they produce at a higher costs and produce less.

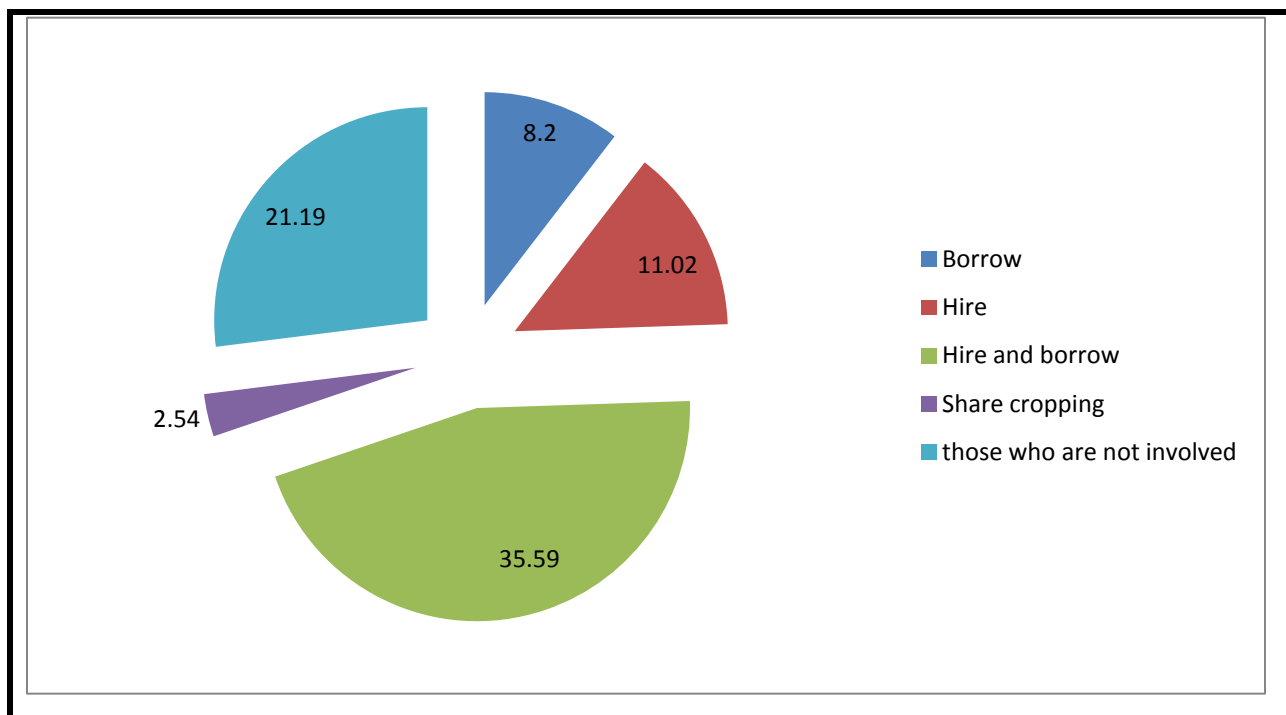


Figure 5.21: Strategies of dealing with lack of equipments.

Source: Survey, 2010

From Figure 5.21, 35.59% of the farmers seemed to be involved in both hiring and borrowing of the equipment for production of crops. This is also followed by 21.19% of those who are having most of the equipments to be used. The last group are those with 2.54% who are able to practise share cropping to solve the problem of lack of equipment. According to Starkey *et al.*, (1995), the availability of resources determines the food security status of the rural households. This is because in rural areas, farmers with animals are always having some food in their storerooms compared to those without animals. However those without equipment are likely to produce less. This is because they may have to hire and sometimes they lack funds.

5.3.4.2 Support from the Ministry of Agriculture

Table 5.17 outlined support services from the Ministry of Agriculture. From the results, few managed to get support while majority of the farmers claimed no support. Figure 5.28 further described the results of support systems given by the department of agriculture to the farmers in the project areas. Support systems play an important role to the development of the small scale

farmers. This is as through some of the support systems given to them, production would improve and reduce food insecurity in rural areas.

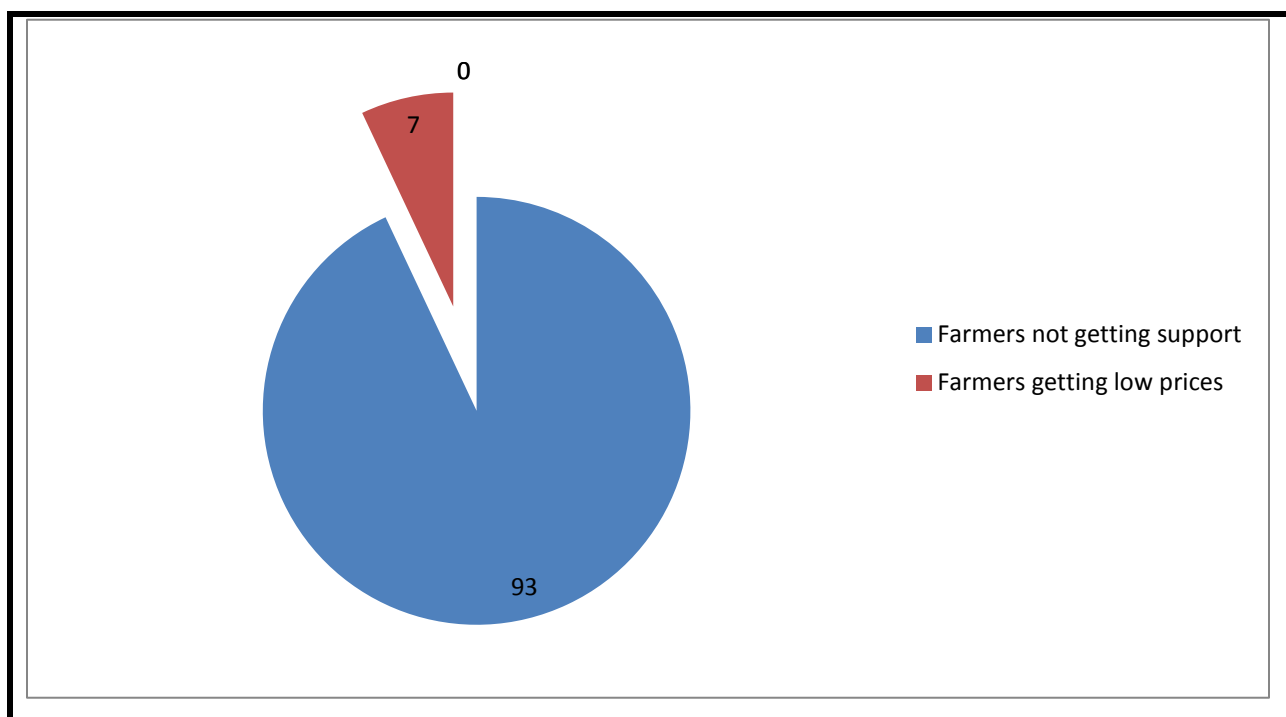


Figure 5.22: Support systems given by the department of agriculture to the farmers in both areas.

Source: Survey, 2010

From Figure 5.22, 93% represented farmers who didn't get any kind of support from the department of agriculture. According to FAO (2009), extension workers just go to rural areas to bring conflicts to farmers as they pick farmers at random in these areas to get subsidised inputs. This is because some of the very poor farmers will be still left out and the ones who are still able to plough their fields are always given subsidies. The lowest groups are those who received some lowest inputs prices. According to the Ministry of Agriculture (2010), there is a decline of inputs prices from the department to subsidise all the farmers to plough at a lower cost, hence achieving a higher yield.

(c) Distance travelled for buying of inputs

The results from Table 5.17 indicated the distance travelled by farmers to buy inputs. It has been noted that some farmers got inputs at home while others travelled to towns for inputs. Figure

5.23 showed the distance travelled by farmers for inputs. Farmers who travel short distances produce at lower costs than those that travel longer distances to buy inputs.

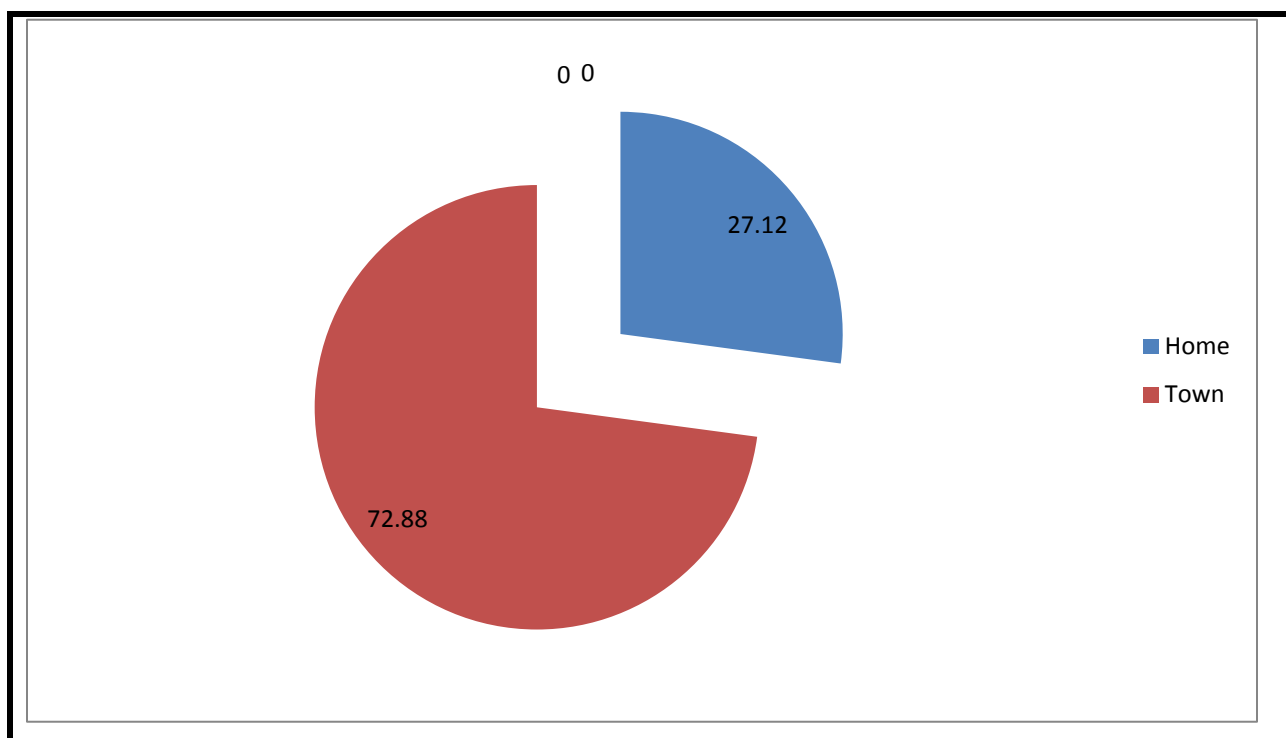


Figure 5. 23: Summary of the distance travelled by both farmers.

Source: Survey, 2010

Figure 5.23 demonstrated that most farmers travel a long distance to get inputs. This number is represented by 72.88% and these farmers incurred costs in the process. This group included farmers who used certified seeds. These were seeds protected from pests. The other group were those that just use seeds from the storeroom and they normally got very low yields. Table 5.19 also described the distance travelled by farmers for buying inputs in kilometres. The costs increase with an increasing kilometre. This affected the production of the farmers because it increased the expenses.

Table 5.19: Distance travelled for buying of inputs.

Number	Mean	St.dev	SE mean	minimum	maximum
118	8.525	9.654	0.889	0	45

Source: Survey, 2010

From Table 5.19, the average distance travelled was 8.525km with the ranges from zero to 45km. Other farmers do not travel for inputs; rather they just take from the store room while there are those who travel 45km for inputs. The distance travelled increases costs for inputs. The farmer may fail to plough due to costs encountered the following season.

(d) Marketing strategies of both sorghum and maize

According to Table 5.17, both maize and sorghum are not sold although it can be sold locally to neighbours. Figure 5.24 presented the summary of the results of marketing strategies in the project areas. The good access to marketing of products would determine the productivity level of any particular farmer. This is as most productive farmers have good access to markets; hence, this stimulates the productivity of the farmers as most have good access to information regarding prices and demand and supply situations.

