ANALYZING THE TECHNICAL AND ALLOCATIVE EFFICIENCY OF SMALL-SCALE MAIZE FARMERS IN TZANEEN MUNICIPALITY OF MOPANI DISTRICT: A COBB-DOUGLAS AND LOGISTIC REGRESSION APPROACH

by

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ABSTRACT

Agriculture plays an important role in uplifting the economy of South Africa. Small-scale farmers in rural areas are linked with poverty and operate inefficiently due to over or under utilization of some of the factors of production.

This study aimed at analysing the technical and allocative efficiency of small-scale maize farmers in Tzaneen municipality. The objectives of the study were: (i) To assess the level of technical and allocative efficiency of small-scale maize farmers in Tzaneen municipality, (ii) To identify socio-economic factors affecting the efficiency of small-scale maize farmers in Tzaneen municipality and (iii) to investigate the areas of improvement with regard to the operational management of the small-scale maize farmers in Tzaneen municipality. The study employed the Cobb-Douglas production function and the logistic regression model to analyse data.

The Cobb-Douglas production function results revealed that small-scale maize farmers in Tzaneen municipality are technically efficient in the production of maize with the highest mean technical efficiency value of 0.71%. The study further revealed that farmers were allocatively inefficient with a mean allocative efficiency value of 0.39%. The logistic regression analysis revealed important variables such as the level of education (1.05), experience in farming (2.74), access to irrigation water (0.59), purchase of hybrid seed (0.74), access to credit (2.13) and extension visits (0.85) were positively significant towards the efficiency of farmers. Variables such as gender of the farmer (-1.79) and off-farm income (-2.72) were found to be negatively significant towards the efficiency of small-scale maize farmers in Tzaneen Municipality.

The findings obtained in this study could be quite useful to policy makers. This study recommend that there is a need for more visits from the extension officers as well as training on inputs allocation, since variables like Seed (0.41), fertilizer (0.17), capital (0.71) and expenses (-0.204) were found to be inefficiently allocated in the production of maize.

The provision of easy, quick and adequate credit deserves to be a top priority on the agenda of policy makers since most small-scale maize farmers in Tzaneen municipality does not receive off-farm income. Small-scale farmers in Tzaneen municipality also need to have access to enough arable land in order to increase production. Small-scale farmers in South Africa and other developing countries contribute to employment creation and food security in the households, therefore, it is important that government fully support such farmers.

Key words: Technical efficiency, Allocative efficiency, Small-scale farmers and Socio-economic factors.

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DECLARATION

I declare that the dissertation hereby submitted to the University of Limpopo, for the degree of Master of Agricultural Management in Agricultural Economics, has not previously been submitted by me for a degree at this or any other university; that it is my work in design and in execution, and that all material contained herein has been duly acknowledged.

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Surname, Initials Date:2015

DEDICATION

This work is dedicated to the following important people in my life, Freddy Mokgalabone, Mmamaropeng Mokgalabone, Koena Mokgalabone, Walter Shingange and to all my siblings.

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LIST OF ACRONYMS

SA: South Africa

AL: Allocative Efficiency

TE: Technical Efficiency

LEAC: Limpopo Export Advisory Committee

SPSS: Statistical Package for Social Science

MPP: Marginal Physical Product

MVP: Marginal Value Product

MIC: Marginal Income Cost

OLS: Ordinary Least Square

CASP: Comprehensive Agricultural Support Programme

APEP: Agricultural Productivity Enhancement Programme

CRS: Constant Returns to Scale

VRS: Variable Returns to Scale

DAE: Data Envelopment Analysis

SFA: Stochastic Frontier Analysis

GNP: Gross National Product

NDA: National Department of Agriculture

GTEDA: Greater Tzaneen Economic Development Agency

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Agriculture plays an important role in uplifting the economy of South Africa. South Africa is characterized by very prominent dualism in its agricultural production. On one hand, there is very well developed commercial agricultural sectors characterized by a relatively small number of producers (about 60 000 commercial farmers) owning 87% of the total agricultural areas and producing more than 95% of the marketed output. On the other hand, a subsistence or small-scale agricultural sector characterized by a very large number of producers, whose majority is settled in the communal areas, making up about 13% of the agricultural land area (Kirsten and Van Zyl, 1998 as cited by Ngqangweni, 2000).

Various efforts to promote small-scale farming have been made in the past decade. It remains clear, however, that much more needs to be done to make a positive difference in terms of the political objective of an integrated agricultural sector. Integration will only happen when small-scale farmers fully participate in the market (Azan and Besley, 1991; Makhura, 2001).

According to Makhura (2001), small-scale farmers in the less-developed rural areas of South Africa are generally poor and not entirely part of commercial agriculture as a result the contribution of Gross National Product (GNP) is limited. Small-scale farmers residing in Limpopo Province are associated with poverty (Mpandeli, 2006). According to a discussion on food security by the Department of Agriculture and Land Affairs (DALA) and the Ministry of Agriculture and Land Affairs (MALA), many households are vulnerable to food insecurity including those in the Limpopo Province (FIVIMS, 2003; Mpandeli, 2006).

