TECHNICAL EFFICIENCY IN MAIZE PRODUCTION BY SMALL-SCALE FARMERS IN GA-MOTHIBA, LIMPOPO PROVINCE, SOUTH AFRICA

BY

BALOYI REBECCA TSHILAMBILU
B.AGRIC. ADMIN HONOURS
(AGRICULTURAL ECONOMICS)

A FULL DISSERTATION SUBMITTED IN FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE MASTER OF AGRICULTURAL MANAGEMENT IN AGRICULTURAL ECONOMICS

DEPARTMENT OF AGRICULTURAL ECONOMICS AND ANIMAL PRODUCTION
SCHOOL OF AGRICULTURAL AND ENVIRONMENTAL SCIENCES
FACULTY OF SCIENCE AND AGRICULTURE
UNIVERSITY OF LIMPOPO
PRIVATE BAG X1106
SOVENGA
0727
SOUTH AFRICA
2011

SUPERVISOR: PROFESSOR A. BELETE
CO-SUPERVISOR: MR. J.J. HLONGWANE

DECLARATION

I, Baloyi Rebecca Tshilambilu, declare that the dissertation hereby submitted to the University of Limpopo for the degree Master of Agricultural Management in Agricultural Economics has not been previously submitted for a degree purpose at this university and any other university.

Signed by: -------------------------------- Date: ------------------------

[redacted]

DEDICATION

This work is dedicated to my late grandmother Margaret N`wamatavheni Baloyi, and to my pillar of strength my mother Peggy Gavaza Baloyi (Tinyiko). It is also dedicated to my precious son Marothi Enos Letsoalo (Amukelani) and daughter Pearl Moorane Letsoalo, who were both born during the course of my studies, and to all my siblings.

ACKNOWLEDGEMENT

Firstly, I would like to give thanks to the Almighty God for giving me the strength throughout my studies. Appreciation also goes to my supervisor, Professor A. Belete, and the co-supervisor Mr. J.J. Hlongwane for their support, patience, commitment, and encouragement throughout my study. My sincere thanks also go to Mrs P. Chaminuka and Ms G.M. Senyolo for their unrelenting support.

To the French Embassy, through the Centre for Rural Community Empowerment (CRCE), for the financial support granted to me for this study and the CRCE team, Mr. E.M. Letsoalo (co-ordinator), Mr. C.K. Mphahlele (assistant co-ordinator), for their involvement by keeping the study focused and improving the quality of the document. CRCE field assistants: Mr. S. Ramaselela, Mr. B. Mashabela, Mrs. M.L. Mangena, and all the 2008 intern students at the CRCE you were all a source of inspiration.

I would also like to convey my greatest thanks to my mother Peggy Gavaza Baloyi, My dearest uncle Kenny Nghembeni Baloyi and my former Mathematics teacher in high school Mr. William Matome (Mkoni) for their encouragement and support throughout my studies as they believed in me. To my dearest fiancé, Lesetsa Samuel Letsoalo (Shane), you have been a source of inspiration and a loving father to our children while I was busy studying. Thank you very much. To my children Marothi and Pearl, many thanks to my siblings (Precious, Remember, and Xiluva), my niece Xihlovo Maphophe, Mama Suzan Mihloti Sibuya and Narry Baloyi, not forgetting my in-laws Mrs. Merriam Mosima Letsoalo and Mr. Marothi Letsoalo thanks. To all the members of the Baloyi`s family and friends Conny Maela, Rathani Nemuramba, Solly Molepo, Khumo Badisa and Dollence Baloyi, GOD BLESS YOU ALL.

"Ahaaa……… N`wa Baloyi, ntukulu wa n`wa Matavheni," wa ka Ndodolovhani, va ka chila ava ololi wo tshama wu lo khotseka" i n`wa Khalanga xelexo, khatsa".

ABSTRACT

Maize is the most important cereal crop grown in South Africa. This crop is produced throughout the country under diverse environments. The study only focuses on the technical efficiency because it is an important subject in developing agriculture where resources are limited, but high population growth is very common. Technical efficiency is the ability of a farmer to obtain output from a given set of physical inputs. Farmers have a tendency of under and/or over-utilising the factors of production.

The main aim of this study was to analyse the technical efficiency of small-scale maize producers in Ga-Mothiba rural community of Limpopo Province. The objective of the study was to determine the level of technical efficiency of small-scale maize producers and to identify the socio-economic characteristics that influence technical efficiency of small-scale maize producers in Ga-Mothiba. Purposive and Snowball sampling techniques were used to collect primary data from 120 small-scale farmers. Cobb-Douglas production function was used to determine the level of technical efficiency and Logistic regression model was used to analyse the variables that have influence the technical efficiency of maize production.

Cobb-Douglas results reveal that small-scale farmers in Ga-Mothiba are experiencing technical inefficiency in maize production due to the decreasing return to scale, which means they are over-utilising factors of production. Logistic regression results indicate that out of 13 variables included in the analysis as socio-economic factors, 10 of them (level of education, income of the household on monthly basis, farmer`s farming experience, farm size, cost of tractor hours, fertiliser application, purchased hybrid maize seeds, membership to farmers` organisation, is maize profitable) were found to be significant and 3 (gender, age and hired labour) are non-significant. However, farm size was found to be the

most significant variable at 99% level, showing a positive relationship to small-scale maize producer`s technical efficiency.

Therefore, it is recommended that government should do the on-farm training since farmers mainly depend on trial and error and farmers` should have access to enough arable land and tractor services. However, farmers need to be trained on matters relating to fertiliser application, on the amount of seeds a farmer should apply per ha, and the importance of using hybrid seed.

Table of Contents

LIST OF TABLES

LIST OF FIGURES

ACRONYMS

CRCE	Centre for Rural Community Empowerment
ARC	Agricultural Research Council
DoA	Department of Agriculture
SAES	School of Agricultural and Environmental Science
UL	University of Limpopo
FAO	Food and Agricultural Organization
SSF	Small Scale Farmers
TE	Technical Efficiency
AE	Allocative Efficiency
CD	Cobb-Douglas Production Function
LDA	Limpopo Department of Agriculture
CMMYT	International Maize and Wheat Improvement Centre
SA	South Africa

CHAPTER 1: INTRODUCTION

1.1 Background

South Africa has an essentially dual agricultural economy, comprising a well-developed commercial sector and a predominantly subsistence oriented sector in the rural areas. Covering 1, 2 million square kilometres of land, South Africa is one-eight the size of the United States and has seven climatic regions, from mediterranean to subtropical to semi-desert. Only about 13% of the country`s land surface area can be used for crop production, of which just 22% can be classified as high potential land. Some 1.3 million hectares are under irrigation. The most important factor limiting agricultural production in the country is the availability of water. Rainfall is distributed unevenly across the country with almost 50% of water being used for agricultural purposes (Aliber, 2003).

Primary agriculture in South Africa contributes about 2.5% to the gross domestic product (GDP) and about 8% to formal employment. However, there are strong linkages into the economy, such that the agro-industrial sector comprises about 12% of GDP. Although South Africa has the ability to be self-sufficient in virtually all major agricultural products, the rate of growth in exports has been slower than that of imports. The only increase in agricultural export volumes occurred during the period of exchange-rate depreciation in 2002, and came to about nine million metric tonnes. Major import products include wheat, rice, vegetable oils and poultry meat (Monde, 2003).

Maize is the largest locally produced field crop, and the most important source of carbohydrates in the Southern African Development Community (SADC) region for animal and human consumption. South Africa is the main maize producer in the SADC region, with an average production of about 8.9 metric tonnes a year over the past 10 years. It is estimated that more than 8 000 commercial maize producers are responsible for the major part of the South African crop, while the rest is produced by thousands of small-scale producers. Maize is produced mainly in North West, the Free State and Mpumalanga Provinces. A total of 6.9 million metric tonnes of maize was produced in 2006/07 on two million hectares of land (developing agriculture included) (DoA, 2007).

The present study focuses only on technical efficiency because it is an important subject in developing agriculture where resources are limited but high population growth is very common. The food balance sheet in Africa has shifted from positive to negative. For example, between 1970 and 1980's food production grew by 1.5 per cent while the population growth was 3 per cent. This has led to a decline in per capita food consumption, making sub-Saharan Africa the only region in the world where average calorific intake has declined over time. This problem of stagnation in food production is reflected in growing reliance on food imports, food aid, rising poverty and increasing degradation of the natural resource base (La-anyami, 1986).

Technical efficiency is the ability of the farmer to achieve the maximum possible output with available resources. There is also allocative efficiency which refers to the ability to obtain optimal output for given resources' prices. The combination of both technical and allocative efficiencies gives rise to economic efficiency. Thus, the measurement of economic efficiency is not complete without the study of technical efficiency, which is the frontier production function that enables the measurement of technical efficiency of farmers (Elsamma and George, 2002).

This study analyses the technical efficiency of small-scale maize producers in Ga-Mothiba, a rural community situated in Limpopo Province. There are many small-scale farmers at Ga-Mothiba community who still practice subsistence farming. These small-scale farmers were allocated land by Mothiba Tribal Authority. They own about 1.5 hectares of land on the average, producing maize during the rainfall season and vegetables during winter when they have harvested their maize. These small-scale farmers at Ga-Mothiba produce mainly maize with the purpose of improving their income and standards of living, since they usually produce for their own consumption, and store their surplus with the local silo owner.

1.2 Problem statement

Limpopo Province is characterised by extreme poverty. Hence, there is a need for subsistence maize production since maize is widely used as a staple crop. In order for subsistence maize production to develop, there is a need for pertinent farming information to be available to farmers. However, even with the availability of extension officers, whose responsibilities include information dissemination, there is still a general lack of awareness of proper farming methods amongst poor rural communities. This may lead to food insecurity.

Small-scale farmers have a tendency of under utilising and over utilising some of the factors of production. Because of poor farming methods and the general poverty in Ga-Mothiba, productivity levels are low. This could also be attributed to technical inefficiencies. The study, therefore, intends to investigate the extent to which technical inefficiency could be contributing this challenge.

The problem of small-scale agriculture includes extension services, which are inadequately funded and poor distribution of agricultural inputs. Also, inadequate education which is considered to be an important input in agricultural development is another hindrance to small scale agriculture (Belete *et al.,* 1991). This study, therefore, attempts to determine the technical efficiency level of small scale farmers in the study area.

1.3. Motivation of the study

Since maize is the main staple food in South Africa, high productivity and efficiency in its production are critical to food security. The government has been investing in agricultural development since the Land Reform Act 22 of 1994 as amended, but most households remain food insecure. Determining the efficiency status of small-scale farmers is very important for policy purposes. Efficiency is also a very important factor of production growth in an economy where resources are scarce and opportunities for new technology are lacking.

The study will provide information to government policy makers and other stakeholders and would benefit small-scale farmers not only in Ga-Mothiba village, but in other areas as well. In this way, poverty and food insecurity will be reduced and this will encourage even non-farmers to engage in subsistence maize production activities.

1.4 Aim and Objectives of the study

1.4.1 Aim

The aim of the study is to analyse the technical efficiency of small-scale maize producers in Ga-Mothiba.

1.4.2 Objectives

Objective 1: To determine the level of technical efficiency of small-scale maize producers in Ga-Mothiba.

Objective 2: To identify the socio-economic characteristics that influence technical efficiency of small-scale maize producers in Ga-Mothiba.

1.5 Hypotheses

Hypothesis 1: The small-scale maize producers in Ga-Mothiba are not technically efficient.

Hypothesis 2: There are no socio-economic characteristics that influence technical efficiency of small-scale maize producers in Ga-Mothiba.

1.6 Organization of the dissertation

Since the aim of this study was to analyse the technical efficiency of small-scale maize farmers/producers in Ga-Mothiba, the remainder of the study is structured as follows: Chapter two reviews literature. Chapter three discusses the methodology, including methods of data collection and analytical techniques used to analyse the data. Chapters four offers empirical analysis. Chapter five presents summary, conclusion and recommendations of the study.

CHAPTER 2: LITERATURE REVIEW

2.1 Importance of maize

In South Africa maize production is carried out using a wide range of farming systems, dominated mostly by subsistence oriented small-scale farmers and emerging medium\large-scale commercial farmers. The production is also generally characterised by low yields regardless of farm size, which results in high unit costs and leads to low returns (DoA, 2002).

According to ARC (2002), presently, maize is the most important and widely grown cereal crop, and it is a major part of the diet for both rural and urban communities in South Africa. The crop occupies a strategic position in the country's food security alongside, sugarcane, and potatoes. Maize also provides income to all the commodity value chain agents: farmers` households produce buyers, processors, exporters and transporters. It is therefore an important crop from both the food security and income generation point of view (Ortmann and Machethe, 2003).

Maize meal is eaten as a staple food by the majority of South Africans. Many other everyday commodities such as pharmaceuticals, confectionary, toothpastes, popcorn and soups, also include maize in various forms (Kirsten *et al.,* 1998).
The production of maize is composed of maize harvested during a particular season, imports and carryover stocks from the previous seasons. Commercial agriculture produces about 98% of maize in South Africa, while the remaining 2% is produced by the developing agriculture. Over the past ten years, the area for planting maize has slightly decreased by about 1, 2%, and contrary to the decrease, production of maize increased by approximately 5% (Agricultural statistics, 2005). This indicates an improvement on the method of production as producers are able to harvest more or less amount on the same piece of land (Jiggins *et al.,* 1997).