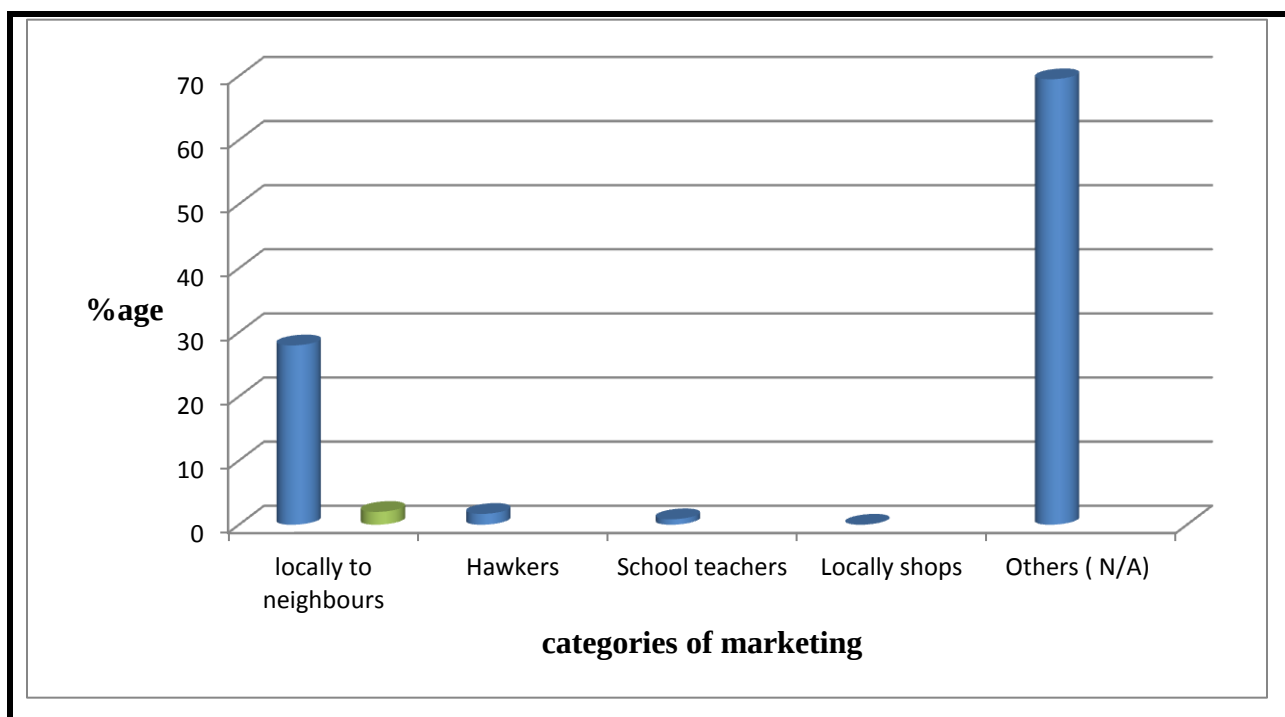


Figure 5.24: Marketing strategies of both sorghum and maize in the sampled villages.
Source: Survey, 2010

Most of the farmers during the 2009/10 season seemed to be struggling as to where to sell their produce. About 27.97% farmers were able to sell locally to neighbours followed by 1.69% farmers who were able to sell to hawkers. Majority were those that were not able to sell anything and obtained 69.49% (Figure 5.24). This summary showed that in the project areas, farmers are facing the scarcity of markets; hence most farmers were producing for consumption. According to Mbata (2001), good access to marketing strategies would enhance production of the small scale farmers in rural areas. This is as the farmer would be self sufficient and dependent. However, such farmers would be eager to learn more and be equipped with information, so at this level, farmers encountered problems and food insecurity. However, Latin (1985) declared that information is the key to making sound decisions. Some farmers are unaware of the availability of suitable machines, tools, or implements that could aid in their usually tedious work.

(e) The nature of marketing problems in the sampled villages

The Table 5.17 describes marketing problems faced by farmers. The results indicated that most farmers did not produce enough for the market while others faced a problem of a distance to

reach the market. The nature of marketing problems lowered the productivity of the farmers. In order to have an increase in productivity, farmers need to have less constraint to marketing. This will help them apply new techniques in their production. Figure 5.25 described the nature of marketing problems in the sampled villages in 2009/10 season.

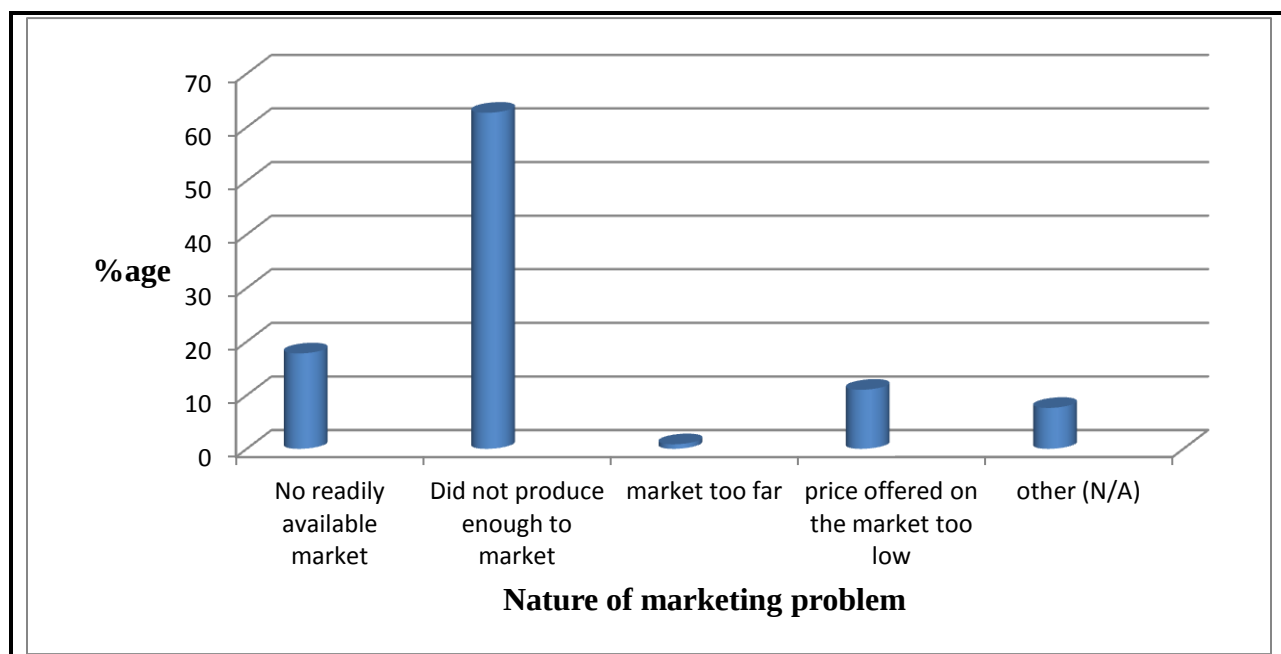


Figure 5.25: Nature of marketing problems in the sampled villages.

Source: Survey, 2010

Most farmers faced marketing problems as a result of low production, followed by farmers who had no readily available market and low prices offered in the market. This is because 62.71% of the farmers produced less for the market (Figure 5.25). These farmers produced mostly for subsistence and supply less to the market. Also there were about 17.80% farmers who showed to have no readily available market and about 11.02% farmers declared to be constrained by very low prices offered at the market (Figure 5.25). Information is the key to making sound decisions (Chisango, 2009). According to Mbata (2001), good access to marketing strategies would enhance production of the small scale farmers in rural areas. About 0.85% of the farmers showed that market is too far. Farmers in the lowlands of Mohale's Hoek district of Lesotho faced the problem less markets for cereal crops such maize and sorghum and low prices offered in the market for the farmers.

(f) Problems faced when conducting extension workers

Table 5.17 presented problems faced by farmers in conducting extension workers. The average for conducting the extension worker is 2.86%. This showed that farmers were not able to find the extension workers. This also contributed to low production of the small scale farmers in the project areas. However, Figure 5.26 presented more on the problems faced by farmers when referring to extension workers. Farmers who were able to contact with extension workers are well-off as they are able to be equipped with information concerning production; hence are producing at the higher rate compared with those who are not contacting extension workers.

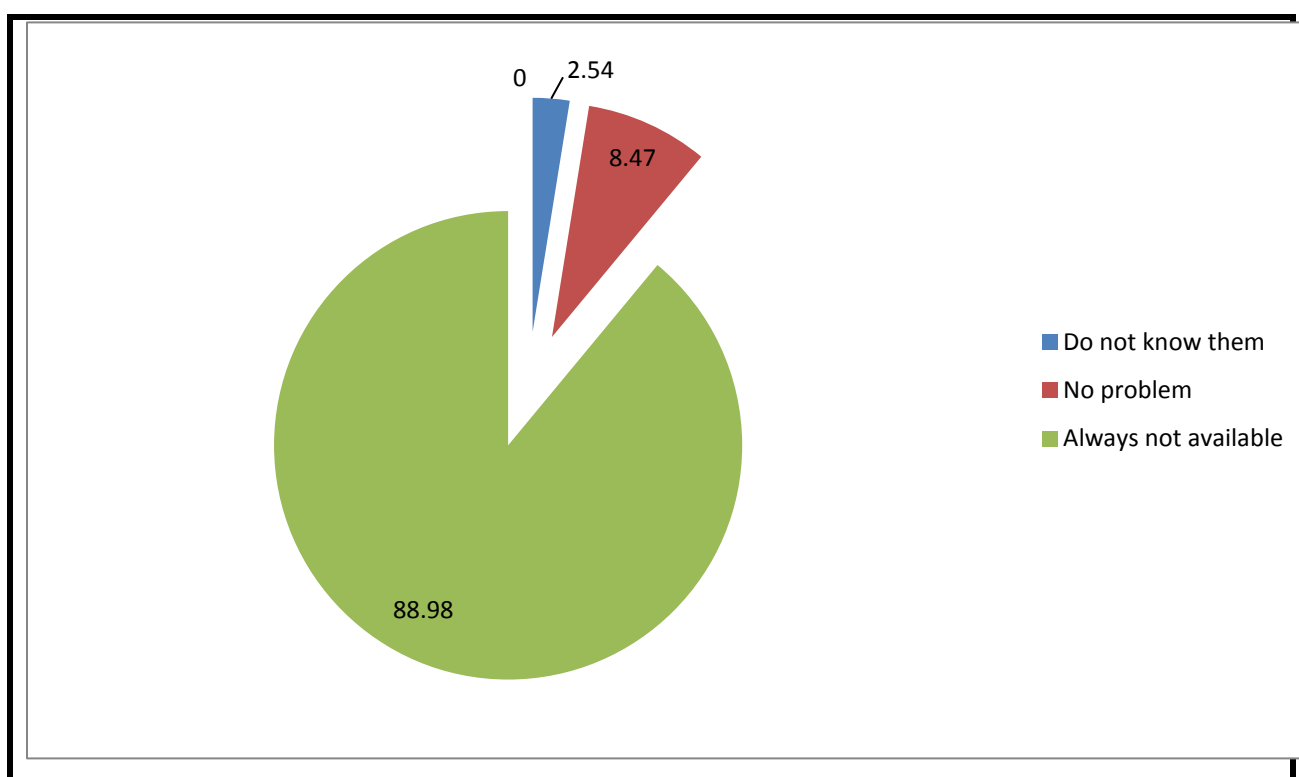


Figure 5.26: Problems faced by farmers when contacting extension workers.

Sources: Survey, 2010

Most of the farmers seemed to have faced the problems with the availability or unavailability of extension workers. This is because 88.98% of the farmers said that extension workers were not always available when need arises, while about 8.47% of the farmers declared to have no problems in contacting extension workers and 2.54% of farmers stated that they don't know their extension workers in their region (Figure 5.26). According to FAO (1996), good extension

services improve productivity of the small scale farmers in rural areas. This is because farmers who are able to refer from extension workers are expected to have good productivity as they will be equipped with bit of information concerning productivity and marketing. This kinds of farmers are always food secure.

(g) Constraints facing farmers in the sampled areas

Figure 5.27 described the summary of the constraints faced by farmers during 2009/10 season in the sampled villages in the lowlands of Mohale's Hoek district. Some of the constraints led to increase in food insecurity. Some control measures would be of great importance.

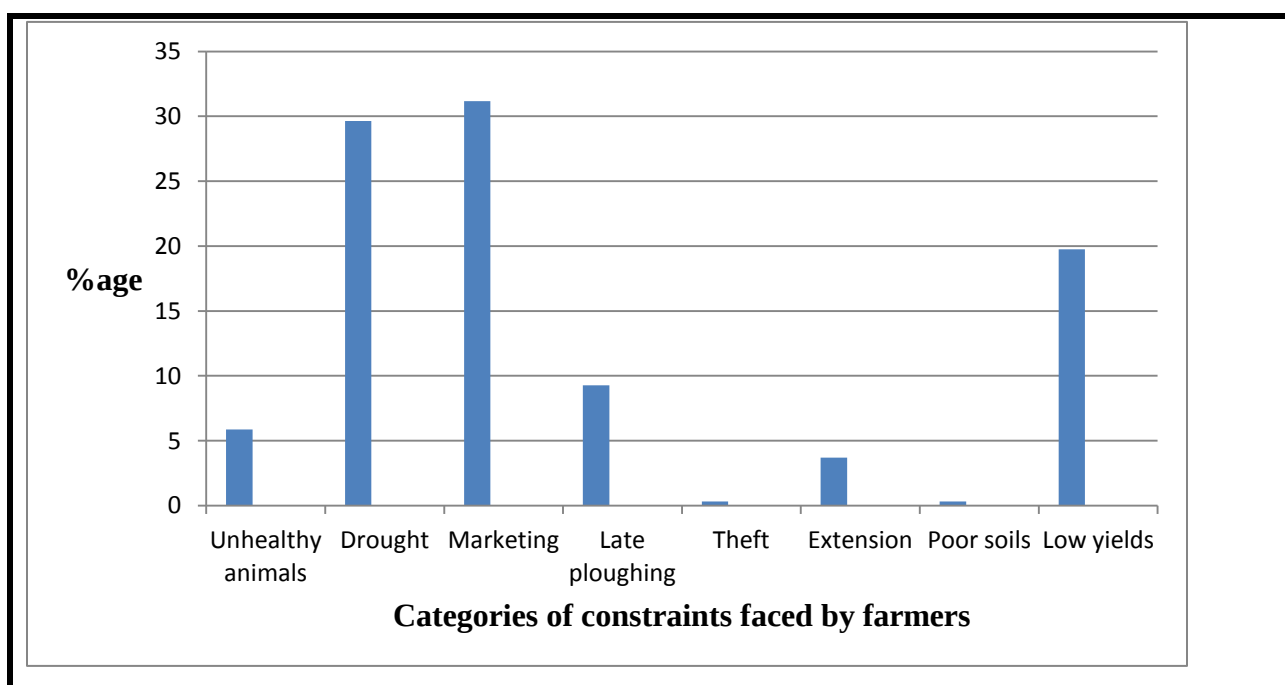


Figure 5.27: Constraints faced by farmers in the sampled villages.