The disadvantaged farmers practise subsistence agriculture in overcrowded semi-arid rural areas. Subsistence farming is characterized by low production, less opportunities of owning land, limited access to inputs and credit. Farmers tend to engage in off-farm or non-farm activities in order to generate enough income (Makhura, 2001).

The process of agricultural transformation in South Africa involves moving small-scale farmers from subsistence production to producing for the market. The latter provides a number of benefits and advantages, including rural employment and income generation (Ngqangweni, 2000). Furthermore, several studies (Delgado *et al*. 1998; Ngqangweni, 2000) had shown positive and strong multiplier effects of investing in agriculture, in other words, agriculture has an important role to play in fostering rural development and poverty alleviation. There are constraints, like poverty and limited access to agricultural inputs which affect small-scale farmers in the Limpopo Province.

The small-scale sector is divided into three categories: net food buyers, intermediate farmers and net food sellers. Net food buyers are those farmers with less than 0.7 hectares who cannot produce food to satisfy their subsistence needs given the technology they use. Resultantly they remain dependent on off-farm activities. Intermediate smallholder farmers are those with land holding between 0.7 and 1.5 hectares who produce just enough for their survival but have very little for sale. Net food sellers are those farmers with land holdings of more than 1.5 hectares who produce more than their subsistence needs for survival during the year (Alwang and Siegel, 1999 as cited by Baloyi *et al*. 2011).

According to Coetzee (1998) as cited by Hlongwane and Belete (2005), there is a challenge in the exact definition of a small-scale farmer and the author further argues that it should be based on agricultural activity in whatever form. Small-scale is often equated with a backward, non-productive, non-commercial subsistence agriculture that is found in parts of the former homeland areas. The production level is generally low due to a traditional land tenure system, lack of physical infrastructure, lack of credit facilities and lack of extension services.

Maize is the most important grain crop and is widely produced by small-scale famers (NDA, 2004). South Africa is the main maize producer in the South African Development Community (SADC), with an average production of about 9,6 million tonnes per year over the past 10 years. Maize has a wider range of uses because of its worldwide distribution and relatively lower prices. It is used directly for human consumption in developing countries, as livestock feed and also as non-food products such as starch, acid and alcohol. Recently there has been interest in using maize for production of ethanol, a substitute for petroleum based fuel (NDA, 2004).

According to Elsamma and George (2002) production is defined as the transformation of goods and services into finished products (that is input-output relationship). The efficiency of a farm is based on its ability to produce the greatest amount of output possible from a fixed amount of inputs. In other words an efficient farm is the one that can produce a given quantity of goods by using the least units of inputs possible. In fact, the concept of efficiency is derived from a particular interpretation of the notion of production frontier. Production efficiency can be measured by two components called technical and allocative efficiency (Torkamani and Harder, 1996).

Technical efficiency is defined as the ability of a farm to obtain maximum attainable output from a given set of physical inputs. Following the classical definition of Farrell (1957), a firm is considered to be technically efficient if it obtains the maximum attainable output given the amount of inputs used and technology. Allocative efficiency on the other hand is defined as the ability of a farm to use inputs in optimal proportions given their respective prices (Rukuni, 1994). The appropriate measure of technical efficiency is input saving, which gives the maximum rate at which the use of all the inputs can be reduced without reducing output.

Allocative efficiency deals with the extent to which farmers make efficient decisions by using inputs up to a level where their marginal contribution to production value is equal to the factor cost (Rukuni, 1994). Allocative efficiency is evaluated from the producer's maximization point of view. The study of efficiency focuses on the possibility of increasing output while conserving resource use. Efficiency measurement provides information which is potentially useful in the formation and analysis of the agricultural policy (Wang *et al*. 1996 as cited by Baloyi *et al*. 2011).

Technical inefficiency arises when less than the maximum output is obtained from a given package of factors. It is generally assumed to reflect inefficiency due to timing and method of application of production inputs. Allocative or price inefficiency arises when factors are used in proportions which do not minimize the cost of producing a given level of output. There is failure to equate the ratio of marginal products of inputs to the ratio of market prices. Allocative inefficiency can be a reflection of unobserved differences in prices or producers' objectives other than profit maximization e.g. utility with risk within utility function which cause different marginal conditions to hold (Farrell, 1957).

Small-scale farming can potentially contribute to agro industrial development. Hence increasing the number of small-scale farmers can increase the demand for agricultural inputs such as fertilizers, pesticides, etc. Strategies to develop small-scale farming and linking them to rural enterprises could reduce rural poverty and limit-urban migration. The importance of sustaining agricultural production to improve the standard has been recognized by all countries throughout the world (Ankomah, 2000).

The role of agriculture in development was considered ancillary to the modern industrial sector where most of the accumulation and growth was expected to take place. Subsequent theoretical investigations and the very disappointing performance of agriculture in many developing countries have led to the belief that the role of agriculture in development should be re-examined (Ankomah, 2000).