Maize plays a vital role in food security for many poor households and is a critical food and cash crop with a per capita consumption of over 100kg per month. Both large and small-scale commercial farmers produce maize. Maize production is unstable because of erratic rainfall, and yields range from 1 to 4 tonnes/ha. Trends towards lower rainfall in the drier areas of Southern Africa suggest these areas are becoming increasingly unsuitable for maize production in South Africa, the area planted to maize has decreased with the deregulation of the industry from over 5 million ha in the mid to late 1980s to around 3.5 million ha in 2004 (DoA, 2005).

In 2005, Grain SA states that South Africa has about 8 000 commercial maize farmers. Since deregulation of the industry, the price of maize has been derived from international prices and dependent on the exchange rate. The value of maize crop varies from below 10% to over 20% of total agricultural production in the country. Large-scale maize production is highly capital intensive and due to rising input costs, farmers become increasingly tied to credit, input suppliers and marketing agents (DoA, 2005).

White maize is preferred for human consumption and is also used for animal feed and for some processed foodstuffs such as cereals. The crop is also used to produce starches and syrups used in a vast array of foods and industrial products. African producers (SADC region) are a major processor of maize and purchases about 10% of the annual maize crop, contracting farmers to grow GE free maize. South Africa exports and imports maize and maize products. Maize is also an important input for the poultry industry which is South Africa`s second largest agricultural sector (Quist and Chapela, 2001).

2.2 Review of technical efficiency studies among smallholder farmers

Technical efficiency is a component of economic efficiency and reflects the ability of a farmer to maximise output from a given level of inputs (e.g. output-orientation). One can trace back the beginning of theoretical developments in measuring technical efficiency to the works of Debreu (1951 and 1959). Since then, however, there has been growing literature on the technical efficiency of smallholder agriculture. Notable works focusing on smallholders include Basnayake and Gunaratne, 2002; Barnes, 2008; Duvel *et al.,* 2003; Shapiro and Muller, 1977; and Seyoum *et al.,* 1998. The average technical efficiency of small-scale reported in these studies range between 0.49 among maize farmers in Kenya to 0.76 among Tanzania sugarcane farmers. This shows that small-scale farmers have low and highly variable levels of efficiency, especially in developing countries.

Most studies have associated farmers` age, farmers` education level, access to extension, access to credit, agro-ecological zones, land holding size, number of plots owned, farmers` family size, gender, tenancy, market access, and farmers` access to improved technologies such as fertiliser, agro-chemicals, tractor and improved seeds with technical efficiency. Farmers` age and education, access to extension, access to credit, family size, and tenancy, and farmers access to fertiliser, agrochemicals, tractors and improved seeds variable are reported by many studies as having a positive effect on technical efficiency (Amos, 2007; Ahmad *et al.,* 2002; Tchale and Sauer 2007; and Basnayake and Gunaratne, 2002).

A clear-cut conclusion on the influence of land holding size on efficiency has not been reached as discussed in the work by Kalaitzadonakes *et al.,* (1992). Although studies by Amos (2007), Raghbendra *et al.,* (2005), and Barners (2008) found the relationship between land holding size and efficiency to be positive. On the other hand, influence of the number of plots on efficiency has been reported by the Raghbendra *et al.,* (2005) to be negative. This implies land fragmentation (as measured by number of plots) have a negative impact on yields. There are conflicting results on the influence of socio-economic variables such as gender on efficiency. Tchale and Sauer (2007) point out that, while some studies (in Lesotho) report that gender of the farmer has no significant influence on efficiency, other studies found that gender plays an important role.

Literature on technical efficiency in African agriculture is emerging. Globally, however, there is a wide body of empirical research on the economic efficiency of farmers in both developed and developing countries (for reviews see Battese and Coelli, 1995). While the empirical literature on the efficiency of farmers is vast in developed countries and Asian economies, few studies focus on African agriculture. Heshmati and Mulugeta (1996) estimated the technical efficiency of Ugandan *matoke*-producing farms and found that they face decreasing return to scale with mean technical efficiency of 65%. On the other hand, they found no significant variation in technical efficiency with respect to farm size. Nor did they identify the various sources of technical efficiency among *matoke*-producing farmers.

Seyoum *et al.,* (1998) consider the technical efficiency and productivity of maize producers in Ethiopia and compare the performance of farmers within and outside the programme of technology demonstration. Using a Cobb-Douglas stochastic production functions, their empirical results show that farmers who participate in the programme are more technically efficient with a mean technical efficiency equal to 94% compared with those outside the project whose mean efficiency equalled 79%.

Also in Ethiopia, Weir (1999) investigates the effects of education on farmer productivity of cereal crops using average and stochastic production functions. This study finds substantial internal benefits of schooling for farmer productivity in terms of efficiency gains, but finds a threshold effect that implies that at least four years of schooling are required to lead to significant effects on farm level technical efficiency. Using different specifications, average technical efficiency ranges between 0.44 and 0.56, and raising education from zero to four years in the household leads to a 15% increase in technical efficiency. Moreover, the study finds evidence that average schooling in the villages (external benefits of schooling) improves technical efficiency.

The impact of education externalities on production and technical efficiency of farmers in rural Ethiopia is the subject of Weir and Knight (2000). They find evidence that the source of externalities to schooling is in the adoption and spread of innovations that shift out the production frontier. Mean technical efficiency of cereal crop farmers are 0.55, for instance a unit increase in years of schooling increases technical efficiency by 2.1 percentage points. One limitation of the Weir (1999) and Weir and Knight (2000) is that they investigate the levels of schooling as the only source of technical efficiency. Using data envelopment analysis, Townsend *et al.,* (1998) investigate the relationships among farm size, returns to scale and productivity for wine producers in South Africa. They find that most farmers operate under constant returns to scale, but the inverse relationship between farm size and productivity is weak.

Mochebelele and Winter-Nelson (2000) assess the impact of labour migration on the technical efficiency performance of farms in the rural economy of Lesotho. Using the stochastic production function (translog and Cobb-Douglas), the study finds that households that send migrant labour to SA mines are more efficient than those that do not, with mean inefficiencies of 0.36 and 0.24, respectively. In addition, there is no statistical evidence that the size of the farm or the gender of the household head affects the efficiency of farmers. These authors conclude that remittances facilitate agricultural production, rather than substitute for it. Their study does not, however, consider the many other household characteristics that may affect technical efficiency such as education, farmers experience, access to credit facilities (capital) and advisory services, and the extent to which households that export labour receive remittances is based on the presumption that migrant labourers remit to their exporting households, and not on some measure of the extent of remittances.

Sherlund *et al.* (2002) investigated the efficiency of smallholder rice farmers in Côte d'Ivoire while controlling for environmental variables that affect the production process. Apart from indentifying factors that influence technical efficiencies, the study finds that the inclusion of environmental variables in the production function significantly changes the results: the estimated mean technical efficiencies increase from 0.36 to 0.76. Binam *et al.* (2004), examine factors influencing technical efficiency of groundnut and maize farmers in Cameroon. They use a Cobb-Douglas production function and found the mean technical efficiency to be in the region of 73% and 77%. They also conclude that access to credit, social capital, distance from the road and extension services are important factors explaining the variations in technical efficiencies.

2.3 Overview of small-scale agriculture in South Africa

South Africa is divided into two economies, that of the rich and that of the poor people. A Gini coefficient of 0.593 shows that there is a vast gulf between rich and poor in the country (Vink and D`Haese, 2003). South Africa also has high unemployment in the rural population of the former homelands and these areas also have a high poverty rate relative to the rest of the country (Vink and D`Haese, 2003). There is a large rural population and a poorly educated and largely unskilled workforce (Lipton *et al.,* 1996). These factors indicate that agriculture could play a key role in uplifting people. According to Rockefeller (1969), agriculture can play a role in uplifting the standard of living of the people in the former homelands. The majority of the people who migrate to urban areas originally resided in rural areas. Most of the young rural men and women left their home districts in search of employment in the mines and factories (Vink and D`Haese, 2003).

Active participation in agriculture could reduce the level of migration to the cities by young rural people, who might otherwise migrate to urban areas in search of jobs that are not available in rural areas. Agriculture can play a role through the use of natural resources such as land that are available to the rural population. Ashley and Maxwell (2001) as quoted by Vink and D`Haese (2003) argue that land is often not the most limiting resource on small farms. The scarce resources are cash to purchase inputs and limited seasonal labour. Lipton *et al.,* (1996) found that small-scale farming has helped employ and generate income in many other developing countries. In middle-income countries with economic and labour profiles similar to those of SA, agriculture accounts for 15% of the GDP and employs 25% of the labour force (Lipton *et al.,* 1996).

However, according to Lipton *et al*. (1996), in South Africa agriculture is only a marginal force in the economy, accounting for 5% of the GDP and employing only 14% of labour. One of the Lipton, (1996) surveys discovered that, of the 70 countries on which data are available, South Africa is one of the lowest in its reliance on agriculture as a source of employment. Some experts say this is because South Africa is a dry country; however, other dry countries have large agricultural sectors. Lipton (1996) main concern is that by 2025 the working age population in SA will be more than double and with agriculture only contributing to the livelihood of few, many could face unemployment. Important questions according to him are; why are people abandoning agriculture? Is there a lack of interest in agriculture, and are people more interested in urban employment? Or was the movement away from agriculture caused by Black South Africans being denied access to land, irrigation and technology (Lipton, 1996).

In an attempt to answer Lipton`s concerns Aliber (2005) notes that the reason why young people in rural areas are moving away from agriculture is based on their observing their parents. Young people have concluded that agriculture is an unpromising avenue to self-advancement. Aliber`s argument is that even the youth that were raised by commercial farms show disinterest in inheriting their parents` farms. The difference between this story and the one that appears to apply to former homeland areas is that, in the commercial farms the disinterest of the youth contributes to land being left unutilised rather than being taken over by others with commercial aspirations, but contribution of the land tenure remains a question particularly because there is low demand to productive land. According to Aliber (2005) agriculture in former homelands is declining because people have diverted to off-farm employment because of economic reasons. If off-farm employment provides better earnings rural households would readily leave agriculture.

It is well known that access to farming was denied to Black South Africans through unequal distribution of land, water and technology. One of the most challenging socio-economic problems currently facing South Africa is how the large number of rural African residents can be assisted in establishing viable livelihoods. From an international perspective, small-scale agriculture has been proven to generate employment and income opportunities in rural areas. According to Kirsten and Van Zyl (1998) small-scale farmers are potentially competitive in certain activities and, with proactive policy support; these opportunities could be developed into viable niches for the future smallholder sector. The challenge in South Africa is to remove the structural constraints that inhibit the growth of a vibrant commercial smallholder sector.

Small-scale agriculture is often the sector of developing economies that presents the most difficult development problems. These include piped water, land redistribution and access to credit. There are two types of agriculture in South Africa: subsistence farming which is practised in the former homelands and large-scale commercial farming. White farmers dominate the large-scale commercial sector, and this is not only the case in South Africa. In the rest of the world, farmers also range from subsistence farmers to agribusiness farmers (Kirsten and Van Zyl, 1998). There are different views on the way people differentiate between subsistence and commercial farming.

2.4 Maize production in South Africa

Maize is produced throughout South Africa with Free State, Mpumalanga and North West provinces being the largest producers, accounting for approximately 85% of the total production. Maize is produced mostly on dry land, although there is less than 10% that is produced under irrigation. South Africa is divided into 36 grain production regions. Region 1 to 9 are winter rainfall areas (Western Cape), as well as Eastern Cape and Karoo where no commercial maize is produced. Region 10 is Griqualand West and region 11 is Vaal harts in the North West. Regions 12 to 20 are all in the North West province. Regions 21 to 28, which are in the Free State and North West, have contributed 63% of the total maize production in SA during 2002/2003. Regions 29 to 33 are within Mpumalanga, which is the third largest maize producing province. Region 34 falls within Gauteng, region 35 within Limpopo and region 36 within Kwazulu-Natal (Agricultural statistics, 2003).

The maize industry is divided into commercial and developing agriculture. Commercial maize farmers are estimated at 8,000 and the number of developing agricultural farmers is unknown. During 2002/2003 the Free State province produced 35% of all the commercial maize in South Africa, of which 75% was white maize and 25% yellow maize. North West produced 28% of all the commercial maize grown in the country, of which 82% was white maize and 18% yellow maize. During the same period, Mpumalanga produced 20% of the total commercial maize production, of which 25% was white maize and 48% yellow maize (DoA, 2003).

2.5 Small-scale maize farmers

The majority of maize farmers are small-scale, farming on less than 3ha. But many small-scale farmers along with subsistence producers follow low input cultivation practices using landraces and saved seed for planting. Small-scale farmers plant mostly their own varieties, which are typically robust and comprise qualities important to them. As this is open-pollinated varieties (OPV) they can replant the seed without experiencing yield reduction as with hybrids (ARC, 2002).

The use and development of OPVs is not officially encouraged or supported. One recent exception is the release of two OPV maize varieties developed by the International Maize and Wheat Improvement Centre, specifically with the needs of small-scale farmers in mind. These qualities include early maturation, and higher yield under drought and low soil fertility conditions. For instance, ZM521 has been shown to yield 34% more than currently grown varieties (ARC, 2000).