Source: Survey, 2010

Most farmers faced the problem of marketing in their production and drought also seemed to be one of the major constraints to these farmers. From Figure 5.27, 33% indicated that marketing seemed to be the most constraint to small scale farmers in the project areas while 29% presented drought to be more constraint to farmers. These led to low yields as they were also affected by late ploughing as a result of drought during time of ploughing. Furthermore, poor health condition of the animals also played major role to some farmers in these regions. Extreme

weather conditions experienced over some few days could destroy crops, especially during critical development stages (Stancich, 2008). On the other hand, Harris (2009) stated that higher production could minimise temperatures for the benefit of the crops, increasing overall productivity in agriculture. According to Morgan (2009), there has been rapid warming in the tropics and subtropics which is likely to reduce crop yields. But with improvement in productivity of crops from the fields, there would be higher rate of vegetation with high rate of moisture in the atmosphere thereby lowering higher temperatures and low evaporation from plants and soils, lower higher rate of water requirements for the crops grown.

According to Harris (2009), growing seasons are changing, ecological niches are shifting, and rainfall is becoming more unpredictable and unreliable both in its timing and its volume as a result of climate change. Such reduces value of traditional agricultural knowledge such as when to plant particular crops and puts greater uncertainty and risks on farmers. However Encanto (2000) declared that the people involved in extension must not only be technically updated but must also possess good management and interpersonal skills. With so much on their shoulders, most of them might be lacking the capability to integrate the mechanization technology into the total farming system.

(h) Solutions to the constraints faced to farmers.

Figure 5.28 presented a summary of the solutions to the constraints faced by farmers during 2009/10 season. The reduction of constraints to production would lead to improving production and household food security.

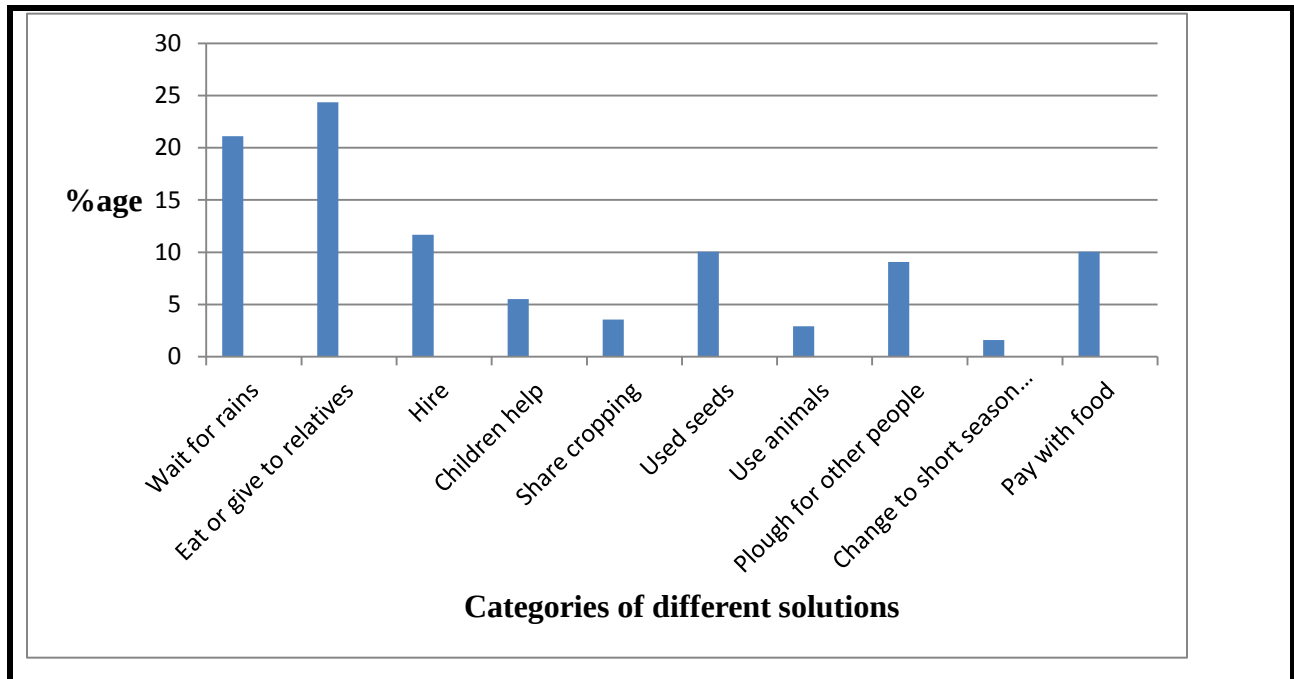


Figure 5.28: Solutions to the constraints faced by farmers during 2009/10 season.
Source: Survey, 2010

The most strategies opted by farmers in these regions for the problem of marketing was to give crops to relatives or friends so as to prevent pests from taking control of their stored food as there are poor storage conditions. From Figure 5.28, 24.35% farmers gave food to relatives or friends when the produce was plenty. Some farmers assumed this was better than selling the food (Monde, 2003). This resulted due to absence or low availability of markets in the project areas. On the other hand, about 21.10% of the farmers waited for rainfall to plough their fields (Figure 5.28). Farmers opted for hiring of either a tractor or animals especially when animals were not healthy enough or to reduce the costs of a tractor or when the tractor is not in good condition is one of the solutions to unhealthy animals or tractor. This is as about 11.69% of the farmers hire if animals could not be healthy during time of ploughing (Figure 5.34). Hiring seemed to be one of the great resorts to many smallholder farmers in rural areas due to some financial constraints faced by individual farmers. However, King (1985) identified some of the operations in the field such as land preparation, transport, harvesting and milling. He further declared that some payments of these services could be in the form of cash or even a certain proportion from the previous harvest. However, Fernando *et al.*, (2010) declared that some of these service

operations appear to be workable for promoting mechanization because it is based on a direct client-provider relationship governed by normal market forces. This is further stated that smallholders have power over the provider and can demand quality and value. On the other hand, smallholders have the most power.

According to FAO (1996), a farmer using animal traction should be able to mechanize most of the farm activities and so justify the keeping of draft animals. Secondary tillage operations like harrowing, planting and weeding of row crops should be carried out using animal power, and this can only be done when the farmer has access to the necessary equipment. Transport on the farm is another important activity that needs to employ animal powerfully. Some of the other solution strategies opted for in farming would be paying with food to labourers mainly during weeding and harvesting stages of crop production. This is as about 10.06% of the farmers pay labour with food while in some other instances; children provide most of the intervention to assist their parents with cash for production. This is as about 5.52% of the farmers declared to have been assisted by their children for productivity purposes. There are still some instances where some farmers still use seeds from their store room. This is because about 10.06% of the farmers are declared of using seeds from their storage.

(i) Some of the major and minor challenges

Figure 5.35 represented some of the challenges facing both animal and tractor users during the 2009/10 season. Farmers who were able to minimise some challenges were well-off as they were able to produce at a higher level.

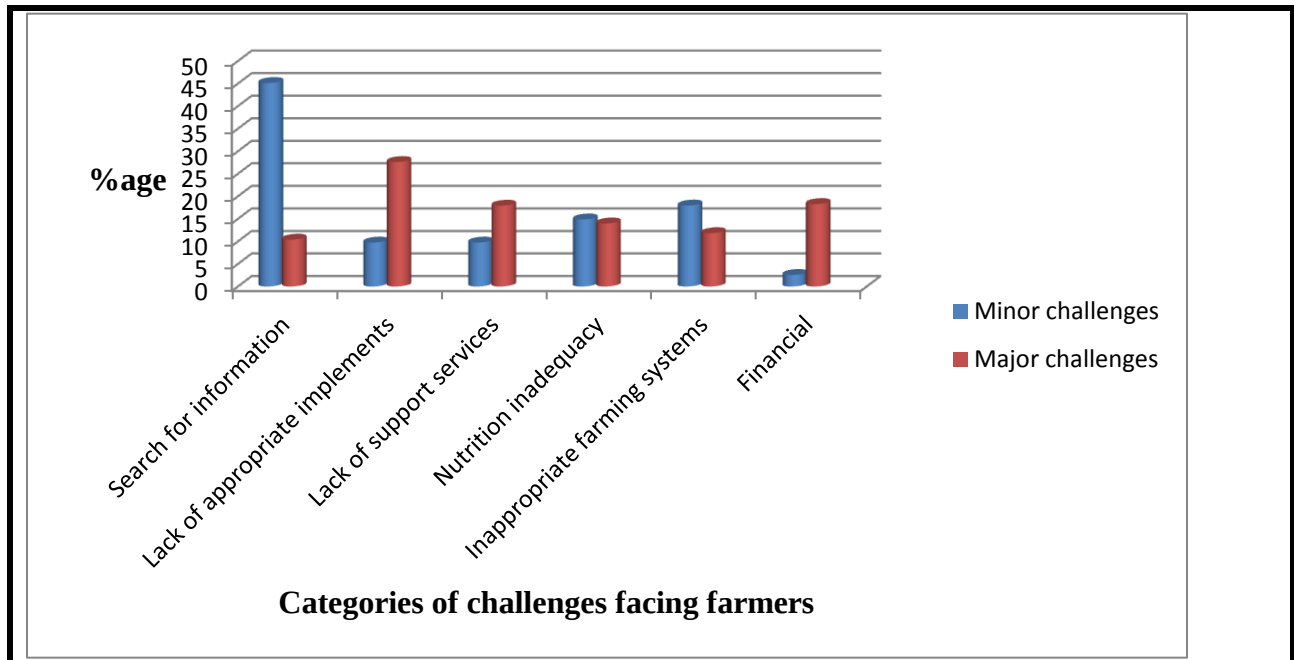


Figure 5.29: Challenges facing both animal and tractor users.
Source: Survey, 2010.

Farmers in the region of Mohale's Hoek district of Lesotho seemed to be facing more challenges compared to other regions in the country. According to FAO/WFP (2007), Mohale's Hoek areas seemed to be getting low production from the yield assessment declared from 2002 to 2007. This also increased the rate of food insecurity in these areas due to the fact that there were higher rate of challenges either as minor or major challenges. Some of these challenges bring an impact to the productivity as most of the farmers were been affected. Consequently, the Kingdom of Lesotho (1991), declared that the government is supposed to provide inputs for the poor farmers for productivity or sometimes have to provide food provisions. According to Mbata (2001), minimized challenges will lead to higher productivity and people will be food secure with high standard of living. So improvement in the type of power used and expansion of area for cultivation used where good use of mechanization would be adopted would improve the standard of living for individual households in rural areas. Mbata (2001) further declared that absence of reliable support services can be a major constraint to profitable employment of draft animals. This is as farmers employing draft animals need to be assured of a reliable source of harnesses and other animal traction equipment. The repair services need to be available at village level. Efforts have been directed to establish production units, and a supply network equipped with

relevant repair skills. However, Rodulfo *et al.*, (2004) said that development of technologies to lower costs in especially to some of the farming techniques such as cultivating machines, seeders, planters, sprayers needs well developed research to develop some of the techniques to lower the costs of fuel in particular.

5.4. The impact of animal power and other inputs on production

The section dwelled more on the impact of animal power on productivity. Gross margins were used for the production of maize crop from both animal and tractor power. The impact of animal power on maize production was done through the use of linear regression, stochastic frontier production model and Cobb-Douglass model.

5.4.1 Impact of animal power through Gross Margins

Detailed crop budgets for maize crop from the study areas were captured based on variable costs and yields by farmers as shown in Tables 5.27 to 5.28.