This study focuses on technical and allocative efficiency because it is an important subject in developing agriculture where resources are limited with high population growth being 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% while population growth was 3%. 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 of food imports, food aid, rising poverty and increasing degradation of the natural resource base (La-anyami, 1986).

1.2 Problem statement

The contribution of agriculture to the provincial Gross Domestic Product (GDP) is declining in the Limpopo Province; this has been due to inappropriate policies that have inhibited small-scale agriculture from contributing to total output. Most farmers in the Limpopo Province are small-scale farmers and suffer immensely from inadequate access to economic and social resources. Most small-scale farmers do not practice high-yield farming methods and produce mainly for subsistence (Makhura, 2001).

Small-scale farmers are amongst the vulnerable groups in rural areas, most of them are women, children and the aged. It is alleged that most small-scale farmers in rural areas are inefficient due to over or under utilization of some of the factors of production. This in turn leads to food insecurity and poverty (Baloyi *et al*. 2011). There is uncertainty as to whether the small-scale farmers operating in Tzaneen Municipality which is under the Mopani district of Limpopo Province are efficient in the production of maize. This study therefore analyses the performance of small-scale maize farmers to discover the efficiency level and identifies socio-economic factors affecting the technical and allocative efficiency of farmers in Tzaneen Municipality.

1.3 Motivation of the study

South African small-scale farmers are usually linked with poverty, inefficiency and illiteracy; factors that often create a wrong impression. South Africans typically judge a farm's viability on the land size without necessarily considering other attributes such as the specific farming enterprise or managerial ability (Mpandeli, 2006). This study provides information that will help in rectifying queries that most people raise about the viability of small-scale farmers.

The results of the study will help to determine how much of the neglected resources can be used to raise productivity given the existing resource base and the available technology. The study focuses on technical and allocative efficiency because it is an important subject in developing agriculture where resources are limited but high population growth is very common (La-anyami, 1986) .

Various agricultural programmes and policies with the aim of raising farmers' efficiency and productivity have been implemented over the past years (NDA, 2004). It then becomes significant to study the current level of efficiency and to analyse factors influencing the level of efficiency. The policy makers need to know the factors constraining farmers from operating at the frontier level, such information can then be used in designing policies that will enable small-scale farmers to operate at the frontier level. Increasing productivity is crucial for improving the livelihoods of small-scale farmers (Makhura, 2001).

1.4 Scope of the study

1.4.1 Aim

The aim of the study was to analyse the technical and allocative efficiency of small-scale maize farmers in Tzaneen Municipality.

1.4.2 Objectives

The objectives of the study are to:

i. Assess the level of technical and allocative efficiency of small-scale maize farmers in Tzaneen Municipality.
ii. Identify socio-economic factors affecting the efficiency of small-scale maize farmers in Tzaneen Municipality.
iii. Investigate the areas of improvements with regards to the operational management of small-scale maize farmers in Tzaneen Municipality.

1.5 Hypotheses of the study

i. The level of technical and allocative efficiency of small-scale maize farmers in Tzaneen Municipality is low.
ii. There are no socio-economic factors affecting the efficiency of small-scale maize farmers in Tzaneen Municipality.
iii. There are no areas which need to be improved with regards to the operational management of small-scale maize farmers in Tzaneen Municipality.

1.6 Organizational structure

The remainder of the study is structured as follows: Chapter two contains the literature review on technical and allocative efficiency. Chapter three presents the agricultural sector in South Africa with emphasis to the small-scale farmers in Limpopo Province. Chapter four presents in detail the methodology used in the study. Chapter five presents the description of the data set, the analytical techniques employed in the study and the main results of the Cobb-Douglas production function and the logistic regression model. The last chapter of the study presents summary, conclusions and recommendations of the study as well as the references.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents the literature review on efficiency of farmers. As a component of production efficiency, technical efficiency is derived from the production function. Production efficiency consists of the technical efficiency and allocative or factor price efficiency. Production efficiency represents the efficient resource input mix for any given output that minimizes the cost of producing that level of output or equivalently the combination of inputs that for a given monetary outlay maximizes the level of production (Coelli and Battese, 1996). The literature on the production or technical efficiency in African agriculture is emerging. There is wide empirical research on the economic efficiency of farmers in both developed and developing countries. The empirical literature on the efficiency of farmers is vast in developed countries and Asian economies as a result only a few studies focus on African agriculture (Coelli and Battese, 1996).

Small-scale farmers face multiple challenges, this is due to the scarcity of livelihood options outside agriculture. According to Msuya (2008) increasing productivity is crucial for improving the livelihoods of small-scale farmers, who make the majority of the poverty stricken rural population in South Africa. Msuya (2008) states that low productivity is one of the primary causes of low and unstable value added along the value chains leading to a stagnant rural economy with persistence of poverty. Hence, increasing productivity is crucial for improving the livelihoods of small-scale farmers in the country.

2.2 Review of previous studies on technical efficiency and its determinants

The factors which influence the performance of production units include the effect of market structure, economic regulation and ownership. Kumbharkar *et al.* (1991) were the first authors to determine the factors responsible for inefficiency. Stochastic frontier approach has found wide acceptance within the agricultural economics literature and industrial settings (Battese and Coelli, 1992, Coelli and Battese, 1996) because of their consistency with the theory, usefulness and relative ease of estimation.