2.6 Farm size and efficiency

According to Nieuwoudt (1990), small-scale farmers may use land much more intensively than do large farmers. The same opinion was supported by Latt and Nieuwoudt (1988), in the `Discriminate Analysis of Input Use` study, where they revealed that farms with less than one hectare applied inputs much more intensively than farms with more than one hectare, thus suggesting that smaller farms may maximise returns to land (their scarce resource); while larger farms maximise returns to labour and capital.

2.7 Gender issues and efficiency

The prevalence of female headed households in rural areas inevitably affects household and community livelihood strategies. It is estimated that three quarters of households' income in the former Bantustan in South Africa is from remittances and 10-15 percent is from informal activities such as crafting and street vending (Levin and Weiner, 1997). The latter activities are largely undertaken by women and children since remittances from migrant labour are not always reliable and are frequently controlled by the males. In addition to rural women's involvement in income generation, they have primary responsibility for domestic tasks and agricultural production, burdens which place significant pressure on their time and physical well-being.

Consequently, informal sector activities have become increasingly important for households, especially in rural areas. Although some attention has been given to small and medium micro enterprises, there is relatively little emphasis in the South African gender and development literature on the gendered nature of these types of activities or the economic potential of women's groups, especially in rural areas. For some women, formal employment outside the home is not a feasible income generating strategy for reasons which include lack of access to transport, domestic responsibilities, inadequate job training or previously work experience, and other barriers to entering the workforce (Orberhauser, 1993).

2.8 Labour issues and efficiency

The high labour use intensities on small-scale farms are that in the land market smaller peasants face higher effective purchased prices for land. This skewed resources position for smaller farmers has several implications on their use of labour vis-à-vis larger farmers: they use more intensively for each crop; they use more of the available land; they choose more labour intensive crops, and they use their own labour for land improvements. All of these implications lead to the conclusion that small-scale farmers have a higher resource use per unit of land. This factor-use intensity gives small-scale farmers a productivity advantage over larger farmers (Cornia, 1985).

Another explanation of the greater intensity of family labour among small peasants is desperation. If small-scale farmers are struggling at the edge of survival, they are more likely to work hard. It would not be prudent to equate the welfare of the small peasant household with its productivity if that productivity is the result of poverty. Dualistic labour markets have also been proposed as an explanation. If family labour is cheaper then there should be a higher labour to land ratio on the small-scale farms. There are logical economic reasons for a gap between the supply prices of family and hired labour; there is less uncertainty about effort with family labour than with hired labour, making the opportunity cost for family labour lower (Mazumdai, 1965). In addition, workers may prefer to work for themselves, or at least for their own family, than working for someone else (Sen, 1975). The control large land owners have over factor markets especially means that different size farms face different factor prices: for small-scale farms land and capital are more expensive than for larger farms, while labour is less expensive.

This leads to excess labour supply in the labour market, which would implies that wage in agriculture will tend towards zero. This is not observed, however, since the wage will not drop below some minimum caloric requirements. Larger farms will hire labour only until the marginal product of labour is equal to this minimum wage. Thus, there will be unemployed labour and the opportunity cost of employing family labour will be low on small-scale farms (Verma and Bromley, 1987, Cornia, 1985).

Such labour market theories of the high family labour use of small-scale farms and its contribution to the inverse relationship have relied on labour market dualism, but the fact remains that small-scale farmers both hire in and hire out labour (though this is not to say that they are perfect substitutes). In addition, hired labour is necessary on larger farms, so family labour is an unlikely explanation for the inverse relationship between 15 and 50 acres, for example. Thus, it is important not to go too far in identifying farm size with characteristics such as capitalisation, mechanisation, and use of wage labour (Dyer, 1996). Feder (1985), offers an alternative explanation of the more intense use of family labour, based on three propositions: first, that family labour is more efficient than supervised labour; second, that family labour is more motivated than hired labour and can supervise the latter; and third, that the supply of working capital is directly related to farm size.

The greater efficiency of family labour on small-scale farms may be due to two factors; first, as the ratio of hired labour to family labour rises, supervision becomes more time consuming and less effective. Second, as the social distance between the supervisors and the hired labour increases, the effectiveness of supervision will decrease (Boyce, 1987).

Another common refrain is that, due to the stochastic effects of weather and so forth on agricultural output, farmers cannot use output to monitor the effort of employees. Thus, farm wage labour requires supervision and this results in the inverse relationship (the larger the farm, the thinner the family labour is spread, the greater the monitoring problems) as well as the structure of agrarian land and labour contacts, and the adoption of labour saving technology by larger farms. These determine that family and hired labour are not substitutes.

Carter and Wiebe (1990), Argue that small-scale hyper productivity is eventually overwhelmed by capital constraints-as farm size increases; it becomes less easy to substitute family labour for hired labour and other purchased inputs. Since credit markets in many less-developed countries are characterised by undeveloped financial institutions (meaning local money lenders marking high interest rate "institutional" credit goes to the richer peasants), the cost of and access to credit are inversely related to farm size (Cornia, 1985).

2.9 Small-scale farming and efficiency

Long-term effectiveness of the individual development strategy applied on small-scale farming level of efficiency of farming activities has important implications. If farmers are reasonably efficient, then an additional increase in efficiency requires the usage of more productive inputs or the application of a more production frontier upwards. If, on the other hand, current inputs or technology could be used more productively, an improvement in the institutional settings e.g. input markets, infrastructure endowment, available extension systems, management and training services - should be targeted to increase the efficiency on farm level.

Hence, the two broad approaches-technology development and transfer versus more efficient use of available technology and resources on the individual farm level-can be considered as a continuum in the process of development (Ali and Bayerlee, 1991, Schultz, 1975). Assuming efficiency of small-scale farming could base on notion that farmers in a more traditional agricultural setting depend largely on their own resources, and consequently manage to adjust their coordination and management effort in the long-run to most efficient use of these resources.

Assuming on the other side inefficiency in a more dynamic and developed agricultural setting could be based on the reasoning that the individual producer find it more difficult to adjust the allocative decisions to a continuously changing production environment: farmers in this situation are likely to be in a continual state of disequilibrium and there will be high returns to improving their information and skills to adjust more rapidly and reduce technical and allocative efficiency errors (Ali and Byerlee, 1991).

Most recently, development economists have questioned the efficient but poor hypothesis again by pointing to the detrimental influence of household decisions and land tenancy arrangements on efficient economic behaviour (Abler and Sukhatme, 2006). However, many empirical contributions to those discussions treat efficiency as a black-box concept and lack of the explicit considerations of the scale of agricultural production (Otsuka, 2006, Admassie and Heidhues, 1996, Flinn and Ali, 1986, Bravo-ureta and Evansen, 1994; Cotlear, 1987, Taylor and Shonkwiller, 1986).

Production theory states that technical efficiency or allocative efficiency can be decomposed into ‘pure’ technical or allocative efficiency as well as scale efficiency (Chambers, 1988, Coelli *et al*., 1998). Hence, a very poor performance of small farmer relative to others operating on the small-scale of his/her agricultural operations and vice versa a good performance relative to others can be simply due to the large-scale of his/her operations compared to the peer group average.

Considering also the scale effects on efficiency could deliver a more precise picture of the relative economic efficiency of small-scale farms in developing areas. If this could be empirically verified then a viable policy option in both a more traditional as well as a more dynamic setting would be to enhance the overall economic performance on the farm level by delivering incentives for an increase in the scale operations and forming bigger production units (Serrao and Homma, 1993).

2.10 Scale and economic efficiency

The concept of returns to scale reflects the degree to which proportional increase in all inputs increases output. This basic economic concept refers to a long-run factor-factor relationship where output maybe increased by simply changing all factors by the same proportion e.g. by altering the scale of the operation (Chambers, 1988). Hence, the observation that a farm has increased its productivity from one year to the next does not imply that the improvement has been resulted from pure technical and/or pure allocative efficiency improvements alone, but may have been (also) due to technical change or the exploitation of scale economies/from some combination of these three factors.

Consequently, besides technical inefficiency failure to maximise output, e.g. maximise output and minimise cost-in a given period, has a systematic allocative inefficiency component, which can involve an inappropriate input and an inappropriate scale. For a farm to be profit efficient it requires technical efficiency and both inputs and output allocative efficiency to be achieved at the proper scale based on an output-oriented measure of technical efficiency the overall measure of profit efficiency can be decomposed (Kumbhakar and Lovell, 2000). The physical and climatic conditions as well as the kind of technology used for land preparation can significantly influence the farmers` income (Sherlund *et al*., 2002).

2.11 Some socio-economic factors and efficiency

It is expected that a farmer`s production efficiency would be improved, if he/she has access to agricultural extension services. Extension agents provide information on new technologies to the farmers for farm inputs. The age of the farmer is used as a proxy for measuring general farming experience and thus has an effect on efficiency. It is assumed that, older farmers are more experienced in farming activities and are better able to assess the risks involved in farming than younger farmers. This may contribute to the improvement of technical efficiency. However, the opposite may be true that, older farmers who did not receive a better education, may be technically inefficient than the younger ones (Tchale, 2009).

Education of the household head is taken into consideration, education of the farmer is expected to have an effect on farm resources use and ability to adopt new technology and hence have a positive impact on technical efficiency. The effect of farm size on efficiency is a controversial issue, small-scale farms may be more efficient in terms of transaction costs than large ones on the other hand, large farms have the advantage of attaining economies of scale by spreading fixed costs over more land and output, getting volume discount for purchased inputs or by achieving better markets and higher prices for their produce (Ogolla and Mugabe, 1996).

A farmer`s ability to purchase farm inputs may depend on financial situation of the household non-farm income received could have an effect on crop production, since the farmer would be capable of purchasing farm inputs and pay for hired labour and machinery, this could positively affect productivity (Heidhues, 1995). Access to credit from formal and informal institutions is important for agricultural productivity; many poor rural farmers heavily rely on informal credit institutions to cope with food insecurity and its effects as well as to finance the purchase of farm inputs (Heidhues, 1995; Heidhues and Buchenrieder, 2004).

Considering the level of technology generally used by smallholder farmers in producing maize, the farmers tend to depend on family and communal, cooperation labour (Kimenyi, 2002). Using improved seed in crop production is one way of increasing productivity in terms of quantity and quality (Kiplang`at, 2003). Despite the low level of production technology used by smallholder farmers in developing countries, the use of improved seeds is said to be on the increase (Kiplang`at, 2003). The availability of these seeds is usually via extension agents or in the markets. Thus, farmers with more access to extension agents may have increased potential of using them appropriately, and subsequently improve crop productivity.

The use of chemical fertiliser is known to be a commonly used method in improving productivity and in the intensification of agricultural production as a whole chemical fertiliser play a big role in regions where the scarcity of farm land is a big problem and traditional fallow periods are either very short or no longer in existence. However, the appropriate use of these fertilisers is very important in achieving the desired results disproportionate use of fertilisers is usually common among farmers with little knowledge about them, or with little access to extension agents. In such a case, productivity may be affected negatively and hence a lower technical efficiency (Hopper, 1965).

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

This chapter provides a brief description of the study area, data collection and analytical techniques employed in the study. It describes the variables that were considered to analyse the technical efficiency of small-scale maize producers at Ga-Mothiba village in Limpopo Province.

3.2 Study area

The study was conducted in Ga-Mothiba community in Capricorn District. Ga-Mothiba is a predominantly mixed-based farming systems village and the village is located 27 km east of Polokwane city and 10 km from the University of Limpopo. In this area farming is under smallholder systems and characterised by low level of production technology and small size of farming holding of approximately 1.5 hectares per farmer and sometimes less than that. Production is primarily for subsistence with little surplus for market. Given the fact that 89% of the population of Limpopo Province is classified as rural, agriculture plays a major role in the economic development of rural areas of the province.

The district which the study area falls is situated in the centre of the Limpopo Province, sharing its borders with 4 District municipalities namely: Mopani District and Vhembe District located on the eastern part, Sekhukhune District, and Waterberg District located on the western part. The Capricorn District is situated at the core of economic development in the Limpopo province and includes the capital of the province. The district is known for its summer rainfall region of South Africa, receiving 478mm of annual rainfall.

Limpopo Province is one of the nine provinces of South Africa and is situated in the Northern part of the country. It is adjacent to North West, Mpumalanga and Gauteng Provinces and the unique features of this province is that it shares borders with three neighbouring countries: Botswana, Zimbabwe and Mozambique. The province covers an area of 12.3 million hectares accounting for 10.2 % of the total area of the country. This province proportionally has the largest rural population in the country. The province`s capital city is Polokwane, formerly called Pietersburg.

The Limpopo Provincial government has identified agriculture, tourism and mining as priority areas for developing the province`s economy. Following major investments in the past few years in mining and tourism, there is a new focus now on agriculture because of its potential for job creation among the poorest sectors of the society, many of whom have no access to agricultural resources. Limpopo Province also has a varied climate which plays a vital role in agricultural produce ranging from maize, wheat, and sorghum, and tropical fruits such as litchis, mangoes, and oranges, as well as vegetables such as potatoes, tomatoes, and onions.

The province used to be known as Northern Province and retained the name until 11th June 2003, when the new name Limpopo Province came into being. Limpopo Province is divided into five districts namely; Mopani, Capricorn, Sekhukhune, Vhembe and Waterberg.

3.3 Data collection

Primary data was used in this study and data was collected through field survey and household interviews using a structured questionnaire. The questionnaire was structured in such a way that the first part covers the socio-economic variables such as the age of the household head, size of the household, off-farm income, gender etc. The second part dealt with the factors of production such as, land, labour, cost of tractor hours and materials use such as fertiliser and seed, and the last part dealt with the collection of marketing information regarding where they buy their inputs and where they sell their output.