Table 5.20: Gross Margin for animal power on maize crop

GROSS MARGIN BUDGET FOR MAIZE			
	Requirement/ha	Units	1ha
Yield		t/ha	0.982
Selling		USD/t	254
Gross income			249
TOTAL VARIABLE COSTS (TVC)			120.09
Gross Margin			128.9
VARIABLE COSTS			Cost (R)
A. PRIOR TO HARVESTING			
1. Seed	25	Kg/ha@USD 0.78/kg	19.5
2. Land preparation			5
3. Labour for ploughing	5	1d/ha@\$ 0.25	1.25
4. Labour for weeding	10	8hrs/ha@0.11	8.8
5. Fertiliser (urea)	100	1d/ha@0.70	70
6 Labour	5	1d/ha@0.88	4.4
7. Planting labour	4	1d/ha@0.11	0.44
SUBTOTAL			109.39
B. HARVESTING & MARKETING			
1. Bag	8	1d/ha@0.5empty bag	4
2. Labour	5	Lab days/ha@\$1.14	5.7
2. Twine	1	1d/ha@usd1	1
SUBTOTAL			10.7

Source: field survey, 2010

Table 5.27 presents the gross margin of the animal power for the production of maize crop. The results show that the use of animals in the production of maize was very low. Average yield for maize among animal users was 0.982t/ha. Farmers realised a gross margin of US\$128.9/ha. The total variable costs of US\$120.09/ha was incurred in maize production. The major variable costs were seeds, fertilizers and labour.

Table 5.21: Gross margin for tractor power on maize crop.

GROSS MARGIN BUDGET FOR MAIZE			
	Requirement/ha	Units	1ha
Yield		t/ha	1.310
Selling		US\$/t	254
Gross income			332.74
TOTAL VARIABLE COSTS (TVC)			125.22
Gross Margin			207.52
VARIABLE COSTS			Cost (R)
C. PRIOR TO HARVESTING			
5. Seed	25	Kg/ha@USD 0.78/kg	19.5
6. Land preparation			5
7. Labour for ploughing	5	1d/ha@\$ 0.25	1.25
8. Labour for weeding	10	8hrs/ha@0.11	8.8
5. Fertiliser (urea)	100	1d/ha@0.70	70
6 Labour	5	1d/ha@0.88	4.4
7. Planting labour	4	1d/ha@0.11	0.44
SUBTOTAL			109.39
D. HARVESTING & MARKETING			
1.Bag	8	1d/ha@0.5empty bag	4
2. Labour	5	Lab days/ha@\$1.14	5.7
3. Twine	1	1d/ha@usd1	1
4. Transport	3	1US\$/ha@\$1.46	4.38
5. Labour	3	1d/ha@\$0.25	0.75
SUBTOTAL			15.83

Source: Field Survey (2010)

Table 5.28 demonstrated the gross margin for the production of the maize crop by the tractor power which indicated the gross margin of US\$207.52/ha, which showed the highest production of maize but higher than that of the animal power. The tractor power showed the higher costs of production of about US\$125.22. This showed that the production of animals in the production of maize was very low. Average yield for maize in tractor users was 1.310 t/ha. The major variable costs were seeds, fertilizers, transport especially for diesel and labour.

5.4.2 Impact of animal power on maize through multi- linear regression

Table 5.29 focused on animal traction on maize yield where multi-linear regression model is used to compute the linear relationship between variables.

Table 5.22: Factors affecting maize yield.

Variable	Coeff.	Standard Error	T Value	Pr> T
Gender	235.7047	186.9556	1.26	0.210
Age	10.63202	7.480873	1.42	0.158
Marital status	-71.13705	230.7782	-0.31	0.759
Household size	-38.06605	41.09895	-0.93	0.357
Family labour	345.1742	79.12233	4.36	0.000***
Education	28.50792	26.49667	1.08	0.285
Income	0.411498	0.518124	0.79	0.429
Other generating activities	69.21908	95.10178	0.73	0.468
Income for generating activities	-0.002498	0.0048073	-0.52	0.604
Cost for hired power	0.185287	0.1079584	1.72	0.089*
Size of land	83.80784	68.1139	1.23	0.221
Unavailable equipment	47.60775	42.38263	1.12	0.264
Tractor costs	-0.0285342	0.1459748	-0.20	0.845
Seeds (kg)	12.91746	3.487899	3.70	0.000***
Fertilizer (kg)	0.8392557	0.8446896	0.99	0.323
Amount consumed	-1593.37	688.7263	-2.31	0.023**

Source: Field Survey (2010)

Significance denoted as follows: * (10%), ** (5%), and *** (1%)..

Gender of the household head, age of the household head, marital status, household size, family labour, education, income, other income generating activities, income for generating activities, cost for hired power, size of land, not having equipment, tractor cost, seed (kg), fertilizer (kg) and amount consumed are highly significant (5% level). Old and middle aged households contributed a significant role in farming especially the married group. These were considered to be experienced in both use of animal power and obtained higher yields. The larger the household size the more it contributed to family labour for the production of maize; if family labour was used productively. Household size also determined the size of land to be planted. The larger the size of the land planted the higher the yield of maize with low costs of labour. This was as there were more to be consumed at household level. Education on the other hand played a major role as it provided some skills for production. Some educated family members were formally

employed which made them ended up assisting in farming. Income from formally employed members played an important role to some of the improved inputs for higher production of maize. Some of the members contributed to family labour in the field which had a positive impact on animal power on maize production. The issue being that, members that assisted with family labour assisted in the management of animals so as to be in good conditions for good production of maize with very low costs. Family labour helped in expanding the areas of maize to be cultivated. The larger the areas to be cultivated the higher the yield of maize. However, inputs such as seeds had a positive impact on animal power for maize production. This is because seeds produced maize which was consumed by both human beings and animals. The animals got fodder from maize stalks to keep them healthy during drought seasons for the benefit of farming activities. Also the amount to be consumed had a positive impact on animal power for maize production. This is because the amount to be consumed depended on how much was produced from the fields. The higher the yield of maize, the more consumption by both animals and human beings. More will also be supplied by farmers in the market.

5.5 Comparing the relative contributions of animal traction and other farming technologies to poverty alleviation and food security in the project area.

The section focused on the contribution of animal traction and other farming technologies to poverty alleviation. Animal power and tractor power productivity have been analysed basing on maize and sorghum yields. T-tests were computed for income and to compare the yield differences for maize and sorghum produced using animal and tractor power. Levene's test for the equality of variance and means for sorghum yield, income and other income generating activities were computed. Lastly, some serial correlation to test the significant status of variables was done.

5.5.1 Production of crops from types of power used

The section focused on the production of maize and sorghum from both animal and tractor power. The sorghum yield computed t-test from types of power used. Sorghum yield for the equality of means and variance from Levene's test was done.

5.5.1.1 Output of maize from animal and tractor power.

Table 5.20 presented the production differences from the two types of powers used. Maize as a staple food was produced at a higher rate than most of the crops in the project area.

Table 5.23: Output of maize according to type of power used

Dependent variables	Statistic		Std. Error	
	Type of power		Type of power	
	Animals	Tractor	Animals	Tractor
Mean (kg/ha)	982.40	1310.00	136.876	214.576
Percentage of farmers	81.36	18.64		
95% Conf. interval for mean;				
Lower Bound	710.66	863.76		
Upper Bound	1254.13	1756.24		
5% Trimmed Mean	786.00	1264.04		
Median	600.00	900.00		
Variance	1798559.463	1012942.857		
Std. Deviation	1341.104	1006.451		
Minimum	0	240		
Maximum	9240	3240		
Range	9240	3000		
Interquartile Range (IQR)	930	1470		
Skewness	3.616	.857	.246	.491
Kurtosis	17.179	-.773	.488	.953

Source: Field survey (2010)

In the Table 5.20, the mean for farmers who were using tractors is 1310 kg/ha compared to 982 kg/ha of those using animal power. There were 81.36% farmers using animals in their production compared to 18.64% of those using tractors. The number of those utilizing tractors was lower than animal users which showed the higher productivity from the smaller number compared to the majority adopting animal power. The std. deviation for those using tractors was higher than those using animals in their field. There were 1341.104 for animals to 1006.451 (Table 5.20). There was a great variation in production from both types of power used for maize production. Also the minimum was zero for animals and 240 for tractor. These results contributed to food

insecurity as farmers using animals ploughed with costs and at time of harvesting there is little obtained for the whole year. IQR is high for tractors than those using animals (9240 to 3000). This is clear that the homogeneity of variance assumption has been met (Table 5.20).

5.5.1.2 Output of sorghum from types of power used

Types of power used have different output in sorghum production. However Table 5. 21 presented yields of sorghum from the two types of power used.

Table 5.24: Output of sorghum according tototype of powerused

Dependent variables	Statistic		Std. Error	
	Type of power		Type of power	
	Animals	Tractor	Animals	Tractor
Mean (kg/ha)	595.36	458.64	119.753	214.576
Total farmers	81.36	18.64		
95% Confidence interval for mean;				
Lower Bound	357.62	208.50		
Upper Bound	833.10	708.77		
5% Trimmed Mean	397.63	429.60		
Median	240	180.00		
Variance	1376714.339	318269.481		
Std. Deviation	1173.335	564.154		
Minimum	0	0		
Maximum	8400	1440		
Range	8400	1440		
Interquartile Range (IQR)	720	993	.246	.491
Skewness	4.208	.783	.488	.953
Kurtosis	22.548	-.1067		

Source: Field survey (2010)

From the Table 5.21, the mean for the tractor was lower than that of animals different from the case of maize output where the mean for tractor was higher. The mean for sorghum output for tractor users was 458.64 kg/ha while that for animal users was 595.36 kg/ha. These results showed preference of tractor usage for maize production as a staple food compared to a substitute which is sorghum in this case. The minimum ranges in both types of power were zero with maximum higher for animals (8400 to 1440). The mean for animals was about 136.72 greater than that for tractor. Also the sample std.deviation for animals was high (1173.335 to

564.154) and the IQR was different. This was as the IQR for tractor was high (993 to 720). Therefore the homogeneity of variance assumption has been met. Both types of power had greater variation in productivity. The animal users opted more of sorghum as a substitute compared to maize as a staple food in both areas sampled.

5.5.1.3 The sorghum yield computed t-test from types of power used.

Some t-tests were used to presents the differences in production from types of powers. However, Table 5.25 presented t-test for the production of sorghum from both tractor and animal powers.

Table 5.25: Sorghum yield t-test results from the types of power used.

Type of power	Number of Respondents	Mean (kg/ha)	Std. Deviation	Std. Error Mean
Tractor	22	458.64	564.154	120.278
Animal	96	595.36	1173.335	119.753

Source: Field Survey (2010)

From the Table 5.25, there was variation in the mean from both types of power used. This was as there was 595.36 kg/ha for animals and 458.64 kg/ha for tractor. This indicated that animal power users were producing more of sorghum than those using tractors. According to FAO/WFP (2007), sorghum was mostly ploughed on a smaller scale as a substitute compared to maize as a staple food. However, Joubert *et al.*, (2004) explained that tractors are mostly economical at hectares above 3 ha, so most tractor power farmers opted for maize production.

5.5.1.4 Sorghum yield for the equality of means and variance.

Table 5.23 presented the equality of means and variance in the production of sorghum.

Table 5.26: Levene's test for the equality of variance and means for sorghum yield.

	F	Sig.	T	Df	Sig. (2-tailed)	Mean difference	Std. Error difference
Equal variance assumed	.873	.352	-.531	116	.596	-136.728	257.319
Equal variance not assumed			-.806	68.410	.423	-136.728	169.728

Source: Field Survey (2010)

From Table 5.23, the probability was quite high (Sig. Value is 0.352). This was above the common 0.05 cut-off. So the standard deviations were identical about 595.154 for tractors and 1173.335 for animals and the homogeneity requirement was met. Since the Sig. Value was above 0.05, this also meant there was no significance between the two types of power used for production of sorghum with animal power having the greater sorghum yield.

5.5.3 Determinants of income used from types of power used

Table 5.24 presented the income differences in both animal and tractor powers used. Income levels constraint maize producing farmers in the project areas. Both animal and tractor required some income for improving farming practices.

Table 5.27: T-test results for income and the types of power used.

Variables	Type of power	Number	Mean (R)	Std. Deviation	Std. Error Mean
Income	Tractor	22	1160	1295	276.23
	Animal	96	1365	2914	297.49
Other generating activities	Tractor	22	0.68	0.894	0.191
	Animal	96	0.78	0.931	0.95

Source: Field Survey (2010)

There was variation of the means for the average income in the different types of power used where both tractor and animal obtained R1160 and R1365 respectively. This meant that animal power used less of income compared to tractor users (Table 5.24).

There was also variation for the means for some other income generating activities where both tractor and animals obtained R0.68 and R0.78 respectively. Animals were used more for other income generating activities than tractors. Animal power was used more because it is the cheapest source of power in rural areas.

5.5.4 Determinants of average income used for equality of means and variance

The Table 5.25 presented the Levene's test for the equality of variance and means for the average income and other generating activities.

Table 5.28: Levene's test for the equality of variance and means for the average income.

	F	Sig.	T	Df	Sig. (2-tailed)	Mean difference	Std. Error difference
Equal variance assumed	1.011	0.317	-0.322	116	0.748	-204.788	636.97
Equal variance not assumed			-0.504	75.509	0.615	-204.788	405.96

Source: Field Survey (2010)

From Table 5.25, the Sig. Value was 0.317 which was above 0.05 which is the cut-off. However, the Std. Deviation for both tractor and animal was 1295 and 2914 respectively. This meant there was no significant difference between both tractor and animals in the use of monthly average income.