The studies on technical efficiency of small-scale farmers have associated variables like farmers` age, farmers` education level, access to extension, access to credit, land holding size, ownership of dwelling, farmers` family size, gender, market access, as well as farmers` access to improved technologies such as fertiliser, agro-chemicals, tractor and improved seeds with a positive effect on technical efficiency (Amos, 2007; Ahmad *et al*. 2002; Tchale and Sauer, 2007 and Basnayake and Gunaratne, 2002).

Heshmati and Mulugeta (1996) estimated the technical efficiency of Ugandan Matoke producing farms and found that farmers experience decreasing returns to scale with mean technical efficiency of 65%. On the other hand, there was no significant variation in technical efficiency with respect to farm sizes.

Seyoum *et al*. (1998) investigated the technical efficiency and productivity of maize producers in Ethiopia and compared the performance of farmers within and outside the programme of technology demonstration. Using Cobb-Douglas production functions the empirical results showed that farmers who participated in the programme were more technically efficient with a mean technical efficiency equal to 94% compared with those outside the project whose mean efficiency was 79%.

Nsanzugwanko et al. (1996) estimated the technical efficiency of individual peasant farmers in the Ethiopian agricultural sector and used the stochastic frontier production functions to estimate the technical efficiency of production. The variable labour was left out despite its importance and also excluded some important socio-economic variables, which could be useful in examining technical efficiency. These included age, education and experience of farmers' as well as access to credit and infrastructure. The stochastic production function of the Cobb-Douglas type was used and the maximum-likelihood estimates of the parameters were obtained using the computer program, frontier, version 2.0.

Ajibefun *et al.* (1996) investigated the factors influencing the technical efficiency of small-scale copper farmers in Nigeria. A translog stochastic frontier production function was used instead of Cobb-Douglas frontier function because the latter was not an adequate representation of the data. The estimated technical efficiency of the sampled farmers varied widely, ranging from 19% to 95%. The results also indicated that technical efficiency of the production of farmers was significantly related to the age and farming experience of the farmers, farm size and the ratio hired labour to total labour used. The inefficiency of these small-scale farmers was not significantly related to the size of farming operations for the farmers involved.

Battese (1998) investigated the efficiency of cotton farmers in Vehari district of Punjab, Pakistan. The study used questionnaires to collect details about the operatin of farms especially varieties grown, yields obtained and the use of inputs like fertilizers, seeds, pesticides etc. The stochastic frontier production function model was used to analyse data obtained from 45 farmers in the mentioned study area above. The results of the study predicted the technical efficiency ranging from 0.699% to 0.991%, with a mean technical efficiency estimated to be 0.930.

Lyubow and Jensen (1998) used the translogarithmic stochastic frontier production function to analyze the technical efficiency of grain production in the Ukraine from 1989 to 1991. Out of the 80 farms considered, it was found that variables such as the number of farm workers per hectare, the proportion of active household members engaged in non-agricultural activities and the distance between farms had a negative impact on technical inefficiency.

The variable farmers' education level is reported by many studies as a variable having a positive effect on technical efficiency. Weir and Knight (2000) found the evidence that the source of externalities to schooling was in the adoption and spread of innovations that shifted out the production frontier. The study revealed a mean technical efficiency of 0.55% on cereal crop farmers and also indicated that a unit increase in years of schooling would increase technical efficiency by 2.1%.

Weir (1999) investigated the effects of education level on farmer productivity of cereal crops using average and stochastic production functions in Ethiopia. The study found substantial internal benefits of schooling for farmers' productivity in terms of efficiency gains but found a threshold effect which implies that at least four years of schooling is required to lead to significant effects of farm level technical efficiency. Using different specifications, average technical efficiencies ranged between 0.44 and 0.56. Raising education from zero to four years in the household leads to a 15% increase in technical efficiency. Moreover, the study found the evidence that average schooling in the villages improves technical efficiency.

Ajibefuni and Igbekele (2002) revealed that the level of technical efficiency would significantly increase with rising level of education and farming experience. The study was conducted in Nigeria using stochastic frontier methodology. The analysis showed a wide variation in the estimated technical efficiencies, ranging between 0.18% and 0.91% with a mean value of 0.63%, indicating a wide room for improvement in the technical efficiency.

Msuya and Ashimogo (2005) analysed the technical efficiency of sugarcane production and the factors affecting efficiency of farmers in Tanzania. The technical efficiency was estimated using the Cobb-Douglas production frontier assumed to have a truncated normal distribution. The results of the estimation showed that there were significant positive relationships between age, education and experience with technical efficiency.

Bayacag and Rola (1999) used a panel data of upland corn farmer's production and soil conservation practices to investigate the influence of farmer's technical and ecological knowledge on the technical efficiency. The technical efficiency was derived from two types of translog production frontiers. It was assumed that farmers face the same environment thus, the study measured production efficiency as influenced by both management and environment. The results of the study showed that on average the technical efficiency of farmers with and without considering the environmental factors were 49.6% and 45% respectively.