3.3.1 Sampling

The study used purposive and snowball sampling techniques The purposive sampling method was used to interview only households who produce maize, since the main purpose of the study was to analyze the technical efficiency of small-scale maize producers. Snowball sampling was used by the researcher to identify households that produce maize; once the researcher has identified one household it becomes easier to identify the next. The respondents were the ones indicating who produced maize as they knew who was engaged in what activity in the community. A sample size of 120 households was used in this study.

3.4 Analytical methods

3.4.1 Descriptive statistics

The purpose of using this type of analytical tool was to summarise the data by describing the basic features of the data in the study, and to provide simple summaries of the variables and measures.

3.4.2 Cobb-Douglas production function

Cobb-Douglas production function was used to analyse the variables that have effect on maize production, and this analytical technique was used to determine the technical efficiency of small-scale maize producers in Ga-Mothiba.

A Cobb-Douglas production function was used as the functional form of the production function. The reason for choosing this type of production function is that it is linear in its logarithmic form, and allows for the usage of Ordinary Least Squares (OLS). At the same time, this function type has been widely used for production function analysis by many researchers.

The theoretical Cobb-Douglas production function is expressed as follows:

$Y=AL^{\alpha} K^{\beta} u$

Where:

Y= output

A= constant

L= labour

K= capital

U = disturbance term

For constant returns to scale, the sum of the parameter coefficients, β and α must be equal to one (1). For increasing returns to scale, they must be greater than one, and for decreasing returns to scale they must be less than one. In mathematical form the returns can be expressed as follows:

$$\alpha = \frac{\delta Y / Y}{\delta L / L}$$

$$\beta = \frac{\delta Y / Y}{\delta K / K}$$

Where β and α are the elasticities of production with respect to labour and capital. These are considered the most important properties of the Cobb-Douglas production function.

However, the Cobb-Douglas production function model has a number of limitations. The major criticism is firstly that it cannot represent all the three stages of Neo-classical production function, representing only one stage at a time. Secondly, the elasticities of this type of a function are constant irrespective of the amount of input used. However, regardless of these limitations the Cobb-Douglas production function was used for its mathematical simplicity, and the functional forms have a limited effect on empirical efficiency measurement. It is also not exclusive to labour and capital but to other variables.

The operational model for this study relating to the production of Y, to a given set of resources X, and other conditioning factors is given as follows:

$Y= aX_1^{\beta 1}\ X_2^{\beta 2}\ X_3^{\beta 3}\ X_4^{\beta 4}\ X_5^{\beta 5}\ e$

Where:

Y is total quantity of maize produced (in kg)

X_1 is land devoted (in ha)

X_2 is family and hired worker days used (man days)

X_3 is capital (Rand)

X_4 is fertiliser used (in kg)

X_5 is seed used (in kg)

And a, β_1….. β_5 are parameters to be estimated.

u is error term.

In order to use the Ordinary Least Squares procedure, the Cobb-Douglas production function was linearlised using logarithms.

Taking logarithms on both sides, the model will be:

$$Ln(Y) = ln(a) + ln\beta_1 X_1 + ln\beta_2 X_2 + ln\beta_3 X_3 + ln\beta_4 X_4 + ln\beta_5 X_5 + u$$

Description of the variables in the model

Output- is the total quantity of maize harvested in that year and it is measured in kg.

Land – is the area of the farm which is devoted to the production of maize and this variable is measured in hectares (ha).

Labour – it is expressed in adult equivalent days per ha and is the sum of family labour and hired labour. Male and female labour is counted equally and individuals who did not spend their holidays on the farm were not considered. The unit of measurement for this variable is man days.

Capital – to represent capital, a cost of tractor hours is used. This variable is measured in rands.

Fertiliser – it includes both basal and top dressing fertilisers. Although some of the small-scale farmers use kraal manure, this has been left out for problems of aggregation. It is measured in kilogrammes (kg)

Seed – is the usage of both certified seed and home produced or recycled seeds. Both are considered. It is measured in kg

3.4.3 Logistic regression model

This study also used the logistic regression model to supplement the Cobb-Douglas production model as it only concentrates on the production of variables/efficiency, while logistic regression model deals with the socio-economic factors. The logistic regression model was chosen because its dependent variable is binary and can only take two values. Also, it allows one to estimate the probability of a certain event occurring. A logit model is also generally preferred to the probit model due to its simpler mathematical structure and it also assume.

The logit model is based on the accumulative distribution function and yields results that are not sensitive to the distribution of the sample attributes when estimated by maximum likelihood.

The operational logit model can be written as follows:

Logit (p) = In (p/1-p) = $\alpha + \beta_1 X_1, + \ldots\ldots + \beta_k X_k$, i

The ratio p/1-p is the odds ratio

P_i = probability that a farmer is efficient.

1-P_i = probability that a farmer is not efficient

X_i = various independent variables.

β_i = estimated parameters.

U_i = disturbance term.

Operational model:

To examine the impact of socio-economic factors on efficiency of small-scale maize producers at Ga-Mothiba, the following linear equation is specified.

The following linear equation is specified.

$EFF = \beta_0 + \beta_1 GEND + \beta_2 AGE + \beta_3 EDU + \beta_4 HHS + \beta_5 INCH + \beta_6 FAREXP + \beta_7 FARSZ + \beta_8 HIRLAB + \beta_9 TRACTCOS + \beta_{10} FERTUS + \beta_{11} PURCH + \beta_{12} FRORG + \beta_{13} MPROF + U_i$

Table 3.1: Definition of variables

Variables	Description of variables	Units
	Dependent variable	
EFF	1,if a farmer is efficient , 0,otherwise	Dummy
	Independent variables	
GEND	1, if a farmer is male, 0,otherwise	Dummy
AGE	Age of the household head	Years
EDU	1, if a farmer has formal	Dummy

	education, 0, otherwise	
HHS	Household size	Numbers
INCH	Total income of the household	Rands
FAREXP	Farmer experience	Years
FARSZ	Farm size	Ha
HIRLAB	1,if a farmer hires labour, 0,otherwise	Dummy
TRACTCOS	Cost of tractor hours	Rands
FERTUS	1,if a farmer applies fertiliser, 0,otherwise	Dummy
PURHMSE	1,if a farmer purchases hybrid seed, 0,otherwise	Dummy
FRORG	1,if a farmer has membership to farmers organization, 0,otherwise	Dummy
MPROF	1,maize profitability, 0,otherwise	Dummy

CHAPTER 4: RESULTS AND DISCUSSION

4.1 Introduction

This chapter summarises the results from the descriptive statistical analysis as described in chapter three. The results indicate the frequency and percentage of each variable and some variables are indicated in means. The reason for using descriptive statistics is to describe the basic features of data in the study and to provide simple summaries of the variables and measures. Following the results which were analysed using the Cobb-Douglas production function model and the logistic regression model. The estimates in both models are estimated using the SPSS 17.0 version.

4.2 Descriptive statistics

The results from the descriptive statistics using the frequency and the mean descriptive statistics are indicated using figures and tables. From Figure 4.1 to Figure 4.9 are the frequency graphs and table two is the mean of some variables. As indicated in the previous chapter, the study used two different models to analyse the data, therefore the descriptive statistics include all the variables found in both models, regardless of whether they are significant or not. Paragraphs which include the figures explain how many farmers have access to some of the variables and those who do not have access. The paragraphs after Table 2 explain the mean of other variables.

Table 4.1: Mean descriptive of variables

Variables	Mean	Standard Deviation
AGE (Years)	63.14	14.031
CAPITAL (Rand)	391.5	77.173
LABOUR (man days)	112.32	27.92276
HHS (numbers)	5.62	2.099
FAREXP (Years)	23.86	12.555
SEEDS (kg)	17.08	6.403
LAND (ha)	1.1521	0.46776
FERTILIZER (kg)	37.328	33.75

Farmers are usually confronted with financial stress which makes them to have a reason to invest in maize production. The results from table 2 show that the cost of tractor is at about R391.50 per hectare. The average man days used for labour are estimated to be 112.32 days per hectare. These include both hired labour and family labour. Labour is the most important input for maize production, especially with small-scale farmers. The household size plays an important role in maize production and most farmers depend mainly on family labour. The results show that the average household size is 5.62, which mathematically represent 6 members per household. This shows that farmers can have easy access to additional labour from family members.

The majority of small-scale farmers are older people, which means the older you get the more experience you have with regard to farming. The average farming experience is about 23.86 years, which is practically 24 years meaning it plays a role in the production of maize as experience enables a farmer to change methods of planting without increasing inputs. It also shows that maize production has been in existence for a number of years as the majority of the small-scale farmers have been in maize production for more than 20 years. The age of the farmer is an important factor of production as older people tend to be resistant to technical efficiency, preferring to use old methods of planting. It is assumed that older farmers are more experienced in farming activities and are better able to assess the risks involved in farming than younger farmers. The average age of the farmers is 63.14 years old. This indicates that older people are the ones participating in agricultural production.

The average seeds used by the farmer per ha is about 17.08 kg, while they own around 1.15 ha of land on average used for the production of maize. This land was given to them by the traditional authority. Most of the small-scale farmers in the study area did not use fertilisers, whereas those who does apply about 33.75 kg on average per farm size.

4.2.1 Land devoted to maize production/farm size

Farm size has an influence on technical efficiency and the total output of maize production. Land plays an important role in farming. The size of the farm is based on the size of land used by the household for maize production. Most of the farmers have limited access to enough land.

Table 4.2: Land devoted to maize production/farm size

Farm size (ha)	Percentage (%)
0.75 ha	40.8 %
1 ha	25.8 %
1.5 ha	15.8 %
2 ha	17.6 %

As can be seen from table 4.2 above, the results show that majority of the farmers own about 0.75 hectare of land that they use for maize production, which is about 40.8% of farmers, followed by 25.8% of farmers owning about one hectare of land, 17.6% of farmers owning two hectares of land and 15.8% owning 1.5 hectares of land. These results indicate that technical efficiency is mainly affected by the farm size as some farmers do not own the land they are using for production processes.

4.2.2 Seeds used per hectare

Farmers are not obliged to use a certain amount of kilogramme of seeds per hectare. Any amount of seeds can be used. Most small-scale farmers who practice subsistence farming do not buy certified seeds, but they use recycled seeds that are stored after every harvest, while others buy recycled seeds from their fellow farmers. This practice affects the crop output every year in terms of quantity as well as quality.

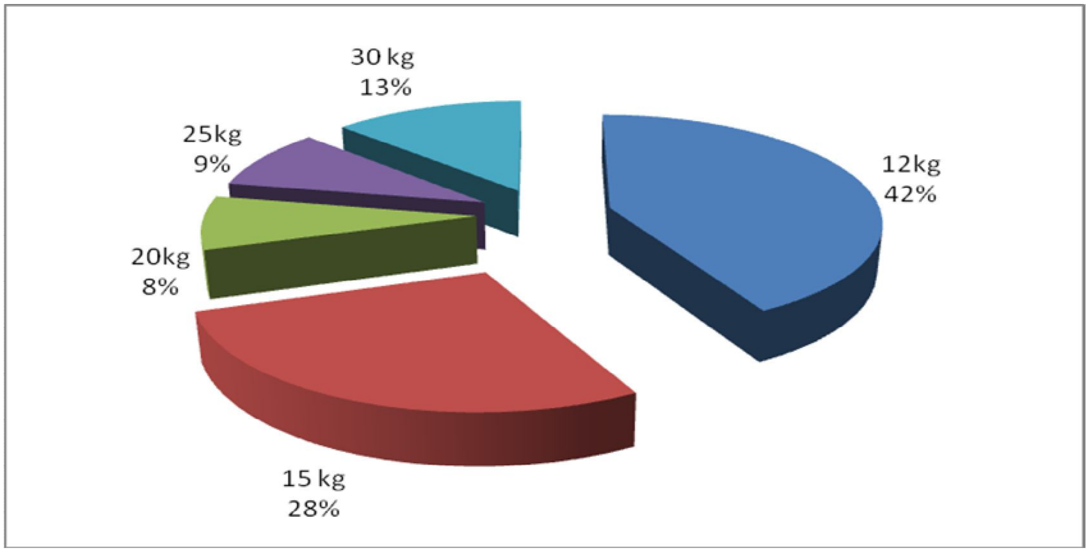

Figure 4.1: Seeds used per ha

Figure 4.1 indicates the different kilogrammes of seeds applied per farmer in the production of maize. About 42 % of farmers apply 12kg of seeds, 28 % apply 15 kg, 30 kg is applied by 13 %, while 9% of farmers apply 25 kg and 20 kg of seeds is applied by 8%. The different amount of seeds applied depends on the size of the farm as maize production ranges from 0.75 ha to 2 ha of land.

4.2.3 Level of education of the household head

Education potentially enhances farm efficiency and knowledge with regard to agricultural production. Educated farmers are able to apply better farming methods. They are also better placed to try newer forms of farming. They can also read about better farming methods from newspapers and magazines, a practice that would greatly improve output.