5.5.5 Determinants for other generating activities for equality of means and variance

From the production of maize, Table 5.26 used Levene's test to determine the significance of other income generating activities.

Table 5.29: Levene's test for the equality of variance and means for other income generating activities.

	F	Sig.	T	Df	Sig. (2-tailed)	Mean difference	Std. Error difference
Equal variance assumed	0.098	0.755	-0.455	116	0.650	-0.099	0.219
Equal variance not assumed			-0.467	32.312	0.644	-0.99	0.213

Source: Field Survey (2010)

From Table 5.26, the probability was high (Sig. Value is 0.755) which was above 0.05 which is the cut-off value. So the Std. deviations of both tractor and animals are 0.894 and 0.931 respectively. Therefore, there is no significant between tractor and animal power which showed that other income generating activities played an important role in both types of power for household food security. Also the homogeneity requirement was met.

5.5.6 The serial correlation to test the significant status of variables.

The Appendix 2 described the use of correlation method to test the significant status between the dependent variables and the independent variables. Gender did not have a significant association with age, household size, household members that assist with family labour in the field, educational status, and other income generating activities of the household head. There was however significant association with the area of sorghum planted. The reason was that the P-values of the variables were greater than 0.05 which is the cut-off figure. Also the area of sorghum planted has a positive significance to gender. The P-value of gender was less than 0.05 which is the common cut-off value (Appendix 2).

Age didn't have significant association with some of the variables such as gender, household size, and income, size of land, maize yield and sorghum yield. The reason was that their P-values were greater than 0.05 which is the cut-off figure. There is a positive significant with household members that assisted with family labour, education, and employment status, quantity of

fertilizers applied and the time taken by the farmer in farming. The reason was that the P-values of the variables were less than 0.05. The old aged family labour provided most of assistance than the younger aged members. This was also because younger people were engaged in some of the income generating activities which ended up assisting on farming activities. Also education provided a positive impact with information to both young and middle aged members who used for improving the use of animal power and crop production. The formally employed old and mid aged members with good income brought an impact by application of farming practises which contributed to higher yield of both maize and sorghum, including the management of animals (Appendix 2).

There was no significant association between the household size, gender, age, education, employment status, income, size of land, maize and sorghum yield but there was positive association between the household members that assisted with family labour and areas of maize planted. Household size had the positive significant with the family labour because the more members to assist with family labour and the more areas of maize to be ploughed to improve the food security status of the larger household size. Also there seemed to be no problems in adopting animal traction as there were enough labour to assist in some of the activities carried out during ploughing.

Household members that assisted with family labour had positive significant with the ages, household size, and employment status, size of land ploughed areas of ploughed for both maize and sorghum and the yield of maize as a staple food. This is because the middle aged and above are more experienced in the use of animal traction hence were able to use animal power productively and able to produce more of maize as a staple food than sorghum as a substitute. Also the household members that assisted with family labour had a positive significant association with amount to be consumed. This is because the more members that assisted with family labour in a certain household, the higher the amount to be consumed and more had to be produced with the lower cost mechanization. Therefore family labour is of significant if used productively (Appendix 2).

There was no significant between the education and the variables such as gender, household size, other income generating activities, size of land, area of sorghum ploughed, the yield of both

sorghum and maize, amount sold and consumed, the seeds used, the fertilizer used and costs, but there was a significant association with the age, employment status, income and the areas of maize ploughed. This is because education played an important role in different ages which had a positive impact on the use of animal power and improve productivity of both maize and sorghum as there will be appropriate farming practises and skills to be used. On the other hand, education brought a positive impact to the employment status of the household head. The income also changed which then improved the farming activities such as manures to be applied and varieties to be used for improvement of yield. Consequently the farmers who were formally employed had stable production and improved household food security, because such households were able to use their income in farming activities than those without unstable income, hence food insecurity increases with those without stable income. Most of the small scale farmers who do not have stable income lacked equipments which influence production of the farmers (Appendix 2).

There was significant association between the employment status and some of the variables such as age, household members that assist with family labour, marital status, amount of fertilizers used and costs. The reason was because their P. Values were less than 0.05 which is the common cut-off figure. The old age on the other hand employed used more of their income on applying appropriate farming practices, used of improved varieties and also able to give good management to their animals by buying supplementary feeds for the animals during drought seasons. In some of the variables such as gender, household size, income, size of land, area of maize, area of sorghum, maize and sorghum yield, amount consumed and amount sold. The income of the household had a positive significant with the education, size of land ploughed, areas of maize, sorghum, maize and sorghum yield, amount sold, and amount consumed. This is because their P-values were less than 0.05 which is the cut-off figure. The reason was that income played major role in the increase of production and some appropriate systems to be applied. However, farmers with little income obtained very low yields. This is because; well established farming practises needed income to assist on some of the technologies which lead to higher productivity. Also the higher supply of products in the markets needs higher income to invest in farming for higher return. However, the lower the income the lower the production. There was positive association between the amount of fertilizer and the income. This resulted from the fact that the higher the income the more fertilizers will be applied to replace the used nutrients in the soil for higher

yields. Nonetheless, there was negative significant between the income and some of the variables such as gender, age, household size, household members that assisted with family labour, employment status, other generating activities, amount of fertilizer to be applied and costs of fertilizers and time in farming. This is because their P-values were higher than 0.05 which is the common cut-off figure (Appendix 2).

There was a positive significant between the size of the land and marital status. The reason was that the P-value for marital status was less than 0.05. The married group seemed to be ploughing the land than the single group or widowed. On the other hand the married group usually entail more of family labour and were more organised. Also there were more married group in the study than other groups (Appendix 2).

There was a positive significant between the size of land and household members that assisted with family labour. The reason was that the P-value for household members that assisted with family labour was less than 0.05 which is the common cut-off figure. The family labour provided a positive impact on the size of the land to be ploughed and increased production if used productively (Appendix 2).

There was a positive significant between the size of the land and the income. The reason was that the P-value for income was less than 0.05 which is the cut-off figure. Income had a positive development on the size of the land to be used and how much to produce. This also determined the yields of both maize and sorghum and the amount to be sold and consumed as they also showed a positive significance to the size of land ploughed.

However there was positive significant between the size of land and the amount of fertilizers, seeds and costs to be used. The reason was that their P-values were less than 0.05. Fertilizers and seeds brought a positive impact to the size of land and determined the yields of both maize and sorghum. As the matter of fact the bigger the size of the land the more costs were incurred as a result of an increase in inputs quantity and quality. This will have great impact on food security as there will be more food (Appendix 2).

There was a positive significant between the areas of maize and the household size, household members that assist with family labour, income, size of land, areas of sorghum, maize and

sorghum yield, amount sold, amount consumed, amount of seeds used and costs. The reason was that most of the variable's P-values were less than 0.05 which is the cut-off figure. The household size had a positive impact on areas of maize as a staple food because the larger the household size the larger the area of maize to be ploughed as there were more members which assisted with family labour, hence there were larger areas of land to be ploughed and got higher yield of both crops.

There was no significant association between the area of maize and some of the variables such as gender, age, employment status, and other generating activities, amount of fertilizers to be applied and costs and time in farming. This is because their P-values were greater than 0.05 which is the cut-off figure (Appendix 2).

There was significant association between the areas of sorghum and the gender and marital status. The P-values of both gender and marital status were less than 0.05. This is as both gender and marital status have a positive influence on the areas of sorghum to be ploughed. Both gender and marital status would provide family labour or even assist with funds for inputs for farming. Also the areas of sorghum ploughed had positive significant with the household members that assisted with family labour (Appendix 2). This is as family labour had positive influence on the area of sorghum to be ploughed and yields obtained if family labour was used productively.

There was significant association between areas of sorghum and maize yield. The reason was that the P-value of maize yield was lower than 0.05 which is the cut-off figure. Also, if the maize yield decreased that had a positive impact on the areas of sorghum to be ploughed as a substitute by expanding the areas of sorghum.

However there was a positive significant between the areas of sorghum and sorghum yield. The reason was that the P-value for maize yield was less than 0.05. On the other hand the yield of sorghum had a positive influence on areas of sorghum by obtaining higher production of sorghum from the expanded areas. There was a positive significance between the areas of sorghum and the amount sold and consumed. However, the higher the amount of sorghum sold and consumed had a positive influence on the areas of sorghum to be ploughed as more areas

were ploughed. On the other hand, if the amount of sorghum sold improved, there were more to consume as a result of an increase in yield of sorghum (Appendix 2).

There was a positive significant between the area of sorghum ploughed, the amount of seeds, fertilizers applied and the costs of maize and sorghum. The reason was that, their P-values were less than 0.05 which is the cut-off figure. The availability of both seeds and fertilizers influenced the areas of sorghum to be ploughed and also influenced the final product (Appendix 2).

Maize yield had a positive significant with household members that assisted with family labour, income, size of land, area of maize, area of sorghum, sorghum yield, amount sold and amount consumed, amount of seeds, amount of fertilizers and costs of both seeds and fertilizers. This is because the P-values of those variables were less than 0.05 which is the cut-off figure. There is positive significant with the maize yield because household members provides family labour to improve on some of the farming activities employed; hence increased the yield of maize and that led to lower area of sorghum produced. Also the higher the amount of maize sold and consumed, the more the fertilizers and improved seeds were adopted which improved maize yield. This also improved on the fodder for the animals during drought conditions.

Sorghum yield had the positive significant with the income, size of land, area of sorghum, area of maize, maize yield, amount sold, amount consumed, seeds, fertilizers applied, costs of both seeds and fertilizers. The reason was that the P-values of those variables were less than 0.05 which was the cut-off figure. The lower the income, the higher the sorghum yield and more adoption of animal power. Also the bigger the size of land, the more production of sorghum. The larger the maize yields, the lesser the yield of sorghum as a substitute. Therefore improved seeds and fertilizers have a positive influence on sorghum yield and determined the amount to be sold and consumed. The higher the amount sold influenced the productivity of sorghum and the costs went down (Appendix 2).

There was a positive significant between the amount sold and some of the variables such as income, size of land, area of maize, area of sorghum, maize yield, sorghum yield, amount consumed, amount of seeds and fertilizer applied and costs. This is because the P-values of all the variables were less than 0.05 which is the common cut-off value. The increase of income

improved more of the amount to be sold as more was produced. This also improved on amount to be sold and consumed as a result of increase in productivity. The size of the land also influenced amount to be sold. This is as the larger the size of the land, the higher the amount to be sold. The decrease of area planted for maize, the larger the areas of sorghum which had a positive impact on the amount to be sold.

There was a positive significant between the amount consumed and the variables such as amount of seeds and fertilizers and costs of both, size of land, area of maize, area of sorghum, maize yield, sorghum yield and amount sold and household members that assist with family labour. The lower the inputs such as improved seeds and fertilizers had positive impact on the amount to be consumed. This is as inputs such as fertilizers helped to replace used nutrients from the soil which led to improve in production thereby improve on amount sold and consumed. Also the larger the area of maize and sorghum had a positive influence on the amount to be consumed (Appendix 2).

There was significant association between the amount of seeds and the income. This is because the increased income had a positive impact on the improved varieties of seeds which had to be used for higher yields (Appendix 2).

According to Appendix 2, there was a positive significant to seeds used with the variables such as size of the land, area of maize, area of sorghum, yield of maize and sorghum, amount sold and consumed, seed costs. The larger area of land will required more seeds to be bought for increased production from the land and there will be more to be sold and consumed.

Amount of fertilizers applied had a positive significant association with the age, marital status, and employment status. The P-values of age, marital status and employment status are less than 0.05 which is the cut-off figure (Appendix 2). The middle and old aged, married members, and formally employed members seemed to apply fertilizers than the other members. This is as the result that all groups were experienced in production and were involved more than other groups in the poverty reduction strategies.

According to Appendix 2, the size of the land, area of sorghum, maize yield, sorghum yield, amount sold and consumed, seed and fertilizer costs seemed to had a positive significant to

amount of fertilizers used. The reason was that the p-values of the variables were less than 0.05 which is the common cut-off figure. The size of land on the other hand influenced how much fertilizers will be applied which also influenced the area of maize and sorghum to grow thereby increasing yield from the use of fertilizers. The amount to be sold and consumed will be influenced by the yield obtained. Also the lower the price of the fertilizer, the more quantities of fertilizers will be bought as a result of a decrease in price (Appendix 2).

There was a positive significant of seed costs and the income, size of land, area of maize, area of sorghum, maize and sorghum yield, amount sold and consumed, amount of seeds to be applied, and the fertilizer costs. The increase in income influenced which varieties of seeds of both maize and sorghum to buy. This is as a result that the improvement of income stimulated a shift to more improved varieties of seeds to be used which also influenced the end result of both crops grown. The higher yield determined the amount to be sold and consumed.