The precise conclusion on the influence of farm size and efficiency has not been reached. This statement is supported by the work of Amos (2007); Raghbendra *et al*. (2005) and Barners (2008) who found that farm size and efficiency to be positively related. A recent study by Baloyi *et al*. (2011) also revealed a strong relationship between the farm size and technical efficiency of small-scale maize farmers in the Limpopo Province. On the other hand, Townsend *et al.* (1998) investigated the relationship between the farm size and returns to scale, the results of the study revealed the inverse relationship between farm size and productivity to be weak.

Mushunje and Belete (2005) conducted a study in which they analysed the relationship between farm size and technical efficiency. The empirical results obtained from estimating the stochastic frontier production models indicated that farm size was one of the most important factors limiting the farmers' technical efficiency. On technical inefficiency effects, the study revealed that farm size, family size, age and level of education of the farmers were important determinants of technical efficiency of the small-scale farmers. All small-scale farmers in the study area indicated increasing returns to scale while large-scale commercial farmers were experiencing decreasing returns to scale.

Kehinde *et al.* (2009) quantified technical efficiency and the determinants of observed technical inefficiency of sawmills in Nigeria. The stochastic frontier approach was used to estimate technical efficiency of both small and medium-scale sawmills. The Ordinary Least Square (OLS) regression analysis was used to estimate the determinants of the observed technical inefficiency. Empirical results indicated that medium-scale saw millers were more efficient than their small-scale counterparts. However, both groups of saw millers in Nigeria had potential to expand their output.

Hlongwane and Belete (2005) assessed the level of technical efficiency of small-scale farmers at Dikgale and Sepitsi irrigation schemes. Maize and cowpea were the main crops produced by the farmers. The Cobb-Douglas production function was used to estimate the technical efficiency of both schemes. The analysis revealed that there was a difference in technical efficiency of both schemes and a positive relationship between farm size and productivity at both irrigation schemes.

Mochebelele and Nelson (2000) assessed the impact of labour migration on the technical efficiency performance of farms of the Economy of Lesotho. Using the stochastic production function (Translog and Cobb-Douglas), the study found households that sent migrant labour to South African mines being efficient than those that do not, with mean inefficiencies of 0.36% and 0.24%, respectively. In addition, there was no statistical evidence that the size of the farm or the gender of the household head affects the efficiency of the farmers.

According to Chirwa (2003) one constraint in achieving food security has been the smallness and fragmentation of land holdings among a large proportion of households in Malawi. Subsidization of farm inputs and provision of credit facilities were also the major challenges faced by farmers in the study area. The study estimated technical efficiency among small-scale maize farmers in Malawi and identified sources of inefficiency using plot-level data. It was found that small-scale maize farmers in Malawi were inefficient; with an average efficiency score of 53.11% and 58% of the plots had efficiency scores below 60%. In conclusion, the results revealed that inefficiency falls with increase in farm size.

Sherlund *et al*. (2002) investigated the efficiency of small-scale rice farmers in Cote d'Ivoire while controlling for environmental factors that affect the production process. Apart from identifying factors that influence technical efficiencies, the study found that the inclusion of environmental variables in the production function significantly change the results, the estimated mean technical efficiencies increase from 36% to 0.76%.

Helfand (2003) used the same approach as Lyubow and Jensen (1998) to explore the determinants of productive efficiency in the Brazilian Center-West. The results of the research reflect that access to credit institutions, goods supplied by the public sector such as electricity and technical assistance, the use of modern inputs like fertilizers and the practice of irrigation, soil conservation and crop protection against pests were the factors responsible for differences in the level of inefficiency between plantations.

Binam *et al*. (2004) examined factors influencing technical efficiency of groundnut and maize farmers in Cameroon. Cobb-Douglas production function was used to find mean technical efficiencies that ranged between 73% and 77% respectively. The study concluded that access to credit, social capital, and distance from the road and extension services are important factors explaining the variations in technical efficiencies.

Onyenweaku and Okoye (2005) employed a Translog stochastic frontier production function to measure the level of technical efficiency and it's determinants in small-scale cocoyam production in Anambara state, Nigeria. The parameters of the stochastic frontier production function were estimated using the maximum likelihood method. The results of the analysis showed that individual farm level technical efficiency ranged between 69.01% and 98.42% with a mean of 92.96%. The study found farm size, farming experience, use of fertilizer and membership of farmers' association or co-operative societies to be positively related to technical efficiency while no significant relationship was found between technical efficiency and age, education, extension contact, household sizes as well as credit.

Onyenweaku and Ohajianya (2005) designed the study to measure the level of technical efficiency and its determinants in rice production in Ebonyi State, Nigeria. A stochastic frontier production function was employed to analyze data. The estimated farm level technical efficiency ranged from 17.19% to 93.13% with a mean of 65.06%. The empirical results of the study revealed no relationship between technical efficiency and age of the farmer, tenancy status and off-farm employment in the study area. While variables like access to credit, education, farm experience, farm size, membership in farmers' associations or co-operative society, use of improved rice varieties, extension contact and system of production as well as timeliness of farm operations bared positive and significant relationship to technical efficiency.