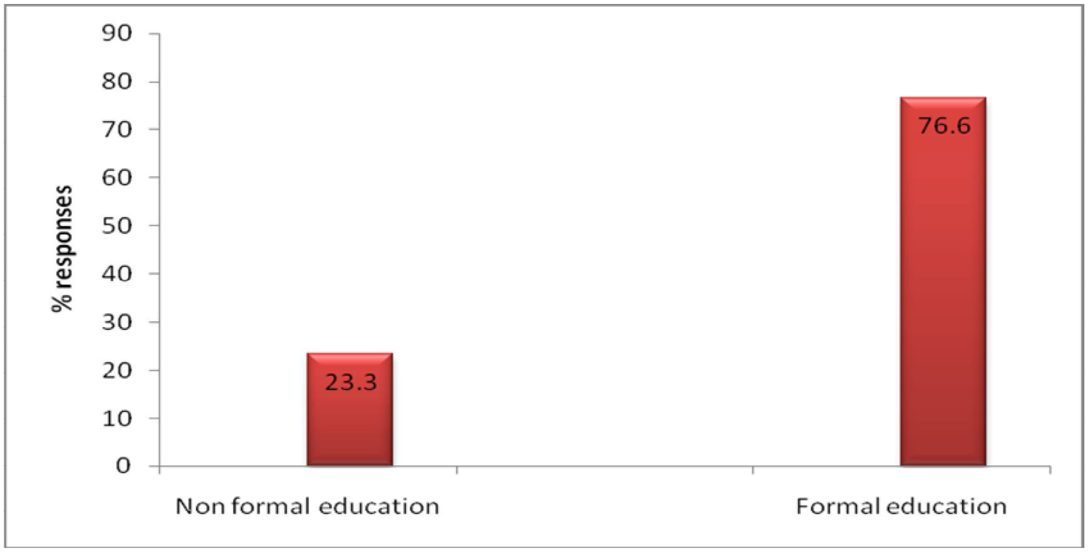

Figure 4.2: Level of education of the household head

The above results in figure 4.2 indicate that 23.3 % of farmers had non formal education, with 76.7% attaining formal education, which includes primary education, followed by secondary education, tertiary and Abet education (Adult Based Education and Training). The majority of the farmers had primary education, with very few obtaining tertiary education, which means most of them are literate. In order for farmers to improve their standards of living, education is of crucial importance.

4.2.4 Gender of the household head

Small-scale farming is mainly dominated by females, as many households are headed by women. Thus, small-scale farmers in Africa are women who farm to support their families.

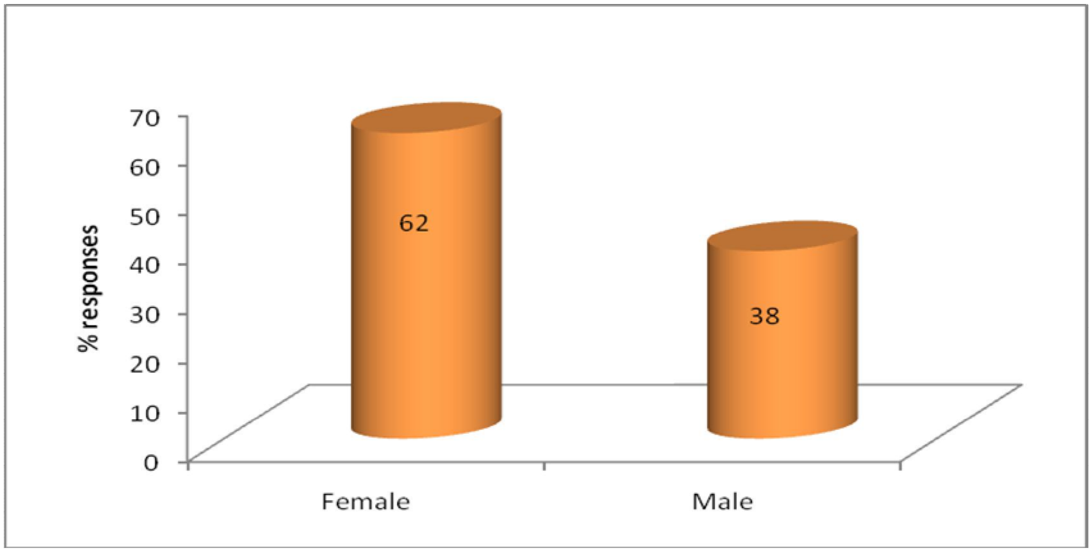

Figure 4.3: Gender of the household head

The results in figure 4.3 indicate that only 62 % out of 100 are female farmers and 38 % are male farmers. Reducing inequalities in human and physical capital between male and female farmers will potentially increase output and technical efficiency will improve because of the joint efforts.

4.2.5 Income of the household on monthly basis

Since the age of most farmers is between 51 and 89, it means that they mainly depend on pension for household income. This income plays a vital role in maize production as they have to invest in capital inputs such as hiring tractor or labour. Without these financial input farmers cannot maintain the required standard of technical efficiency.

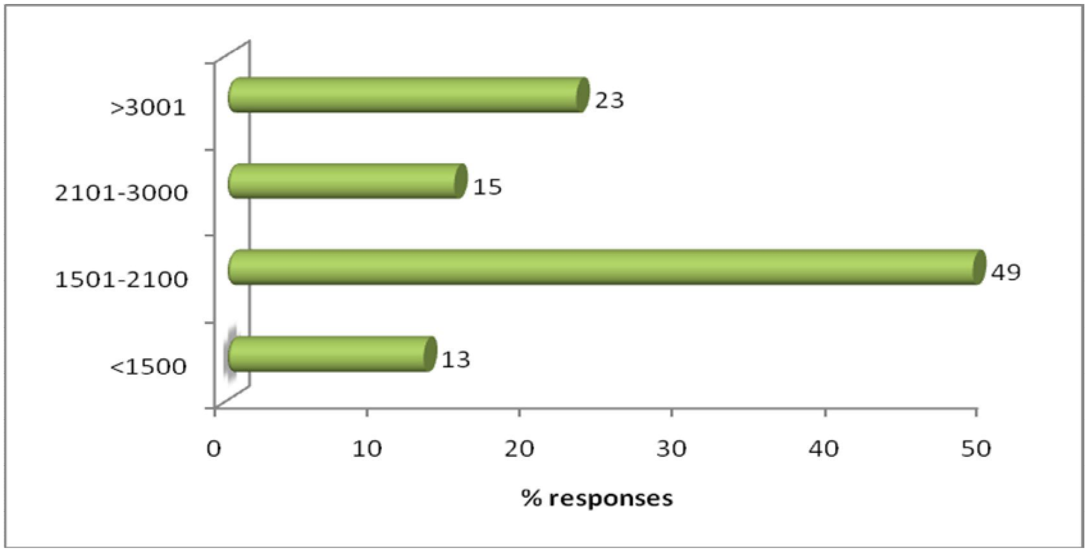

Figure 4.4: Monthly household income

The results in figure 4.4 show that 13 % of the farmers get less than R1500 monthly, with the majority 49 % of farmers earning between R1501 and R2100 at 49 %, and 15% of the farmers earning between R2101 to R3000 monthly, while 23 % of the farmers earned more than R3001. Since farming is dominated by older people who mainly depend on old age social grant or child grant for some, it indicates that farmers with less off-farm income are heavily dependent on farming, unable to buy the necessary inputs, and adversely affecting efforts to increase output and thereby limiting farmers from increasing their technical efficiency levels.

4.2.6 Farm labour

Even though small-scale farmers mainly depend on family labour, they still hire labour to add to the family labour. Usually one or two people are hired. Farmers with smaller family size are the ones who usually hire labour. Hired labour helps in accelerating production at the various stages of farming.

Figure 4.5: Farm labour

According to figure 4.5 shows that 55 % of the farmers agree that most farmers depend on family labour since they do not hire labour, while 45% of the farmers hire labour. Family labour tends to influence the technical efficiency of small-scale maize producers as they have the best interest of the farmer/household at heart unlike hired labour.

4.2.7 Fertiliser application in maize production

Fertiliser plays a vital role in maize production as no matter how large and small the farm size is, if applied properly yields will increase. Small-scale farmers tend to have difficulties in obtaining fertiliser as they lack financial means.

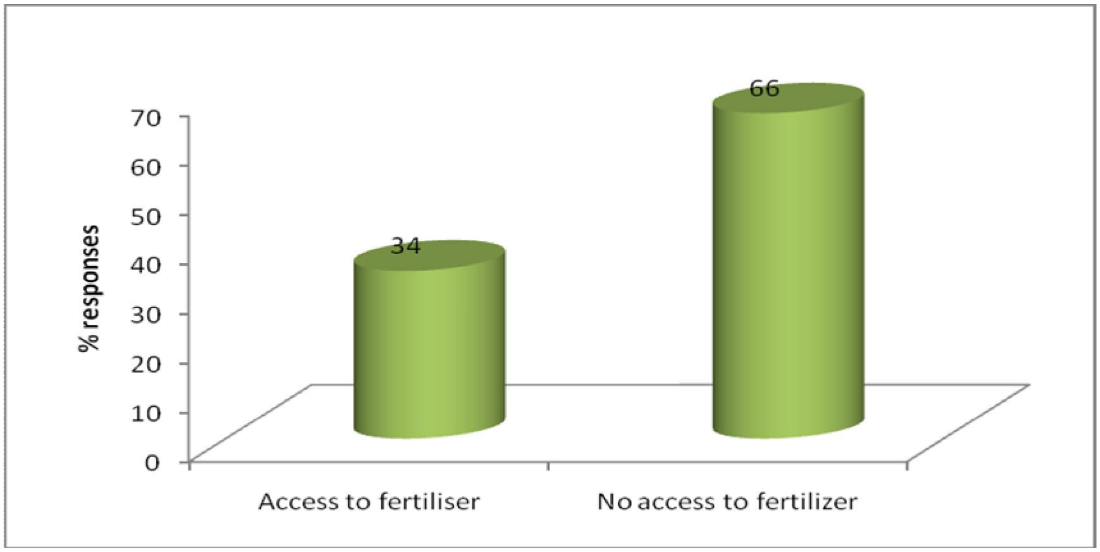

Figure 4.6: Fertiliser application in maize production

The above results indicate that about 34 % of the farmers do apply fertiliser in maize production. This includes even those farmers using kraal manure and ready made fertiliser. About 66% of farmers have no access to fertiliser. This can be due to lack of funds to buy and transport fertiliser. The non-application of fertiliser certainly influences technical efficiency.

4.2.8 Purchased hybrid maize seeds

Hybrid maize seed plays an important role in maize production since has been assumed that 1ha of land can produce 1tonne of maize with the use of hybrid seeds which are fortified to increase the yields of maize. Most small-scale farmers use the same seed they used previously. After harvesting they store some of the maize in order to use it in the next planting season, a practice which hampers the effort of trying to increase productivity.

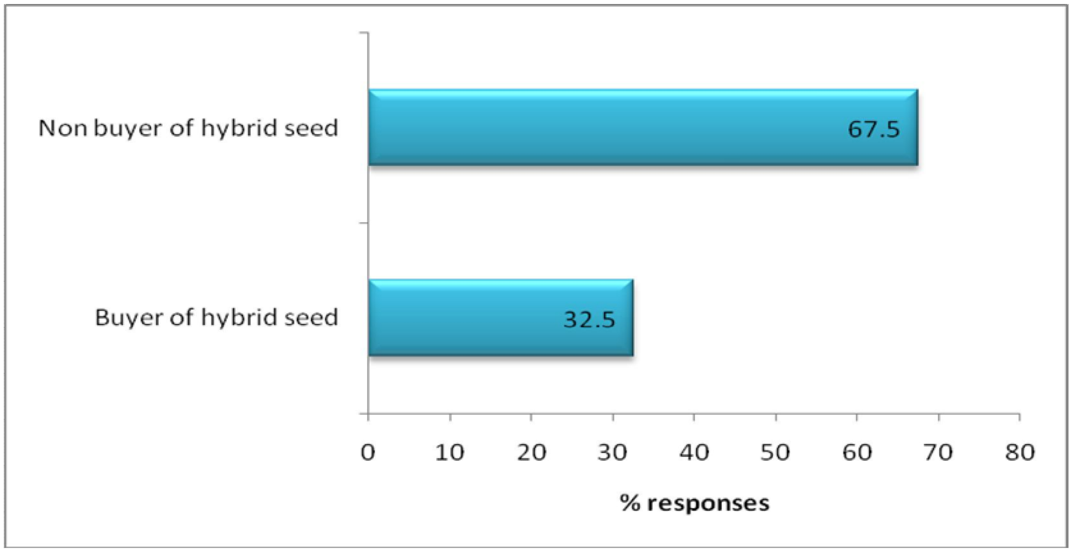

Figure 4.7: Purchased hybrid maize seeds

The results show that 32.5 % of the farmers buy hybrid maize seed. These are not the accurate numbers since some farmers buy used seed from their fellow farmers, indicating that those seeds are more affordable than the ones sold at cooperatives. About 67.5 % of the farmers are not purchasing hybrid seed at all; they use their own recycled seed instead. Such practices hinder farmers from increasing their technical efficiency through attaining maximum output with available resources.

4.2.9 Membership to farmers` organisation

Farmers` organisations play an important role in organising members into input cooperatives and in creating access to financial services from state and non-government organisation (NGO) sectors and seeking access to other financial development agencies. This is an important factor affecting technical efficiency. With availability of finance much can be done to improve crop production.