There was a positive significant association between the cost of fertilizer and the employment status, size of land, area of sorghum, maize yield, sorghum yield, amount sold and consumed. The reason is that the P-values of the variables are less than 0.05 which is the common cut-off value. The formally employed members brought a positive impact on the cost of fertilizer as more fertilizers were bought regardless of costs for the improvement of production from both maize and sorghum. Also the larger areas of land influenced the costs of fertilizers as more had to be bought due to expansion of areas ploughed. Amount of fertilizers on the other hand had a positive impact on the cost of fertilizer. This is as more quantity of fertilizers was bought when the price of fertilizer decreased. There was a positive significant association between the number of years in farming and the age of the farmer, and the marital status. The P-values of the variables were less than 0.05 which is the cut-off figure. However old and middle aged members were more experienced and able to get high yield. Also the married group who had many years in farming were able to get higher yields (Appendix 2).

5.5.3 Impact of animal traction on maize yield through Stochastic Production Analysis.

Table 5.30 described the impact of animal power on maize production using the Stochastic Frontier Production model to estimate the technical efficiency of the farming system.

Table 5.30: Stochastic Frontier Production analysis on maize yield

Variables	Coeff.	Std. Error	Z	P-Values	95% confident interval	
Gender	184.07	163.17	1.13	0.26	-135.742	503.888
Age	2.54	6.095	0.42	0.68	-9.403	14.49
Household size	-7.08	37.39	-0.19	0.85	-80.368	66.213
Education	29.49	24.74	1.19	0.233	-18.995	77.98
Income	-.0014	.004	-0.31	0.757	-0.010	0.007
Cost if hired	.080	.103	0.78	0.437	-0.122	0.283
Equipment unavailable	24.21	41.89	0.58	0.563	-57.89	106.32
Tractor costs	-.072	.144	-0.50	0.615	-0.355	0.210
Labour costs	.232	.182	1.28	0.201	-0.123	0.210
Animal costs	-1.53	.752	-2.04	0.042**	-3.003	-0.567
Area of maize	272.03	78.527	3.46	0.001***	118.13	425.95
Seeds (kg)	13.62	1.891	7.20	0.000***	9.91	17.33
Fertilizer	2.23	.794	2.81	0.005***	0.68	3.79
Amount consumed	-595.68	2668.79	-0.22	0.823	-5826.42	4635.059
/Insig2v	13.451	0.131	102.89	0.000	13.19547	13.70798
/Insig2u	-5.215	88436.06	-0.00	1.000	-1733326.7	173326.3
Sigma-v	833.6908	54.50017			733.4324	947.6542
Sigma-u	.0737164	3259.594			0	.
Sigma2	695040.3	90872.93			516932.7	873148
1ambda	0.000088	3260.154			-6389.785	6389.785

Likelihood-ratio test of sigma u=0: chibar2 (01) = 0.00

Proba> chibar2 = 1.000

Significance denoted as follows: * (10%), ** (5%), and *** (1%).

The model highlighted the importance of animal costs in technical efficiency for agricultural production. Animal costs were significant at 5% but the negative coefficient (-1.53) implies that the higher the costs the lower the production of maize and vice versa. Since the indication is that animal costs are low, its impact on increasing maize yield is confirmed. The use of animals was regarded as the cheapest source of power in rural areas with low costs of management for the farmers (Starkey *et al.*, 1995). But there is evidence of sub-optimal utilization of the animal power in view of the small coefficient of 1.5 which represented the extent to which maize yield would rise with a 1% decline in animal costs. However, owners of animal power could be regarded as food secure as most were more likely to take advantage of the early rains as they do not have to wait for equipment to become available before they can plough their fields. In that way, they are able to benefit from conservation of moisture through winter ploughing.

The results show that area cultivated to maize made an enormous difference in the yield of maize with a very coefficient of 272 representing the factor by which the yield of maize would rise as the area increased by a mere 1%. This result underscores the very high value of land in the farming system stemming from the acute shortage of this vital resource in Lesotho. This result was positively significant ($p=0.001$). Enhanced access to land would definitely make a significant contribution towards improving household food security.

Furthermore, the amount of seeds in kilograms with its coefficient estimates of 13.62 was regarded to be positively significant to the production of maize ($p=0.000$). It is clear that the quantity and quality of seeds used had a positive influence on the production of maize which also had a positive influence on the areas to be ploughed and increasing amount of yield to be harvested.

Application of fertilizer is significant ($p = 0.005$) to the production of maize (Table 5.30). According to King (1985), application of fertilizer improves the yield of maize as it replaces the used nutrients by the crops from the soil. The findings further explained that the amount of fertilizer to be applied per hectare was very important. This is as high amount of fertilizers would be harmful to maize yield through burning of crops (Owen *et al.*, 1999). Therefore farmers who did not apply fertilizers during the production of maize encountered very low maize yield as well.

There were variables which had probability values that were statistically significant. Greater values those which didn't deviate much from the set level of significance indicated that there was a strong correlation between the variable and the level of production obtained by the farmer. Again on the basis of the values of the coefficient estimate of -0.001% and a standard deviation value of 0.004 (Table 5.30). The results justified the literature reviewed which acknowledged that income related to the production of maize and, other factors assumed constant, farmers with enough income were likely to be more productive (FAO/WFP, 2007). Tractor costs were not significant in the production of maize. This is as its probability is above the set level. According to Joubert *et al.*, (2004), tractors are capital intensive and most farmers in rural areas buy second

hand tractors which have reached their economic life, such that farmers spend more money for maintenance and that increases production costs even though able to expand areas to be cultivated.

5.5.4 Impact of animal power through Cobb-Douglas Model

Table 5.31 presents results of the modelling of maize production using the Cobb-Douglas Model to estimate technical efficiency.

Table 5.31: Cobb-Douglas Model for production efficiencies on maize yield.

Variables	Coeff.	Std. Error	Z	P-Values	95% confident interval	
Gender	169.62	165.31	1.03	0.305	-154.382	493.63
Age	2.70	6.18	0.44	0.662	-9.411	14.81
Household size	-7.91	38.05	-0.21	0.835	-82.48	66.66
Education	23.999	25.89	0.93	0.354	-26.75	74.75
Income	-0.023	0.05	0.45	0.655	-0.078	0.12
Income generating activities	-0.001	0.004	-0.27	0.787	-0.00997	0.008
Size of land	26.17	71.97	0.36	0.716	-114.885	167.22
Equipment not available	24.51	41.96	0.58	0.559	-57.73	106.76
Tractor costs	-0.70	0.15	-0.48	0.630	-0.355	0.22
Diesel costs	0.08	0.25	0.40	0.693	-0.320	0.48
Labour costs	0.13	0.28	0.47	0.635	-0.420	0.69
Animal costs	-1.55	0.76	-2.03	0.042**	-3.04	-0.055
Area of maize	260.54	85.75	3.04	0.002***	92.47	428.61
Seeds (kg)	11.91	3.37	3.53	0.000***	5.302	18.513
Fertilizer (kg)	2.12	0.898	2.36	0.018**	0.358	3.88
Amount consumed	-561.63	2667.19	-0.21	0.833	-5789.23	4665.96
Costs hired	0.0699	0.106	0.66	0.509	-0.14	0.277
/Insig2v	13.4463	1307443	102.84	0.000	13.19004	13.70255
/Insg2u	5.21506	88198.05	-0.00	1.000	172870.2	172859.8
Sigma-v	831.4304	54.35241			731.4439	945.0849
Sigma-u	.0737164	3250.822			0	-
Sigma2	691276.6	90380.84			514133.4	868419.8
1ambda	.0000887	3251.381			-6372.589	6372.589

Likelihood-ratio test of sigma_u = 0: chibar2 (01) = 0.00

Prob> = chibar2 = 1.000

Significance denoted as follows: * (10%), ** (5%), and *** (1%).

The model highlighted the importance of animal costs in influencing technical efficiency in agricultural production. Animal costs were significant but negatively affecting maize yield. Costs from animals seemed very low compared to tractor costs. These also included labour, transport, maintenance costs, diesel, and equipment (Table 5.31). The low costs of animals involved costs from management of animals as well. According to FAO (1996), most animals feed from the grasses in the rangelands and very few farmers practice supplementary feeding especially during drought weather conditions in the lowlands of Molepolole district of Lesotho. However, the area of maize also had a positive significant relationship in the production of maize. Land area under maize is also capable of improving the household food security with high yield of maize. The results show that area planted to maize is strongly influential ($p=0.002$) (Table 5.31). On the other hand, the amount of seeds used had the positive association in the production of maize ($p=0.000$). The positive relationship of amount seeds indicated that maize yield would be increased and improved household food security (Table 5.31).

The amount of fertilizers was statistically significant and positive ($p=0.018$) in the production of maize. Application of fertilizers replaced the nutrients in the soil and improved the soil fertility; hence more yield of maize was obtained. On the other hand, farmers who did not apply fertilizers in their fields obtained very low yields of maize. This was because maize needs more nutrients from the soil for high yields. Additionally, there were some of the constraints in the production of maize which included tractor costs, labour costs, diesel costs, which increase production costs and lead to low production of maize due to high costs of production of the farmers. All these constraints had negative significant in the production of maize.

5.6 Chapter Summary

The chapter has presented the results of diverse statistical and econometric analyses conducted to address the research questions posed at the beginning of this dissertation. Descriptive statistics were employed to broadly describe the farming systems and challenges facing small scale farmers. Gross Margins analysis was conducted to compare the relative performances of the animal power and tractor power options based on the yield levels for maize crop which is a dietary staple in Lesotho and plays an important role in the economy of Lesotho. The multiple

linear regression model was fitted to determine the key factors influencing differences in yield under the alternative power regimes as well as determine the impact of animal traction on agricultural productivity. Some diagnostic tests to detect serial correlation and heteroskedasticity and t-tests were also performed and the data and model adequacy were confirmed. The stochastic frontier production model for the production efficiencies was fitted and revealed that animal costs strongly influenced maize yields. The model also provided insights into the relative contributions of animal power and traditional systems to poverty alleviation and food security in the project areas. The significant variables include the area of sorghum ploughed, members of the household that assist with family labour, education, quantity of fertilizer applied, time taken by the farmers in farming, members who are formally employed, household size, area of land ploughed, old age, costs of tractor and animal, marital status, income, area of maize ploughed, area of sorghum ploughed, quantity of fertilizers applied, costs of seeds and fertilizers applied, maize and sorghum yield and amount sold and consumed. The study revealed that monoculture is mainly practised and many smallholder farmers used traditional technologies that fail to replace nutrients in the soil. Nonetheless family labour was not a problem. During the farming season, tractors were used as the main source of power for ploughing. Most farmers hired these for maize production as it is a staple food crop even where animal power is available. It was noted that the tractors were few and in most cases old and malfunctioning. The cost of using animals in farming obviously played a role in the production of both maize and sorghum in the lowland areas of Mohale's Hoek district. Smallholder farmers who owned both tractors and animals produced more but they were mainly affected by high costs of maintaining the aging tractors, generally purchased on the used-equipment market. The increased challenges resulted in lower productivity of the smallholder farmers, including: unhealthy animals, drought, marketing problems, late ploughing, poor soils, lack of extension services, low yields, low income, lack of information, lack of appropriate implements, lack of support services, nutrition inadequacy, inappropriate farming systems.

CHAPTER 6

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

The study examined the impact of animal power on agricultural productivity, with special reference to the small scale farmers in the lowlands of Mphahle's Hoek district of Lesotho. The key considerations that motivated this study were that most farming at subsistence level is located in rural areas where the majority of smallholder farmers have low productivity which results in high rate of food insecurity. The areas are characterised by animal traction and poor farming practises, and monoculture is mostly preferred. In order to understand the relative contributions of alternative power use regimes on agricultural productivity in the lowlands of Lesotho, the study employed a wide range of methods and analytical techniques to generate information which has provided sufficient insight into the farming system's constraints and opportunities. The major findings of the study are summarized in the next sections following this introductory section. The chapter then presents possible recommendations based on the results of the study.

6.2 Summary

This study is concerned with the assessment of the impact of animal power on agricultural productivity. It focused on components of agricultural productivity based on production levels of maize and sorghum in the smallholder farmers in the lowlands of Mphahle's Hoek district of Lesotho. This research documents the trends and sequential patterns in the adoption of animal power technology and assesses the evidence on the productivity.

The dissertation is divided into six chapters. The background of the study was presented in Chapter 1 and focused on the assessment of the impact of draft power for agricultural productivity on the small scale farmers. The chapter also presented the problem statement and the main objectives of the study as well as the research hypothesis. The justification and the delimitations of the study were also discussed.

The relevant literature is reviewed in respect to the poverty situation in the developing countries, general overview of mechanization, and impact of mechanization on agricultural productivity and poverty reduction. Some of the constraints facing mechanization development in Southern Africa were considered in addition to how these constraints can be achieved in these areas for household food security. Some of the anticipated outcomes of an improvement in food security as a result of adoption of mechanization were considered.

The next chapter presented the study area and the methodology adopted to conduct the study. As was clarified earlier, the study was conducted in the lowlands of Mohale's Hoek district in the villages namely; Potsane, Mapotsane, Tsoloane and Siloe. The region is considered a semi-arid region and has low agricultural potential due to drought and declining soil fertility in the face of inappropriate farming methods. Farmers in the region use both animal and tractor power for production and high costs of acquiring these pose serious constraints to the resource-poor farmers. This leads to increasing food insecurity situation in these areas necessitating the recommendation for immediate improvements in the production technologies to increase production.