Seidu *et al*. (2006) examined the farm specific technical efficiency of small-scale rice farmers in the upper East region of Ghana, during the cropping year 2002 to 2003. The farm specific technical efficiency was estimated using the stochastic production function and the maximum likelihood estimation method. The results showed that smallholder rice farmers were technically inefficient as they produce about 34% on an average, which was far below the maximum output. The most striking results were the significant difference between the mean technical efficiency for irrigators and non-irrigators, as well as male and female farmers. The availability of credit, family size and non-farm employment significantly determined the technical efficiency of smallholders.

Mushunje *et al.* (2006) examined the technical efficiency of the resettlement sector of the agricultural system in Zimbabwe. The stochastic frontier function model of the Cobb-Douglas type was used to determine the technical efficiency of a group of 44 cotton farmers from Mutanda resettlement scheme of Manicaland province. The results revealed some technical efficiency level of the sampled farmers that varied widely, ranging from 22% to 99%, with a mean value of 71%. The technically inefficiency effects were found to be significant at 25 percent level. Technical efficiency of cotton production decreased with improved family size and age of the household head, but increased with farm size and education level of the household head.

Igbekele *et al.* (2006) estimated empirically the technical efficiency of rural and urban small-scale farmers in Ondo State, Nigeria, using the stochastic frontier production function. The empirical results found that farmers from rural centres had relatively larger farms while urban farmers had better access to production inputs, especially fertilizer. However, rural farmers with a mean technical efficiency of 0.66% were found to be more technically efficient than urban farmers whose mean technical efficiency was 0.57%. The results of the study also revealed that the level of education, farming experience and land were found to have negative effects on technical inefficiency of both rural and urban farms. The marginal effect of inefficiency variables was, however, found to be highest for education among rural and urban farms.

According to the results from the study of Bakhsh *et al*. (2007) factors such as irrigation, labour and locations contributes towards higher yield whereas fertilizer contributes negatively to yield in the production process. The authors used Cobb-Douglas production function to determine technical efficiency among bitter gourd growers. The results of the study indicated an average technical efficiency of 60 percent, designating a great potential to increase bitter gourd yield with the use of available resources and technology. On the other hand, the Inefficiency effect model showed that age of bitter gourd growers was positively related to technical inefficiency while family size, fertilizer and plant protection measures were found decreasing technical inefficiency.

According to Idiong (2007) the productivity of rice farmers can be raised by either one or both of the following factors: adoption of improved production technologies and improvement in efficiency. A stochastic frontier function that incorporated inefficiency factors was estimated using a maximum likelihood technique to provide approximations of technical efficiency and its determinants using data obtained from 112 small-scale swamp rice farmers in Cross River State.

The results revealed that rice farmers were not fully technically efficient. The mean efficiency obtained was 77% indicating that there was a 23% allowance for improving efficiency. The results also indicated that farmer's educational level, membership in cooperatives or farmer associations and access to credit facilities significantly influenced the farmer's efficiency positively.

Nchare (2007) analysed the factors influencing the technical efficiency of Arabica coffee farmers in Cameroon. To carry out the analysis, a translog stochastic production frontier function, in which technical inefficiency effects were specified to be functions of socio-economic variables, was estimated using the maximum likelihood method. The empirical results of the study showed some increasing returns to scale in coffee production. The mean technical efficiency index was estimated at 0.896% and 32% of the farmers surveyed had technical efficiency indexes of less than 0.91%. The analysis also revealed that educational level of the farmers and access to credit facilities were the major socio-economic variables influencing the farmer's technical efficiency.

Shehu and Mshelia (2007) investigated the productivity and technical efficiency of small-scale farmers in Adamawa State, Nigeria, using the stochastic frontier production function. Primary data was collected using interview schedules administered to a sample of 180 rice farmers selected using multi-stage random sampling techniques. The empirical results indicated that the farmers were operating in the irrational stage of production (stageI) as depicted by the returns to scale of 1.06%. The predicted technical efficiencies for the farmers ranged from 74% to 98.9% with a mean of 95.7%. The study suggested that improved farmers' education level through adult education and literacy campaign as well as regulating household size by highlighting the need for family planning would probably lead to improvement in technical efficiency in the long term.

Shehu *et al.* (2007) used the stochastic frontier production function to investigate the technical efficiency and its determinants for small-scale rain-fed upland rice farmers in North West agricultural zone of Adamawa State, Nigeria. The empirical results indicated that more than 88% of the sampled farmers were found to be more than 80% technically efficient. It was also found that farming experience, household size and level of educational attainment reduces technical inefficiency while on the other hand, farmers' age enhance technical inefficiency.