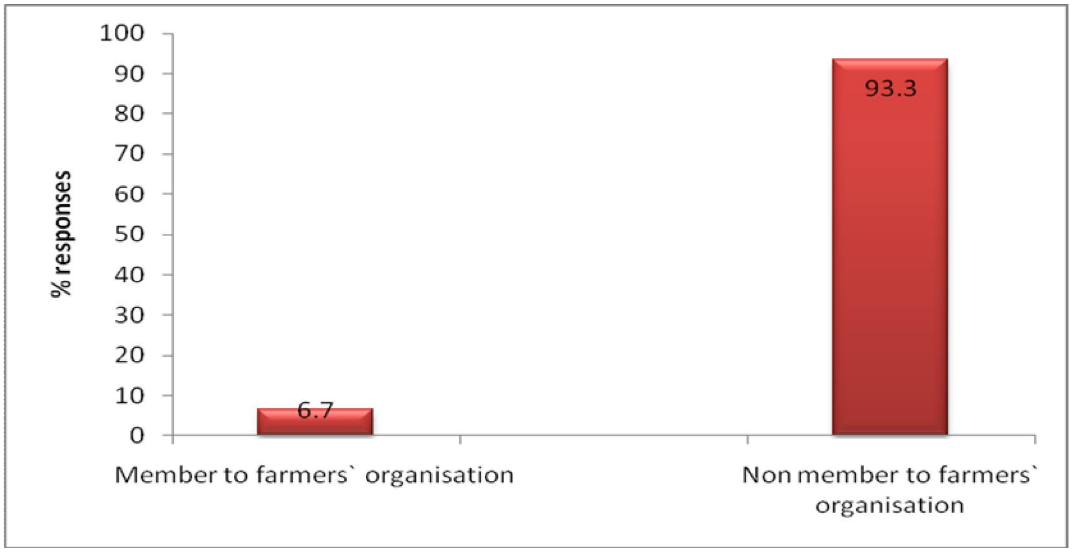

Figure 4.8: Membership to farmers` organisation

The results show that farmers who are members of farming organisations are rather small as compared to those farmers who are non-members, with only 6.7% farmers being members and 93.3% who are non-members of farming organisations. For small-scale farmers it is important for them to form part of an organisation in order for them to get access to credit which they can use to buy new improved inputs, especially seed to increase technical efficiency. Since inputs are expensive they can form a group and buy in bulk as it becomes cheaper compared to individual purchases. They can also have access to extension officers as they are able to help a group of farmers and not individuals.

4.2.10 Maize profitability

Profit from maize production is likely to influence the farmer`s technical efficiency. If there is no profit, naturally the farmer will not invest. Since maize is a staple food it can be profitable or not. Figure 4.9 below indicates how the profitability of maize is distributed amongst small scale farmers.

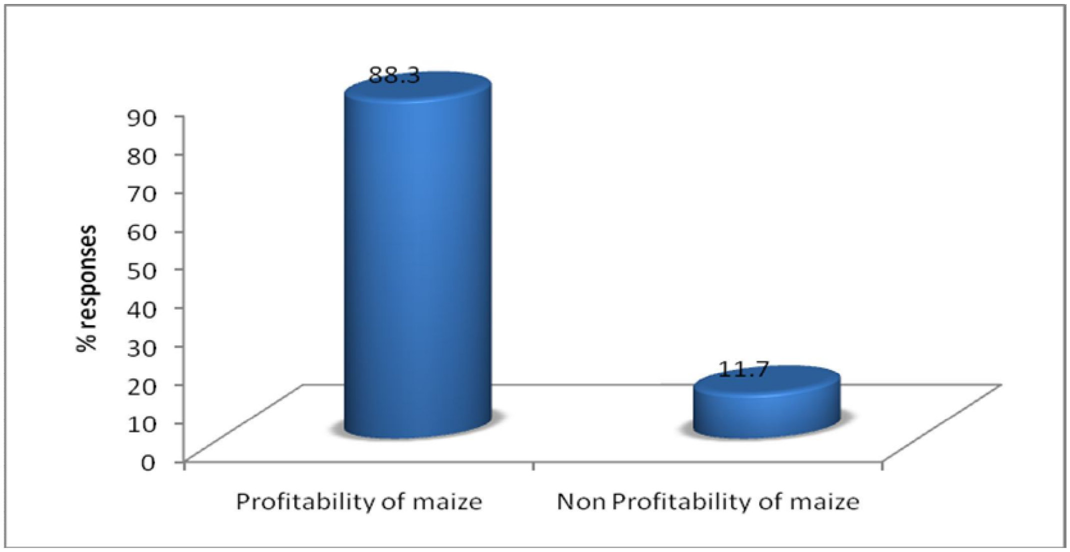

Figure 4.9: Farmer perception on maize profitability

Figure 4.9 indicates that 88.3 % of the farmers see maize as a profitable product as they no longer buying maize meal from shops. They process their own maize product after harvest through the miller, and the processing cost is reasonable. However, 11.7 % perceive maize as not profitable. For the small-scale farmers it is very important to know if maize is profitable or not in order to make informed choices with regard to production inputs. This variable has a relationship with the surplus output after consumption.

4.3 Cobb-Douglas production function model results

Table 4.3 presents the results of a Cobb-Douglas production function as described in chapter 3. The main reason for using Cobb-Douglas production function is to determine the technical efficiency of maize production by small-scale farmers in Ga-Mothiba. There are a number of variables that are known to affect agricultural production. As a result, it is important to use a model that relates production to those variables for better understanding of the functional relationships.

The results indicate that out of 5 variables/inputs used in the Cobb-Douglas, 3 were found to be significant with 1 being negatively significant. This implies that there is an input to output relationship. Paragraphs below Table 4.3 interpret the Cobb-Douglas results.

Table 4.3: Cobb-Douglas production function model results

Variables	Standard error	Coefficient of elasticity	t-ratio
Constant	190.598		2.990
Land (ha)	60.158	0.276***	3.090
Fertilizer (kg)	0.745	0.247**	2.807
Capital (rand)	0.363	-0.177*	-1.992
Labour (man days)	0.998	-0.047	-0.535
Seeds (kg)	4.314	0.099	1.127
Sum of b`s	0.398		
Adjusted R^2	0.564		

*, **, *** Significant at 10%, 5% and 1% respectively

4.3.1 Elasticity of production

The results in Table 4.3 show that the estimation of the production function resulted in adjusted R^2 of 0.564, indicating that the independent variables included in the model explain about 56 percent of the variation in the maize production in Ga-Mothiba. It sounds that some relevant social factors were not included in the model such as farmers farming experience. However, according to Coudere and Marijse (1991), as cited by Mushenje and Belete (2001), an adjusted R^2 of 0.54 is a good result for the regression of cross- sectional data.

4.3.1.1 Land devoted to maize (ha)

The result shows that access to land is important explaining the differentiation in output of each farmer. Land elasticity is positive and significant at 1 % level. This implies that an increase in one hectare of land can result in 28 % increase in the total production of maize, which means the variable land is more sensitive to the production of maize.

4.3.1.2 Fertiliser used per farm (kg)

The elasticity of fertiliser is positively significant at 5 % level, even though not all small-scale farmers have access to fertiliser. The implication is that input contributes positively to the production of maize in Ga-Mothiba. The results show that output is more sensitive to fertiliser, which implies that a one percent increase in the quantity of fertiliser used will lead to 24.7 % increase in the total output of maize. It simply means that fertiliser used by small-scale farmers in the production of maize is more effective and efficient. At this stage farmers are under-utilising fertiliser.

4.3.1.3 Capital (Rand)

Cost of tractor hours was used as a proxy for capital. The elasticity coefficient of capital is negative even though it is significant at 10 % level, which explains that the input is important but farmers are over-utilising it in the production of maize. This indicates further that small-scale maize producers at Ga-Mothiba operate in the stage 3 of the neo-classical production function. This implies that an increase in the use of this input leads to a decrease in the level of maize production.

4.3.1.4 Labour (man days)

The elasticity of labour is negative and not significant in the production of maize. It means input is not used efficiently. The result indicates that farmers are over-utilising this input, implying that they should reduce the use of this input as it responds less to output, meaning a decrease by 1 % of this variable will result in a 5 % decrease in the output losses. The negative sign implies that an increase in the use of these inputs leads to a decrease in the level of maize production and technical efficiency.

4.3.1.5 Seeds used per farm (kg)

The elasticity of seeds is positive, but lower and not significant. The results indicate that farmers are under-utilising this variable. It further means one percent increase in the quantity of seed for maize, holding all other inputs constant, will results in 10.8 % increase in maize output. The variable “seed” is sensitive to the total output of maize, meaning that there is an input to output relationship.

4.3.2 Return to scale

For constant return to scale, the sum of the technical coefficients β and α must be equal to one (1), for increasing return to scale, they must also be greater than one, and for decreasing return to scale they must be less than one (1). The regression results as shown in Table 4.3, the sum of b`s is less than one (1), simply indicating that a decreasing return to scale. This maybe implying that the resources used for the small-scale maize production at household level are price output below marginal cost. It means there are over-utilised, which results in them being technically inefficient in the production of maize. Return to scale was calculated by adding up the coefficient for elasticity of each variable, the sum of b`s is used as an indicator of return to scale.

It means that the cost per unit of input used in the production process of an output of maize is more than the return from that output of maize. It indicates some inefficiency as they are spending more on inputs than they should in view of the output, given that their livelihoods depend on farming. As a result, they over-invest resources with the assumption that they can maximise output and thereby returns. They are incentives for farmers to decrease the amount of inputs used, since farmers experience decreasing returns to scale, in order for farmers to reach the point where the cost per unit of inputs used is equal to per unit of output/returns.

4.4 Logistic regression model results

In this section, results of the test for significant and non-significant of the determinants of whether a farmer is efficient/not were given. Logistic model was used in Table 4.4 below which displays the estimated results for the logistic regression model to explain the socio-economic factors influencing technical efficiency of maize production. The variables which are significant and non-significant are represented.

Table 4.4: Logistic regression results

Variables	Coefficient	Stard.error	Wald	Significant
GEND	0.427	0.547	0.009	0.435
AGE	-0.245	0.564	0.189	0.663
EDUC	0.591*	0.373	2.505	0.114
HHS	-1.465***	0.360	16.563	0.000
INCH	0.690**	0.303	5.207	0.023
FAREXP	0.042*	0.029	2.165	0.141
FARSZ	0.587***	0.182	10.365	0.001
HIRLAB	0.747	0.552	1.829	0.176
TRACTCOS	-0.016***	0.005	11.776	0.001
FERTUS	1.119*	0.618	3.277	0.070
PURCHS	-0.954*	0.647	2.178	0.140
FARORG	2.839**	0.403	4.094	0.043
MPROF	-1.433*	0.902	2.526	0.112
Constant	4.477	2.511	3.178	0.075
-2 log likelihood		99.326		
R squared		53%		
% cases correctly predicted		75.0%		
Chi squared		38.5		

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

The results indicate that out of 13 variables that were included in the model, 10 of them are significant which are: level of education (EDUC), household size (HHS) income of the household on monthly basis (INCH), farmer`s farming experience (FAREXP), farm size (FARSZ), cost of tractor hours (TRACTCOS), fertiliser application (FERTUS), purchased hybrid maize seeds (PURCHS), membership to farmers` organisation (FARORG), maize profitability (MPROF). This shows that these are the most major factors influencing technical efficiency of small-scale maize producers.

The principle assumption, on which the -2 log likelihood ratio is based, is that there are socio-economic characteristics that influence technical efficiency of small-scale maize producers in Ga-Mothiba. The log likelihood ratio of 99.326 in Table 4.4 rejects the null hypothesis, which reveals that there are no socio-economic characteristics that influence technical efficiency of small-scale maize producers in Ga-Mothiba. The model is correctly predicted at 75 %. This implies that 25 % of the variables are insignificant but are included in the final analysis, which explains the relationship between the dependent and explanatory variables. The model chi-squared at 38.5 indicates the significant of 1% level, meaning that there is a significant relationship between the independent variables and the dependent variable. Pseudo R^2 was 53 %. Next, the variables which were found to be significant in the model are explained.

Level of education

The level of education is positive and significant at 10% level. This implies that it has a positive relationship with technical efficiency. Greater schooling could potentially enhance farm efficiency, either through acquisition of knowledge relevant to agriculture and the usage of available resources efficiently. Education of the farmer is expected to have an effect on farm resources use and the ability to adopt new technology and hence have a positive impact on technical efficiency (Ogolla and Mugabe, 1996).

Household size

Household size is significant at 1% level, which happens to be the most significant variable, but negative. Labour input replaces capital input and the majority of family labour is applied to maize, so access to family labour is an important catalyst for increasing yield. Therefore, it eases the labour constraint faced by most smallholder farms. However, the result implies that there is negative relationship between household size and technical efficiency.

Income of the household

Income of the household is positively and significant at 5% level, this implies that there is positive relationship between the income of the household on monthly basis and the small-scale`s technical efficiency. Since most of the small-scale farmers in Ga-Mothiba are old, they mainly depend on their pension for monthly income, which becomes difficult for them to sustain productivity as they are unable to buy inputs. Income plays a significant role in efficiency since maize production is labour intensive, this can be through hire labour and hire tractor.

Farmer`s farming experience

The variable "farmer`s farming experience" has a positive sign and it is significant at 10% level, with the implication that there is a positive relationship between the farmer`s farming experience and technical efficiency of the small-scale maize producers. It is assumed that the more experience the farmer has, the better the use of available resources thus has an effect on efficiency and this may contribute to the improvement of technical efficiency.