The chapter on methodology describe the means by which the sample was selected and the data were collected from farmers and extension workers using semi-structured questionnaires, with the few open-ended questions and face to face interviews allowing for the collection of a wide range of information that provided immense insights into the nature of the farming system and the decision process for the use of alternative technologies in the farming system. A wide range of analytical procedures was also used to analyse the data, including descriptive statistics to describe the household characteristics of sampled households, farming systems and challenges facing small scale farmers. Several empirical models were employed by the study, including Gross Margin analysis which was conducted to compare the yield levels for the production of maize under two types of farm power use. The multiple linear regression model and the Stochastic Frontier Production Model as well as several hypothesis testing procedures were employed and the diagnostic tests to detect serial correlation and heteroskedacity were conducted and it was possible to confirm both model and data adequacy in all cases. .

Taking more closer look at the results, the data revealed significant differences between the two groups; animal and tractor power, not only in household production levels and income generation but also in input usage. The results suggested that animal power users are more productive than tractor power farmers in the productivity of sorghum as a substitute. This is because sorghum is allocated a smaller portion of land than maize as a staple food. The tractors are more productive in the production of maize especially during ploughing stage and the other activities such as cultivation and planting are mainly done by animal power in order to lower the costs of production. In general, maize is allocated a larger portion of land and tractors are efficient at land sizes in excess of three hectares (Joubert *et al.*, (2004). On the other hand, the animal costs are found to be more significant in the production of maize and sorghum based on the Stochastic Frontier Production Model. This is because animal power is considered to be cheaper than the use of tractors. The source of this productivity differential is found to lie in differences in machinery ownership and complementary input usage.

The study also examined the challenges and farming systems on animal power users in the lowlands of Mohale's Hoek district agricultural productivity. Most rural households practised monoculture in their farming which contributed to low production. This is because most are not able to replace lost nutrients from the soil through application of fertilizers; hence low yields are obtained. The high rate of unemployment proved to be a serious constraint. For instance, it was observed that very few household members are formally employed and even for those, incomes are very low such that most are unable to buy improved inputs needed to obtain higher production. It was also identified that some still utilize seeds from stored harvests.

Marketing was still a problem in the project areas. Marketing is important because it stimulates the productivity of smallholder farmers if the farmers are aware of the marketing opportunities. Furthermore, most farmers were not able to keep records. Even though they lacked skills such as risk management, marketing and financial management but there was determination on the part of the farmers to improve production. The indication is that these farmers experience lack of support from the Ministry of Agriculture which is a serious demotivation to them. The dominant type of land tenure in the project areas is by inheritance and very few farmers managed to buy

land. FAO/WFP (2007) declared that most of the land is not cultivated. This is due to lack of funds and high rate of poverty. As such, most farmers lacked inputs even when owning fields.

6.3 Conclusion

This thesis takes a different look at the way animal draft power with low rate of extension affects the performance of smallholder farmers in the lowlands of Mohale's Hoek district. Using data from Potsane, 'Mapotsane, Tsoloane and Siloe, a stochastic frontier production model is estimated where impact of animal traction on agricultural productivity was measured. Having the observations from the different results allowed to derive conclusions regarding the impact of animal power on agricultural productivity in the project areas. The results in this paper shed light on the interaction between animal power users and the extension departments from the Ministry of Agriculture, non-governmental organizations.

The overall conclusion from the analysis is that with an improved rate of agricultural extension in the project areas, animal power should be viewed as the low-cost mechanisation for smallholder farmers. This is as from the stochastic results, animal costs are more significant in the production of maize compared to a tractor costs. However, these could be of great importance since most farmers produce at a subsistence level. Also enhanced extension would result in well managed animals which would result in commercialization of cattle in the project areas since most farmers have animals and equipment for animal power.

6.4 Recommendations to the Ministry of Agriculture and the Governmental organizations

Due to very low productivity in the lowlands of Mohale's Hoek district and high rate of food insecurity in especially the maize crop as a staple food and sorghum as a substitute, there is need to improve on the extension in the project areas since there is very low rate of extension services in the project areas. This is because agricultural extension is a mechanism by which information on new technologies, more effective management options, and better farming practices could be transmitted to farmers (Owens *et al.*, 2003). On the other hand, extension agents interact with farmers, providing information and aiding in developing their managerial skills (Birkhaeuser *et al.*, 1991). In addition, extension agents disseminate information on crops and livestock

practices, optimal input use, and consult directly with farmers on specific production problems, thus facilitating a shift to more efficient methods of production. That is agricultural extension not only accelerates the diffusion process and the adoption of new varieties and technologies but also improves the marginal ability of farmers and affects the efficient utilization of existing technologies by improving farmers' know-how. Also these two roles of agricultural extension could have different effects on the performance of farmers attempting to close the management and technology gaps, respectively. However, well considered extension in the certain farms will assume that the farm is operating at full technical efficient levels and thus do not purposely waste resources. If they waste resources but are ignorant of doing so, this is only being due to lack of knowledge. Also the on-farm trials and demonstrations on new techniques on production should be carried out using easily available types of power which will reach most of the farmers especially those with limited resources. Furthermore, whenever input support programmes are to be implemented they should be on time, provide a complete package and should be co-ordinate well to ensure synergy. Conditions that promote sufficient quantities of seeds, fertilizers and fuel to be placed on the market in a manner that adequately rewards the inputs suppliers should be put in place. To encourage household level food security, input support programmes should prioritize smallholder farmers who depend mostly on own production for their subsistence requirements.

For the purposes of draft power, measures should be put in place to promote restocking in smallholder farming areas and development of the commercial cattle and large scale commercial sectors through improved livestock husbandry (management) as most farmers have ox-drawn implements. For the benefit of the food security status, there is need to enhance the co-ordination, organizations and planning of activities, workshops, seminars, tours and networking within and outside the country. On the other hand, most of the farmers are food insecure, some lack information concerning marketing of their production. According to Mbata (2001), smallholder farmers would be stimulated to produce high if exposed to good access to markets. This is as some produce high and loose to pests in their poor storage rooms. Farmers also need to be well equipped with information concerning management of the power, which is why most of the animal and even tractors deteriorate at a higher rate. According to Joubert *et al.*, (2004), a

farmer with animal power is considered food secure. This is as the farmer would be able to exploit the early rains at the same time having food in their store rooms even during drought conditions. This is because animal power is cheaper than the use of a tractor. According to FAO/WFP (2007), many fields are left idle. There is motivation needed from extension workers to bring back their lost form or status in the project areas. Extension workers need to show up in the fields during the ploughing season. Farmers on the other hand will be able to share to other members at home, so this issue would bring them back to farming. Joubert *et al.*, (2004) declared that most of the animal power users hire tractors even when there is animal power option which would be used which is affordable. Most of these farmers think they are behind time when they plough using animal power while most use tractor. This is as tractors are capital intensive and only efficient at hectares above three hectares. However, Joubert *et al.*, (1999) further declared that tractor users in rural areas are struggling in farming, this is as most of them buy second hand tractors which reached their economic life; hence they are now producing at higher costs because of high rate of maintenance of these tractors.

6.4 Policy implications

The findings discussed the impact of animal traction on agricultural productivity for the smallholder farmers in the lowlands of Mohale's Hoek district of Lesotho. Regionally, food security is recently in the forefront for the international development agencies, calling for increase in food production and a sustainable use of resources. However, the role of animal traction in achieving food security remains mute. Some of the implications include the likes of agricultural extension which is seemed to be very limited in the project areas because of very low production from both maize and sorghum due to lack of knowledge which led to poor application of farming systems from the power adopted. In any case farmers that had access to extension outlets demonstrated higher levels of performance compared to those who were not able to have access to extension. What makes farmers who had access to extension to be more productive is the nature of the issues addressed by the extension agents that cover the entire spectrum of the farmers' needs. This issue is of great importance for policy makers deserve further investigation. Thus, it is suggested that policies be crafted that encourage research of high yielding varieties of maize and sorghum suitable for the regions of Mohale's Hoek district.

The other major important factor, which was shown to constrain production of small grains in semi-arid areas, was lack of credits and support systems in terms of seed and fertilizer for maize and sorghum. These findings are supported by literature that the trends in Lesotho have been that the government and non-governmental organizations have been treating farmers as a homogenous group by issuing maize inputs throughout all the agro-ecological farming zones. Rather it is recommended that farmers in areas such as Potsane, 'Mapotsane, Tsoloane and Siloe which are considered to be characterised by limited resources, be assisted with subsidized hybrid seeds and fertilizer for both maize and sorghum production. According to FAO/WFP (2007), such crops are considered have better adaptability to such agro-ecological environments. Therefore, concerted efforts are required from government, non-governmental organizations (NGOs) and the private sector to extend credit to farmers for the production of both maize and sorghum.

Policies that strengthen input and product markets for sorghum and maize in Lesotho areas are also recommended. This might act as a great incentive for farmers to adopt the animal power for the production of these crops on a large scale. This is in view of price differences between sorghum and maize on the market. Hence, in terms of market potential there is a good reason to expand production of sorghum and maize in Lesotho.

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APPENDICES

Appendix 1: The Questionnaire

QUESTIONNAIRE ON THE IMPACT OF ANIMAL DRAFT POWER AND NON-DRAFT POWER USERS FOR AGRICULTURAL PRODUCTIVITY: THE CASE STUDY OF THE SMALL SCALE FARMERS IN THE LOWLANDS OF MOHALE'S HOEK AREAS OF LESOTHO BY MR RAMPOKANYO

ALL INFORMATION PROVIDED WILL BE TREATED AS HIGHLY CONFIDENTIAL

Date.....

Enumerator name.....

Name of village.....

Name of respondent (Optional)

Relation to household head

A. DEMOGRAPHIC DETAILS

Fill in the relevant information and where possible mark with an X

A.1. GENDER		A.2. AGE (Years)	A.3. MARITAL STATUS				A.4. HOUSEH OLD SIZE
M=1	F=2		Single=1	Married= 2	Widowe d=3	Divorced= 4	Total=5

A.5. How many household members assist with farm labour.....?

A. 6. What is the highest educational level the head of household has completed.....?

A.7. What is your employment status?

EMPLOYMENT STATUS		
	Tick	Average Income (Rand per month)
1.Full time farmer		
2.Part time farmer		
3.Formally employed		
4.Pensioner		
5.Unemployed		
6.Other (Specify)		

A.8. What other income generating activities do you do?

.....

A.9. How much money did you realize from the activity (Rands)?

.....

B. LAND, FARMING METHODS AND COPING STRATEGIES

B.1. How do you cultivate your land?(Tick as appropriate)

Types of power	Own	Borrowed	Hired	Cost
1.Tractor				
2.Animal drawn				
3.Both				
4.Other (Specify)				

B.2. Why do you use that method?

.....

.....

B.3. Indicate the land tenure system on the land in use and how you acquired it?

LAND TENURE SYSTEM			HOW YOU ACQUIRED THE LAND			
1=Communal	Rent/Lease=2	Privately owned=3	Bought=1	Inherited=3	Resettled=4	Other (specify)=5

B.5. Are you able to till your land after harvesting (winter) to conserve moisture: (1) Yes (2) No

B.6. If no to B.5. State

reasons.....

B.7. Indicate the type of farming practiced on your farm? Tick from the following: use X.

Types of farming	Tick (X)
1.Livestock	
2.Arable	
3.Mixed	

B.8. If arable farming is involved, state systems of crop production practiced in your farm. Tick with X below:

Types of systems	Tick below
1.Monoculture	
2.Mixed cropping	
3.Crop rotation	
4.Continuous cropping	
5.Inter-cropping	

B.9. Please indicate the type of traction (tractor or animals) used for the following agricultural activities.

Activity	Size of land (ha)	Type of traction used	Number of each used
1.Ploughing			
2.Cultivation			
3.Planting			
4.Discing			

B.10. Are you able to plough in a time required? (1) Yes (2) No

B.11. If no, why.....

.....

.....?

B.12. Do you always apply manures in your fields? (1) Yes (2) No

B.13. Do you cultivate all your fields every year? (1) Yes (2) No

B.14. If animals used, how did you train them for use in farming?

.....

.....

B.15. what experience do you have in handling animals

.....

.....?

B.16. Have you ever been trained on how to use animal traction or use a tractor?

1. Yes 2. No

B.17. How has this training impacted on you as a farmer?

.....

.....

B.18. what kind of equipment is required when ploughing with animals or a tractor in the field?

.....

.....

B.19. Do you have all this equipment? 1. Yes 2. No

B.20. If no to B.18, please indicate which ones you don't have?

.....

.....

.....

B.21. how then do you deal with that challenge of lack of equipment?

.....

.....

.....

B.22. what are other constraints do you face in animal traction or tractor power and indicate costs if any?

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

B.23. how do you deal with these constraints?

.....

.....

.....

B.24. what kind of support do you receive from the department of agriculture in dealing with these constraints?

.....

.....

.....