Goksel (2008) determined the extent to which conventional dummy variables such as age, education and experience can explain efficiency level. Logistic regression model in agricultural enterprises was used to analyze data. It was found that conventional dummy variables such as age, education and experience were not significant. What was found to be significant in explaining efficiency level in the case study, however, was the type of enterprise for all efficiency levels and scale of enterprise for total efficiency levels.

Kiribige (2008) estimated technical efficiency and allocative efficiency of farmers belonging to Agricultural Productivity Enhancement Program (APEP) and identified the determinants of technical efficiency among them as well as Non-APEP maize farmers in three selected sub countries of Masindi District i.e. Kigumba, Pakanyi and Miria. The study revealed the elasticity of land used in maize production by APEP farmers being greater than one and thus elastic. There were 62% APEP and 53% Non-APEP farmers found to operate at a level of 60% and above in technical efficiency.

It was also revealed that 31% of Non-APEP farmers were technically inefficient and operating at less than 40% of technical efficiency while only 21% of APEP farmers were operating at the same level of technical efficiency. Allocative efficiency was estimated for both APEP and Non-APEP farmers. APEP farmers were allocating more efficiently seeds input than all inputs used whereas Non-APEP farmers were allocating inefficiently all inputs (labour, animal draught power and seed input).

The technical efficiency of small-scale farmers is influenced by many variables e.g the level of education, access to credit, farm size, extension contact, age and family size. Seidu (2008) examined the level of farm-specific technical efficiency of farmers growing irrigated and non-irrigated rice in Northern Ghana. The study fitted cross-sectional data into a transcendental logarithmic (translog) production frontier. The results of the study revealed the mean technical efficiencies for non-irrigators being 53% and irrigators 51%. In conclusion, rice farmers were technically inefficient and it was also recommended that providing farmers with both formal and informal education will be a useful investment and a good mechanism for improving efficiency in rice farming.

Speelman *et al.* (2008) analysed the efficiency with which water was used in small-scale irrigation schemes in the North-West Province of South Africa and studied its determinants. The study used Data Envelopment Analysis techniques to compute farm-level technical efficiency measures and sub-vector efficiencies for water use. The results revealed that under Constant Returns to Scale (CRS) and Variable Returns to Scale (VRS) specification, substantial technical inefficiencies, of 49% and 16% respectively, existed among farmers.

Furthermore, the Tobit regression technique was used to examine the relationship between sub-vector efficiency for water and various farmers' characteristics. The variables that showed a significant impact were farm size, land ownership, fragmentation, the type of irrigation scheme, crop choice and the irrigation methods applied also bared a significant impact.

Ekunwe and Emokaro (2009) applied the stochastic frontier production function to analyse the technical efficiency of catfish farmers in Nigeria. The results of the study reflected a negative relationship between the technical efficiency and the variables gender of the household head, household size and education level while experience of farming and age of the famer were found to be positively related to technical efficiency. The results also revealed the return to scale of 0.66 which gives an indication that those farmers operates in stage two of catfish production in the study area.

Ironkwe *et al.* (2009) examined the relative technical efficiency and its determinants on gender basis in cassava production in Enugu state, Nigeria. The study used the stochastic frontier production function to analyse data. Household size, educational status, farming experience, land ownership, farm size, marital status and extension contact were found to be positively and significantly related to the technical efficiency of both male and female farmers whereas age was negative but significantly related to their technical efficiency.

Dlamini *et al.* (2010) used the stochastic production frontier function model of the Cobb-Douglas type to incorporate a model for the technical inefficiency effects. The results of the study revealed that small-scale sugarcane farmers in Swaziland over-utilized land. Appropriate land utilization could increase the sugarcane production. Furthermore the results showed that technical inefficiency decreased with increased farm size, education and age of the sugarcane farmer. An increase was noted when small-scale sugarcane farmers engaged in off-farm income earning activities.

Baloyi *et al.* (2011) used Cobb-Douglas production function to determine the level of technical efficiency and Logistic regression model to analyse the variables that influence the technical efficiency of maize production, in Ga-Mothiba rural community of Limpopo Province. The author revealed that small-scale farmers experience technical inefficiency due to the decreasing returns to scale. The Logistic regression results indicated that the level of education, income of the household on monthly basis, farming experience, farm size, cost of tractor hours, fertiliser application, purchased hybrid maize seeds, membership to farmers' organisations were the factors found to be significant. Gender, age and hired labour were non-significant.

Chang and Wen (2011) investigated the differences in yield production, production efficiency and yield risk for farmers both with and without off-farm work. The study applied the stochastic production frontier models that accommodate technical inefficiency and production risk simultaneously to estimate the results. The empirical results indicated that these two groups of farmers used resources in different ways and off-farm work was not necessarily associated with lower technical efficiency. Farmers with off-farm work were more efficient than their counterparts without off-farm work.

Khan *et al.* (2011) examined the technical efficiency of rice farmers and inefficiency factors that affect production. The paper has employed stochastic production frontier approach to estimate technical efficiency and its determinants for Boro and Aman rice. Results of the study reflected that the mean technical efficiency of the Boro (95%) and Aman (91%) rice farmers was highly satisfactory. Farm size, human labour, pesticide, irrigation and power tiller were important factors for production of Boro and Aman rice. Younger farmers were more efficient than the elder ones.