Farm size

The variable farm size is positively significant at 1 % level, which tends to be one of the most significant variables found. The implication is that there is a positive relationship between farm size and small-scale maize producers` technical efficiency. Land plays a vital role in farming with an impact on productivity and efficient, as one of the most available resources one can use efficiently. The size of the farm is based on the size of land used for maize production by the household. Access to land is by far the most important variable, explaining the differentiation in output. Amos (2007), Raghbendra *et al*., (2005) and Barners (2008) found the relationship between land holding size and efficiency to be positive.

Cost of tractor hours

Cost of tractor hours used by the farmer has a negative sign, but it is significant at 1% level. The implication is that there is a negative relationship between the cost of tractor hours and technical efficiency. Even though is one of the most significant variables in the model, it can negatively influence efficiency on maize production as one can prefer using traditional method of ploughing than a tractor.

Fertiliser application

This variable has a positive sign and it is significant at 10 % level. Fertiliser plays an important role on maize production. This implies that the use of fertiliser influence technical efficiency. Therefore, there is a positive relationship between fertiliser and technical efficiency of small-scale maize producers at Ga-Mothiba. The use of chemical fertiliser is known to be commonly used method in improving productivity and in the intensification of agricultural production as a whole; it also plays a big role in regions where the scarcity of farm land is a big problem. However, the appropriate use of these fertilisers is very important in achieving farm efficiency (Hopper, 1965).

Purchased hybrid maize seed

This variable is significant at 10 % level, but it has a negative sign. It means that if a farmer buys certified seeds instead of using the recycled seeds, a farmer may tend to maximise output. There is a negative relationship between purchased hybrid maize seeds and the small-scale maize producer`s technical efficiency. However, purchased hybrid maize seeds can still influence efficiency positively, since the use of improved seed in crop production is one way of increasing productivity in terms of quantity and quality (Kiplan`at, 2003).

Farmers’ organisation

The farmers` organisation is positively and it is significant at 5% level, which implies that a farmers` organisation plays an integral role in maize production and efficiency. Through dissemination of recent agriculture information to other farmers, they can buy seeds in bulk and share; negotiate cost of tractor as they will be using one tractor as a group. Therefore, this may have an impact on smallholder as many become efficient. This means that farmer’s organisation influences technical efficiency and there is a positive relationship between farmer's organisation and the technical efficiency of small-scale maize producers.

Maize profitability

The variable is significant at 10% level and has a negative sign. The implication is that the probability of the small-scale farmers to be technically efficient is not determined by farmers` perception on maize profitability, since small-scale farmers only produce for home consumption not for the market. There is a negative relationship between the profitability of maize and technical efficiency.

CHAPTER 5: SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter summarises the main findings of the study and concludes on the basis of the findings derived from the empirical results. However, the chapter discusses the extent to which objectives and hypotheses posed at the beginning of the study have been addressed by the analysis. This chapter also generates the recommendations on the basis of the results.

5.2 Summary

The main aim of the study was to analyse the technical efficiency of small-scale maize producers in Ga-Mothiba. The first objective was to determine the technical efficiency of small-scale maize producers and the second one was to identify the socio-economic characteristics that influence technical efficiency of maize production in Ga-Mothiba in Limpopo Province. Production of maize by small-scale farmers in Ga-Mothiba plays a vital role in alleviating poverty and generating income, since maize is the staple food in the province, South Africa and in African countries as a whole, so high productivity and the technical efficiency in its production are critical to food security in the country. Ga-Mothiba area was used as the study area.

The study used a set of analytical techniques to analyse the data; the descriptive statistics, Cobb-Douglas production function and logistic regression model whereby significant and the non-significant variables were identified. The descriptive statistics revealed that small-scale maize producers in Ga-Mothiba used different quantities of seeds and fertilisers, while others do not use fertiliser at all, and some of the farmers do not have access to some of the variables (inputs) while others have access. They all hire tractors for the production of maize and many of them depend mainly on family labour. The majority of the farmers interviewed fall under the old age pension group, since young farmers are fewer. Descriptive statistics was used to summarise the data of the study through frequency and the mean descriptive.

Cobb-Douglas production function results indicates that some of the variables were found to be positively significant, while others were negative but signicant, and some were positive but non-significant. Even though some variables were not significant, it still shows that the variables used in the analysis have a positive effect on the output (the total quantity of maize produced) which simply means that there is a good inputs-output relationship, and the small-scale maize producers in Ga-Mothiba are experiencing a decreasing returns to scale.

Logistic regression model was employed to identify the socio-economic characteristics that influence the technical efficiency of small-scale maize producers in Ga-Mothiba. The findings from the logistic regression indicate that there are socio-economic factors influencing the technical efficiency of small-scale maize producers. These are: level of education, household size, farmer`s farming experience, farm size, membership to farmers organization, income of the household on a monthly basis, fertiliser application, and cost of tractor hours. These factors were found to be significant. However, some of the variables were showing a negative relationship to small-scale maize producers` technical efficiency.

5.3 Conclusion

Hypothesis 1: Small-scale maize producers in Ga-Mothiba are not technically efficient. The findings of this study provide support for this hypothesis. Therefore, the hypothesis is not rejected since the empirical analysis have indicated that there is decreasing returns to scale which means that farmers are over-utilising some of the factors of production/resources used in the production of maize.

Hypothesis 2: There are no socio-economic characteristics influencing the technical efficiency of small-scale maize producers in Ga-Mothiba. The hypothesis is rejected as the empirical results show a positive influence of socio-economic factors in technical efficiency. Variables that were found to be highly significant are: household size, farm size, cost of tractor hire, income of the household on monthly basis and membership to farmers` organisation.

In general the study concludes that farmers are technically inefficient since they are over-utilising resources at farm level, and that farmers` technical efficiency can be determined through the influence of certain socio-economic factors.

5.4 Recommendations

The recommendations discussed below are on the basis of the findings of this study. To avoid technical inefficiency amongst small-scale maize producers, the study recommends the need to adopt modern agricultural technology such as improved maize varieties/purchased, seed hybrid maize and fertiliser usage should be governed by a complex set of factors such as human capital improvement and institutional support. This will make sure that people in rural areas, specifically small-scale farmers who practice subsistence farming which are mainly found in the Limpopo Province improve their standards of living.

The study also recommends that the government should not only include the Land redistribution and restitution for agricultural development project on the capacity building programme, but it should also include those farmers who are practicing subsistence farming by training and giving them skills on how to allocate resources efficiently such as fertilisers and seeds during the production periods, farmers also need to have access to enough arable land and tractor services. Since letsema programme already exists in the government, the study recommends that the government should intensify and roll-out the Letsema programme to reach more small-scale subsistence farmers in Limpopo Province, and this can be equally replicated to other provinces.

It also recommended that extension services in the Limpopo Department of Agriculture (LDA) should intensify their efforts to assist small-scale farmers, to overcome the challenges of economic scale and technical efficiency. Also help farmers with the creation of farmers' organization, since the findings have shown that only fewer farmers have membership to farmer's organization. Small-scale farmers need help in a number of areas as the discussion as shown, areas such as education and credit facilities. Subsistence farming in South Africa and indeed in many developing countries provides employment as well as food. In other words, this type of farming contributes significantly in the economic health of a country. It is therefore important that the government fully participate in assisting such community efforts

REFERENCE

ABLER, D.G. and V.A. SUKHATME. 2006. The efficient but poor hypothesis.

Review of agricultural economics, 28: 338-343.

ADMASSIE, A. and F. HEIDHUES. 1996. Estimation of technical efficiency of smallholder farmers in the central highlands of Ethiopia. Ethiopian journal of agricultural economics, 1: 19-35.

AGRICULTURAL STATISTICS. 2003. Maize production per province. Agricultural statistics committee report. Pretoria. National Department of Agriculture.

AGRICULTURAL STATISTICS. 2005. Pocket guide to South Africa. Agriculture, forestry and land: Pretoria. Department of Agriculture.

AHMAD, M.C., GHULAM, M. and M. IGBAL. 2002. Wheat productivity, efficiency, and sustainability: A stochastic production frontier analysis. The Parkistan development review, 41: 4.

ALI, M. and D. BYERLEE. 1991. Economic efficiency of small farmers in a changing world: A survey of recent evidence. Journal of international development, 23: 1745-1753.

ALIBER, M. 2003. Small-scale agriculture as revealed by the labour force survey version 2: 473-490.

ALIBER, M. 2005. Synthesis and conclusion. Trends and policy challenges in the rural economy, South Africa.

AMOS, T.T. 2007. Analysis of productivity and technical efficiency of smallholder cocoa farmers in Nigeria. Journal of social science, 15: 127-133.

AGRICULTURAL RESEARCH COUNCIL (ARC). 2000. Technology report. Grain crops institute, Pretoria, South Africa.

AGRICULTURAL RESEARCH COUNCIL (ARC). 2002. Food and Agricultural research council. Proceeding of the fifth annual meeting of Agricultural Scientists, Pretoria.

ASHLEY, C. and S. MAXWELL. 2001. Rethinking rural development. Development policy review, 19:4.

BARNES, A. 2008. Technical efficiency estimation of Scottish agriculture: A note, Journal of agricultural economics, 59: 370-376.

BASNAYAKE, B.M.J.K. and L.H.P. GUNARATNE. 2002. Estimation of technical efficiency and it`s determinants in the tea small-holding sector in the mid-country wet zone of Sri Lanka. Sri Lanka journal of agricultural economics, 4: 137-150.

BATTESE, G.E. and T.J. COELLI. 1995. A model for technical inefficiency effects in the stochastic frontier production functions for panel data. Empirical economics, 20: 325-332.

BELETE, A., DILLON, J. and F. ANDERSON. 1991. Development of Agriculture in Ethiopia since the 1975 Land Reform. Agricultural economics, 6: 159-175.

BINAM, J.N., TONYE, N.W., NYAMBI, G. and M. AKOA. 2004. Factors affecting the technical efficiency among smallholder farmers in the slash and burn agriculture zone of Cameroon. Food policy, 29: 531-545.

BOYCE, J.K. 1987. Agrarian impasse in Bengal: Institutional constraints to technological change. Oxford: Oxford University Press.

BRAVO-URETA, B.E. and R.E. EVANSEN. 1994. Efficiency In Agricultural Production: The case of peasant farmers in Eastern Paraguay. Agricultural economics, 10: 27-37.

CARTER, M.R. and K.D. WIEBE. 1990. Access to capital and its impact on agrarian structure and productivity in Kenya. American journal of agricultural economics, 72: 1146-1150.

CHAMBERS, R. 1988. Applied production analysis: A dual approach. Cambridge: Cambridge University Press.

COELLI, T., PRASADO, D.S. and G.E. BATTESE. 1998. An introduction to efficiency and productivity analysis. Boston: Kluwer.

CORNIA, G.A. 1985. Farm size, land yields and the agricultural production function: An analysis for fifteen developing countries. World development 13: 513 - 534.

COTLEAR, D. 1987. Farmer Education and Farm Efficiency in Peru: The role of schooling, extension services and migration: Discussion paper no. EDT49. Department of Education and training. Washington, DC: The World Bank.

DEPARTMENT OF AGRICULTURE (DoA). 2002. The integrated food security strategy for South Africa. Pretoria: Department of Agriculture.

DEPARTMENT OF AGRICULTURE (DoA). 2003. Abstract of agricultural statistics. Pretoria, National Department of Agriculture, directorate of statistical information.

DEPARTMENT OF AGRICULTURE (DoA). 2005. Published by National Agricultural Marketing Council, in cooperation with the Department of Agriculture. Republic of South Africa.

DEPARTMENT OF AGRICULTURE (DoA). 2007. South Africa year book, agriculture and land affairs. Department of Agriculture, South Africa.

DEBREU, G. 1959. The coefficient of resource utilisation. Econometrica, 19: 273-292.

DUVEL, G.H., CHICHE, Y. and G.J. STEYN. 2003. Maize production efficiency in the Arsi Nigel farming zone of Ethiopia: a gender perspective. South African journal of agricultural extension, 32: 51-75.

DYER, G. 1996. “Output per acre and size of holding, the logic of peasant agriculture under semi-feudalism.” Journal of peasant studies, 24: 103-131.

ELSAMMA, J. and M.V. GEORGE. 2002. Technical efficiency in rice production: A frontier production function approach. Agricultural economic research review, 15: 50-55.

FEDER, G. 1985. Relation between farm size and farm productivity. The role of family labour, supervision and credit constraints. Journal of development economics, 18: 297-313.

FLINN, J.C. and M. ALI. 1986. Technical efficiency in Basmatic rice production. Pakistan journal of applied economics, 5: 63-79.

HEIDHUES, F. 1995. Rural financial markets- An important tool to fight poverty. Quarterly journal of agricultural economics, 34: 105-108.

HEIDHUES, F. 2004. Africa`s food and nutrition security where we do we stand? Successes, failures, lessons learned. Paper presented at the CTA seminar on the role of information tools in food and nutrition security, Maputo – Mozambique, 8-12 November.

HEIDHUES, F. and G. BUCHENRIEDER. 2004. Rural financial market food security. In food and nutrition security in the process of globalisation. Schulz Mental, (eds): Muster, Germany: Lit-verlag.

HESHMATI, A. and Y. MULUGETA. 1996. Technical efficiency of the Ugandan Matoke farms. Applied economic letters, 3: 491-494.

HOPPER, W.D. 1965. Allocation efficiency in a traditional Indian agriculture. Journal of farm economics, 29: 175-398.