C. CROP PRODUCED AND COPING STRATEGIES:

C.1. which crops do you grow?

Crop	Area devoted to crop	Yield (tonnes)	Amount consumed (t)	Amount sold	Amount of income (Rands)
1.Maize					
2.Sorghum					
3.Beans					
4.Wheat					
5.Pumpkin					
6.Other Specify					

C.2. Indicate the production inputs that you use?

INPUT	AMOUNT per ha	COST per ha
1.Treated Seeds		
2.Fertilizer		
3.Pesticides		
4.Insecticides		
5.Other (Specify)		

C.3. where do you get the production inputs that you use?

List input	Place you get it	Distance (km)	Reason for using the market
1.			
2.			
3.			
4.			
5.			

C.4. For the farming season 2009/2010 did you produce enough food to last until next harvest?

1. Yes 2.No

C.5. If 'no', are you able to purchase supplement food?

1. Yes 2.No 3.N/A

C.6. If the answer to b) is 'no' what consumption coping strategies do you use?

1) Reduce number of meals 2) Borrow from relatives and friends 3) Switch to substitutes (specify) 4).N/A 5) Other specify

C.7. What kind of assistance do you want to increase crop output and household food security?

.....

C.8. If livestock farming is involved, which type of draft animals are kept? (Tick with X)

Types of draft animals	Tick used one	Purpose
1.Cows		
2.Horses		
3Donkeys		
4.Oxen		
5.Small stock		
6.Others (Specify)		

C.9. Did you sale any of your livestock during 2009/2010 season? 1. Yes 2. No

C.10. If yes specify amount and livestock?.....

C.11. Where did you use the income?.....

D. MARKETING

D.1. a) Where did you sell the crops you grow?

Crop	Market
1.Maize	
2Sorghum	
3.Beans	
4.Wheat	
5.Pumpkin	
6.Other specify	

[1] Locally to neighbours [2] Hawkers [3] School teachers [4] Local shops [5] other specify

D.1. b) Do you have problems in selling some of your crops? [1] Yes [2] No

D.2. a) If the answer is Yes specify crop.....?

D.2. b) Specify nature of the marketing problem

1) No readily available market 2) did not produce enough to market 3) market too far

4) Price offered on the market too low 5) other specify.....

F. HUMAN CAPITAL ENDOWMENTS

F. 1. For how long have you been farming?years

F. 2. How do you rate the farming knowledge applied on your farm?

Farmer knowledge	Poor=1	Average=2	Good=3	Employees knowledge	Poor=1	Average=2	Good=3
How knowledge was acquired	Experience=4			How knowledge was acquired	Experience=4		
	Education=5				Education=5		

F. 3. Is there any household member with any of the following skills?

SKILL	Yes	No	Where they studied
1.Animal/ Crop production			
2.Financial management			
3.Marketing			
4.Risk management			
5.OTHER (Specify)			

F. 4. What specific training do you need at your farm?

	Reason why you think it is important
1.Marketing	
2.Budgeting	
3.Record keeping	
4Other (specify)	

F. 5. Do you attend workshops to learn about farming practices?

YES=1	How often?	NO=2	Reason for not

F. 6. Which farm records do you keep?

Costs=1	Sales=2	Other (such as :)=3

G. EXTENSION SERVICES

G. 1. How do you rate the services provided by extension officers in your area?

Unavailable=1	Not helpful=2	Helpful enough=3

G. 2. Do you contact extension officers during the marketing period?

Yes=1		No=2	
-------	--	------	--

G. 3. What services are provided by extension officers?

Advice on marketing=1	Advice on record keeping=2	Other (Specify)=3

G. 4. Are the extension officers always available when you need help?

Never available=1	Available sometimes=2	Always available=3

F. 5. List the problems that you face in contacting extension officers?

.....

.....

.....

.....

H.

INSTITUTIONAL SUPPORT SERVICES

H. 1. Are you aware of the role played by organizations in marketing?

Yes=1	No=2	
-------	------	--

H. 2. Do you think that public institutions (such as local administration, national government, public organizations) are willing to help and to support your farm business?

Explain.

.....

.....

.....

.....

.....

H. 3. Are you a member of any organization?

NO=1	Reason for not joining	YES=2	Name of Organization

H. 4. State some of the challenges you are facing in your farm?

	Minor challenge	Major challenge
1) The search for information 2) Lack of appropriate implements 3) Lack of support services 4) Nutrition inadequacy 5) Inappropriate farming systems 6) Financial 7) Others (specify)		

THANK YOU VERY MUCH FOR YOUR TIME – ENJOY YOUR DAY

QUESTIONNAIRE TO EXTENSION WORKERS IN THE MINISTRY OF AGRICULTURE.

1, a) what farming systems and activities employed by the farmers in the lowlands of Mohale'shoek district ('Mapotsane, Potsane, Tsoloane, and Siloe).

b) Is there way forward in what they are doing?

c) Do you hold workshops for farmers in those areas?

d) If so how often?

2, a) which type of power is mostly used by the farmers in those areas?

b) How is the management of that power and its conditions?

c) How is the performance of farmers adopting both animal and tractor power in those areas?

3, a) Can you state some of the challenges facing the farmers adopting either tractor or animal power in those areas?

b) How can these challenges be rectified or what is the way forward in these challenges?

c) How is the development of agriculture in those areas?

4, State some of the policies and support systems for the development of farmers using either animal or tractor power in those areas?

THANK YOU VERY MUCH FOR YOUR TIME- ENJOY YOUR DAY

Appendix 2: The correlation Table showing the significance between variables.

Table 5.26: the correlation variables to test the significant status of variables to the dependent variable.

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1.Gender																				
Sig. (2-tailed)	-	.800	.224	.453	.643	.303	.619	.235	.129	.579	.049	.586	.066	.168	.940	.110	.236	.069	.357	.334
Person correlation	1	.024	.113	-.70	.043	.096	-.046	.110	-.141	-.051	-.181	-.051	.170	.128	-.007	-.148	-.110	-.168	-.086	.090
2.Age																				
Sig. (2-tailed)	.800	-	.514	.050	.010	.001	.202	.529	.316	.980	.110	.941	.498	.988	.227	.950	.028	.694	.131	.004
Person correlation	.024	1	-.061	-.181	-.237	.290	-.118	-.059	-.093	.002	-.148	-.007	.063	.001	-.112	-.006	-.203	-.037	-.140	.264
3.Household size																				
Sig. (2-tailed)	.224	.514	-	.000	.343	.266	.647	.166	.636	.029	.934	.308	.543	.372	.603	.412	.656	.521	.650	.447
Person correlation	.113	-.061	1	.425	-.088	-.103	.043	.128	.044	.201	.008	.095	.057	.083	.048	.076	-.041	.060	-.042	.071
4.Members assisting with labour																				
Sig. (2-tailed)	.453	.050	.000	-	.645	.036	.552	.119	.019	.000	.018	.000	.107	.108	.000	.259	.089	.153	.098	.166
Person correlation	-.070	-.181	.425	1	.043	-.193	.055	.144	.216	.325	.218	.357	.149	.149	.401	.105	.157	.132	.153	.128

5.education																				
Sig. (2-tailed)	.643	.010	.343	.645	-	.084	.007	.667	.134	.027	.374	.115	.704	.823	.121	.701	.538	.406	.842	.422
Person correlation	.043	-.237	-.088	.043	1	.160	.249	-.040	.139	.204	.083	.146	.035	.021	.143	.036	-.057	.077	-.019	-.075
6.Employment status																				
Sig. (2-tailed)	.303	.001	.266	.036	.084	-	.500	.685	.564	.455	.421	.403	.440	.414	.264	.641	.006	.298	.013	.059
Person correlation	.096	.290	-.103	-.193	.160	1	.063	.038	-.054	-.069	-.075	-.078	-.072	-.076	-.104	-.043	-.251	-.097	-.228	.174
7. Income																				
Sig. (2-tailed)	.619	.202	.647	.552	.007	.500	-	.594	.000	.000	.000	.000	.000	.000	.002	.000	.720	.000	.820	.212
Person correlation	-.046	-.118	.043	.055	.249	.063	1	-.050	.559	.398	.443	.546	.635	.667	.287	.774	-.033	.665	-.021	-.116
8.Other generating activities																				
Sig. (2-tailed)	.235	.529	.166	.119	.667	.685	.594	-	.894	.845	.629	.762	.481	.783	.055	.416	.583	.323	.350	.622
Person correlation	.110	-.059	.128	.144	-.040	.038	-.050	1	-.012	-.018	.045	.028	.066	-.026	.177	-.076	-.051	-.092	-.087	.622
9.Size of land																				
Sig. (2-tailed)	.129	.316	.636	.019	.134	.564	.000	.894	-	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.854
Person	-	-	.044	.216	.139	-.054	.559	-.012	1	.612	.664	.626	.680	.695	.43	.730				

correlation	.141	.093													5		.346	.773	.392	.017
10.area of maize	.579	.980	.029	.000	.027	.455	.000	.845	.000	-	.000	.000	.000	.000	.00	.000	.412	.000	.364	.484
Sig. (2-tailed)	-	.002	.201	.325	.204	-.069	.398	-.018	.612	1	420	.574	.331	.406	0	.507	.076	.516	.084	.065
	.052														.397					
11.Area of sorghum																				
Sig. (2-tailed)	.049	.110	.934	.018	.374	.421	.000	.629	.000	.000	-	.000	.000	.000	.00	.000	.003	.000	.021	.397
Person correlation	-	-	.008	.218	.083	-.075	.443	.045	.664	.420	1	.448	.742	.617	0	.632	.274	.577	.213	.079
	.181	.148													.365					
12.Maize yield																				
Sig. (2-tailed)	.586	.941	.308	.000	.115	.403	.000	.762	.000	.000	.000	-	.000	.000	.00	.000	.037	.000	.001	.224
Person correlation	-	-	.095	.357	.146	-.078	.546	.028	.626	.574	.448	1	.663	.765	0	.662	.192	.669	.294	-.113
	.051	.007													.772					
13.Sorghum yield																				
Sig. (2-tailed)	.066	.498	.543	.107	.704	.440	.000	.481	.000	.000	.000	.000	-	.000	.00	.000	.000	.007	.010	.815
Person correlation	-	-	.057	.149	.035	-.072	.635	.066	.680	.331	.742	.663	1	.911	0	.789	.245	.720	.238	-.022
	.170	.063													.502					
14.amount sold																				
Sig. (2-tailed)	.168	.988	.372	.108	.823	.414	.000	.783	.000	.000	.000	.000	.000	-	.00	.000	.040	.000	.006	.257
Person correlation	-	-	.083	.149	.021	-.076	.667	-.026	.695	.406	.617	.765	.911	1	0	.859	.190	.825	.253	-.105
	.128	.001													.393					

15.amount consumed																				
Sig. (2-tailed)	.940	.227	.603	.000	.121	.264	.002	.055	.000	.000	.000	.000	.000	.000	-	.001				
Person correlation	-.007	-.112	.048	.401	.143	-.104	.287	.177	.435	.397	.365	.772	.502	.393	1	.310	.001	.000	.000	.858
																	.293	.323	.323	-.017
16.seeds (kg)																				
Sig. (2-tailed)	.110	.950	.412	.259	.701	.641	.000	.416	.000	.000	.000	.000	.000	.000	.001	-	.573	.000	.438	.397
Person correlation	-.148	-.006	.076	.108	.036	-.043	.774	-.076	.730	.507	.632	.662	.789	.859	.310	1	.052	.909	.072	-.079
17.Fertilizer (Kg)																				
Sig. (2-tailed)	.236	.028	.656	.089	.538	.006	.720	.583	.000	.412	.003	.037	.007	.040	.001	.573	-	.010	.000	.775
Person correlation	-.110	-.203	-.041	.157	-.057	-.251	-.033	-.051	.346	.076	.274	.192	.245	.190	.293	.052	1	.236	.898	.027
18.Seed costs																				
Sig. (2-tailed)	.069	.694	.521	.153	.406	.298	.000	.323	.000	.000	.000	.000	.000	.000	.000	.000	.010	-	.002	.198
Person correlation	-.169	-.037	.060	.132	.077	-.097	.665	-.092	.773	.516	.577	.669	.720	.825	.323	.909	.236	1	.280	-.119
19.Fertilizer costs																				
Sig. (2-tailed)	.357	.131	.650	.098	.842	.013	.820	.350	.000	.364	.021	.001	.010	.006	.000	.438	.000	.002	-	.615
Person correlation	-.086	-.140	-.042	.153	-.019	-.228	-.021	-.087	.392	.084	.213	.294	.238	.253	.323	.072	.898	.280	1	-.047

20. Time in farming (years)																				
Sig. (2-tailed)	.334	.004	.447	.166	.422	.059	.212	.622	.854	.484	.397	.224	.815	.257	.858	.397	.775	.198	.615	-
Person correlation	.090	.264	.071	.128	-.075	.174	-.116	.046	.017	.065	0.79	-.113	-.022	-.105	-.017	-.079	.027	-.119	-.047	1

Source: Field Survey (2010)

Correlation is significant at the 0.01 level (2-tailed).

Correlation is significant at the 0.05 level (2-tailed).