JIGGINS, J., SAMANTA, R.K. and J.E. OLAWOYE. 1997. Improving women farmers' access to extension services: In: Improving agricultural extension: a reference manual, (eds: Swanson, B.E., Bentz, R.P. and A.J. Sofranko). Rome: FAO.

KALAITZADONAKES, N.G., WU, S. and J.C. MA. 1992. The relationship between technical efficiency and farm size revisited. Canadian journal of agricultural economics, 40: 427-442.

KUMBHAKAR, S.C. and C.A. LOVELL. 2000. Stochastic frontier analysis, Cambridge; Cambridge University Press.

KIMENYI, S.M. 2002. Agricultural, economic growth and poverty reduction. Nairobi: Kippraa.

KIPLANG`AT, J. 2003. Does agricultural extension have a new beginning because of ICTs? Reflection on experience in Sub-Saharan Africa. Keynote paper, presented at the 6th Consultative Expert meeting on CIA`s observatory on ICTs. Wageningen University, Netherlands. Sept 23-25.

KIRSTEN, J.F., TOWNSEND, R. and C. GIBSON. 1998. Determination of agricultural production to household nutritional status in Kwazulu-Natal. South Africa: Dev. South Africa, 15: 573-587.

KIRSTEN, J.F. and J. VAN ZYL. 1998. Defining small-scale farmers in the South Africa context. Agrekon, 37: 560-571.

LA-ANYAMI, S. 1986. The economics of agricultural development in Tropical Africa. Macmillan Publications.

LATT, E.A. and W.L. NIEOWOUDT. 1988. Identification of plot size affects on commercialization of small scale agriculture in Kwazulu. Development Southern Africa, 5: 371-382.

LEVIN, R. and D. WEINER. 1997. An *more tears*….A struggle for land in Mpumalanga, South Africa. Trenton, N.J.: Africa World Press.

LIPTON, M. 1996. Rural reforms and rural livelihoods: the context of international experience. In: Lipton, M., De Klerk, M. (eds.). Land, Labour and Livelihood in Rural South Africa. Western Cape. Indicator Press.

LIPTON, M., ELLIS, F. and M. LIPTON. 1996. Introduction. In:Lipton, M., de Klerk, M. And Lipton, M. (eds). Land, Labour and Livelihood in Rural South Africa. Western Cape. Indicator Press.

MAZUMDAI, D. 1965. Size of farm and productivity. A problem of Indian peasant Agriculture. Economica, 32: 161-173.

MOCHEBELELE, M.T. and A. WINTER-NELSON. 2000. Migrant labour and farm technical efficiency in Lesotho. World development, 28: 143-153.

MONDE, N. 2003. Household food security in rural areas of central Eastern Cape: The case of Guqukain Victoria East and Koloni in the Middle drift district. Unpublished PhD Thesis. University of Fort Hare. Alice, 263pp.

MUSHUNJE, A. and A. BELETE. 2001. Efficiency of Zimbabwean small-scale communal farmers. Agrikon journal, 40: 3.

NIEUWOUDT, W.L. 1990. Efficiency of Land Use. Agrekon, 29: 210-215.

OBERHAUSER, A.O. 1993. An industrial restricting and women's homework in Appalachia: Lessons from West Virginia, at South-eastern Geographer 33: 23-43.

OGOLLA, B.D. and J.W. MUGABE. 1996. Land tenure system and natural resource management. In land we trust: Environment, private property and constitutional change. Juma, C. and J.B. Ojwang: 79-120. Nairobi, Kenya initiatives publishers.

ORTMANN, G. and C. MACHETHE. 2003. Problems and opportunities in South African agriculture: In Nieuwoudt, L. and Groenewald, J. The challenge of change: agriculture, Land and the South African economy. University of Natal press, 47-62.

OTSUKA, K. 2006. Why can`t we transform traditional agriculture in Sub-saharan Africa? Review of agricultural economics, 28: 332-337.

QUIST, D. and I.H. CHAPELA. 2001. Transgenic DNA introgressed into traditional maize landraces in Oaxaca, Mexico. Nature, 414, 541-543.

RAGHBENDRA, J., HARI, K.N. and D.P. SUBBARAYAN. 2005. Land fragmentation and its implications for productivity: Evidence from Southern India, Australia South Asia Research Centre (ASARC) working paper 2005/01.

ROCKEFELLER, J.D. 1969. The challenge of population and food. In: R. Clifton and Whatrton, J.R. (Eds.). Subsistence agriculture and economic development. New York: Frank Cass.

SCHULTZ, T.W. 1975. The value of the ability to deal with disequilibria. Journal of economic literature, 13: 827-846.

SEN, A. 1975. Employment, technology and development. Oxford: Clarendon Press.

SERRAO, E.A.S. and A. HOMMA. 1993. Brazil country profile in national research council. Sustainable agriculture and the environment in the humid tropics. Washington, DC: National Academy Press.

SEYOUM, E.T., BATTESE, G.E. and E.M. FLEMING. 1998. Technical efficiency and productivity of maize producers in Eastern Ethiopia: A case study of farmers within and outside the Sasakawa-Global 2000 project. Agricultural economics, 19: 341-348.

SHAPIRO K.H. and J. MULLER. 1977. Sources of technical efficiency: The role of modernization and information. Economic Development and Cultural change, 25: 2.

SHERLUND, S.M., BARRETT, C.B. and A.A. ADESINA. 2002. Smallholder technical efficiency controlling for environmental production conditions. Journal of development economics, 69: 85-101.

TAYLOR, G.T. and S. SHONKWILER. 1986. Alternative stochastic specifications of the frontier production in the analysis of agricultural credit programs and technical efficiency. Journal of development economics, 21: 149-159.

TCHALE, H. and J. SAUER. 2007. The efficiency of maize farming in Malawi: A bootstrapped translog frontier. Cahiers d`économie et sociologie rurales, n˚ 82-83.

TCHALE, H. 2009. The efficiency of smallholder agriculture in Malawi. AFJARE, 3: 2.

TOWNSEND, R.F., KIRSTEN, J. and N. VINK. 1998. Farm size, productivity and returns to scale in agriculture revisited: A case study of wine producers in South Africa. Agricultural economics, 19: 175-180.

VERMA, B. and D.W. BROMLEY. 1987. The political economy of farm size in India: The collusive quest. Economic development and cultural change, 35: 791- 808.

VINK, N. and M. D`HAESE. 2003. The development debate and agriculture. In: M. D`Haese, N. Vink, G. Van Huylenbroeck, F. Bostyn, and J. Kirsten, (Eds.). Local institutional innovation and pro-poor agriculture growth.

The case of small-woolgrowers associations of South Africa. Garant, Belgium.

WEIR, S. 1999. The effects of education on farmer productivity in rural Ethiopia. Working paper CSAE WPS99-7. Centre for the Study of African Economies, Oxford University.

WEIR, S. and J. KNIGHT. 2000. Education externalities in rural Ethiopia: Evidence from average and stochastic frontier production functions. Working paper CSAE WPS/2000-4. Centre for the Study of African economies, Oxford University.

APPENDICE

Appendix: Questionnaire

Title of Research study: Technical Efficiency in Maize Production by Small-Scale Farmers: A Case Study of Ga-Mothiba Village in Limpopo Province, South Africa.

The main aim of the study is to analyse the technical efficiency of small-scale maize producers in Ga-Mothiba, and to identify the socio-economic characteristics that influence the technical efficiency of maize production in the area.

Researcher: Baloyi Rebecca Tshilambilu

ENUMERATOR'S NAME:

QUESTIONNAIRE NO:

NAME OF VILLAGE:

DATE OF INTERVIEW:

PART ONE: SOCIO-ECONOMIC QUESTIONS

1. Respondent/ farmer's name and surname:

…………………………………………………………………………………………..

2. Gender of the household head:

Male	Female

A.	B.

3. Age of the household head:

………………………………………………………………………………………………

4. Marital status of the household head:

Married	Divorced	Single	Widowed
A.	B.	C.	D.

5. Highest educational qualification (of household head):

No formal education	Primary	Secondary	Tertiary	Abet
A.	B.	C.	D.	E.

6. Number of people in the household (who have been living with you for the past three months):

……………………………………………………………………………………

7. Sources of income:

Salary	Farming	Pension	Child grants	Remittance
A.	B.	C.	D.	E.

8. What is the income of the household head per month?

< 1500	1501 - 2100	2101 – 3000	>3000
A.	B.	C.	D.

9. Do you use credit facility?

Yes		No	

9.1 If (yes), how much do usually get per annum?

…………………………………………………………………………………………..

9.2 Where do you get the credit from?

Financial institution	Relative or friend	Money lender	Output buyer	Supplier	Other
A.	B.	C.	D.	E.	F.

9.3 What do you use the money for?

Farming	General maintenance/ household purchase	Food
A.	B.	C.

9.4 Do you have any outstanding debts?

Yes		No	

9.5. If (yes), how are you repaying them?

…………………………………………………………………………………………..

PART TWO: PRODUCTION INFORMATION

1. How long, in terms of years, have you been involved in farming (years)?

…………………………………………………………………………………………

2. Do you own the land which you use for ploughing/cultivation?

Yes		No	

2.1. If (yes), where did you get the land from?

Traditional authority	Lease	Bought	Inherited	Other
A.	B.	C.	D.	E.

3. When did you start ploughing maize?

………………………………………………………………………………………..

4. What was the motive for start ploughing maize?

Income generation	Employment	Pastime	Home consumption	Other
A.	B.	C.	D.	E.

5. How many bags of maize do you normally get in a year?

…………………………………………………………………………………… (in kg)

6. How many hectares/Morgan of land do you have?

……………………………………………………………………………………

7. How many hectares/Morgan do you use to produce maize?

………………………………………………………………………………………..

8. Do you normally hire labour for the production of maize?

Yes		No	

8.1 If (yes), how many labourers do you normally hire?

………………………………………………………………………………………..

8.2 How much do you pay them per day?

………………………………………………………………………………………..

8.3 If you do not have any labourers, how do you compensate for the labour?

………………………………………………………………………………………

8.4 How man days used labour for maize production?

....

9. Do you normally hire a tractor for ploughing maize?

Yes		No	

9.1 If (yes), how much does it cost per hour or per ha?

……………………………………………………………………………………………..

9.2 If (no), how do you compensate for the tractor?

……………………………………………………………………………………………

10. Do you apply fertiliser for the maize production?

Yes		No	

10.1 If (yes), how many kilogrammes do you apply per hectare?

……………………………………………………………………………………………

10.2 How much do you spend on fertiliser?

……………………………………………………………………………………………..

10.3 If you do not buy fertiliser, how do you compensate for it?

……………………………………………………………………………………………

11. Do you use manure?

Yes		No	

12. Do you normally use any type of pesticides for maize?

Yes		No	

12.1 If (yes), how much is the cost of pesticides per hectare?

……………………………………………………………………………………………

12.2 If (no), how do you compensate for the pesticides?

…………………………………………………………………………………………

13. How many kilogrammes of seeds do you normally use per hectare of maize?

…………………………………………………………………………………………..

13.1 How much does it cost?

…………………………………………………………………………………………

14. Do you purchase hybrid maize seed?

Yes		No	

14.1 If (yes), how much does it cost per kg?

…………………………………………………………………………………………..

15. Do you belong to any farmers` organisation?

Yes		No	

15.1 If (yes), which organisation do you belong to?

…………………………………………………………………………………………..

15.2 How long have you been a member of the organisation?

…………………………………………………………………………………………..

16. What problems do you have with maize production in the area?

……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………
………………………………………

17. Do you want to increase your production?

Yes		No	

17.1 If (yes), explain the reason you want to increase your output:

…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………

PART THREE: MARKETING INFORMATION

1. Do you have access to markets?

Yes		No	

2. What are your main market outlets?

Hawkers	Contractors	Shops	Consumers
A.	B.	C.	D.

3. How many kilogrammes of maize do you consume per year?

…………………………………………………………………………………………

4. How many bags of maize do you sell per year?

…………………………………………………………………………………………..

5. At how much do you sell per bag?

………………………………………………………………………………………

6. How much does it cost to market your product in terms of transport cost, packaging and other expenditure?

………………………………………………………………………………………

7. Are you left with surplus output after consumption?

Yes		No	

7.1 If (no), explain why that is not the case?

……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………
…………………………………………….

8. Who are your main inputs suppliers?

Local shops	Stores in town	Cooperatives	Friends/ family relatives
A.	B.	C.	D.

9. How much does it cost to reach the inputs market?

………………………………………………………………………………………

10. What problems do you have about inputs supplier?

……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………

……………………………………………………………………………………………………
…………………………………………

11. Do you own any large farming equipments?

Yes		No	

11.1 If (yes), which one?

Wheelbarrow	Tractor	Motor Bakkie	implements	Other
A.	B.	C.	D.	E.

11.2 Do you hire them out?

Yes		No	

11.3 If (yes), at what price do you hire them out?

……………………………………………………………………………………………………
…………………………………………………………………………………

11.4 How is the interest rate?

Expensive	Affordable	No interest rate
A.	B.	C.

12. Has producing maize become profitable to you?

Yes		No	

12.1 If (yes), explain in details?

……………………………………………………………………………………………………
……………………………………………………………………………………………………

…………………………………………………………………………………………………
………………………………………………………………………………………

13. What final general comments would you like to make?

…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
………………………………………………………………………...................................