The study conducted by Kyei *et al.* (2011) shows that the age of a farmer was observed as an important variable that affect the technical efficiency of cocoa farmers in Ghana. The author used the stochastic production frontier function and the inefficiency determinants based on socio-economic variables of individual farmers to analyse data.

Oyewo (2011) estimated the technical efficiency of maize producing-farmers in Oyo State, Nigeria and further examined the factors that determine the difference in efficiency index. The inferential statistics stochastic frontier production model was used in the analysis to determine the relationship between the maize output and the level of input used in the study area. The empirical results revealed that farm size and seed were statistically significant at 10% and 1% level respectively in the study area.

Simonyan *et al.* (2011) examined the relative technical efficiency and its determinants on gender basis in maize production in Essien Udim Local Government area of Akwa Ibom State of Nigeria. The study used descriptive tools and the stochastic frontier production function to analyse the data. The results of the study revealed an estimation farm level technical efficiency of 93% and 98% respectively for both male and female farmers. The estimated production function results revealed that farm size, household size and access to credit was the most important variable that positively influenced both male and female farmers in the study area.

Ngeno *et al.* (2012) examined the efficiency of different categories of maize farmers using the survey data obtained from a sample of 540 farmers who were selected randomly. Data were analysed using the stochastic frontier and data envelopment analysis. Considering the performance of different categories of farmers, the results showed the mean technical efficiency of 95%, 83% and 80% for large, medium and small-scale farmers, respectively.

Oladeebo and Oluwaranti (2012) used the analysis technique of the descriptive statistics to explain the socio-economic characteristics of the cassava producers and stochastic frontier profit function to estimate profit efficiency of cassava producers in the study area. Result of the analysis showed that the profit efficiencies of the farmers ranged between 20% and 91%. The study further indicated that household size and farm size were the major significant factors which influenced profit efficiency positively.

2.3 Review of previous studies on allocative efficiency

Using the production function approach, Inonio (2007) examined the efficiency of resource utilisation in pond fish production in Delta State, Nigeria. Data for the study were obtained from a cross section of 72 farms using a multi-stage sampling procedure. Regression results indicated that pond size, feeds, fingerlings, and labour were significant determinants of output in pond fish production. The index of resource-use efficiency revealed that fish farmers were not only inefficient in the allocation of productive resources, but grossly over-utilised feeds, fingerlings, fixed costs and labour with an allocative efficiency index of 0.0025, 0.00064, –0.00017, and 0.00025 respectively. Pond size was however, under-utilised with an allocative efficiency index of 3.22.

According to Henderson and Kingwell (2002) Greater gains in profitability are possible by improving allocative rather than technical efficiency because technically efficient farms are not necessarily allocatively efficient. The authors analysed the technical and allocative efficiency of broad acre farmers in a southern region of Western Australia over a three-year period. Applying Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA) the results revealed some inefficiency in each year, which decreased over time. The empirical results also confirmed that farmers' education level and farmers' age positively influenced technical efficiency.

Sauer and Mendoza (2007) investigated the well known 'poor-but-efficient' hypothesis formulated by Schultz (1964) assuming that small-scale farmers in developing countries were reasonably efficient in allocating their scarce resources by responding positively to price incentives. Contrary to Schultz's findings, it was assumed that scale effects explain a considerable proportion of small-scale farmers' relative efficiency.

The discussion on theoretical consistency and functional flexibility was considered by imposing convexity on the Generalized Leontief (GL) profit framework. The empirical results confirm the revised hypothesis that purports that small-scale farmers in traditional development settings are 'poor-but-allocatively efficient' by clearly suggesting considerable inefficiency with respect to the scale of operations.

Kareem *et al.* (2008) carried out a study that investigated the costs and returns analysis of respondents in Ogun State. Stochastic frontiers production analysis was applied to estimate the technical, allocative and economic efficiency among the fish farmers using concrete and earthen pond systems in the state. The allocative efficiency results revealed that concrete pond system was 79% while earthen pond was 85%. Stochastic frontier production function models indicated that pond area, quantity of lime used and the number of labour used were significant factors that contributed to efficiency of concrete pond system. Quantity of feed and labour were the significant factors in earthen pond system.

Ogundari (2008) analysed the resource-productivity, technical efficiency and allocative efficiency of rain fed rice farmers in Nigeria. The results of the parameters that entered the production function showed that herbicide had the highest elasticities, then seeds, followed by fertilizer, land, and labour with the least contribution to output.

Similarly, the results for the allocative efficiency based on the marginal value product MVPx=Px showed that none of the respondents optimally allocated the inputs, though, a greater number of the respondents were found to under utilise variables such as land, seeds, fertilizer and herbicide (MVPx<Px) while a greater number of the farmers over utilised labour (MVPx >Px). However, in both cases, it was revealed that the use of more labour decreased the rice production from the study area faster than any of the selected variables. Extension contact and access to credit were found to be significant determinants of technical efficiency among the farmers.

According to Bifarin *et al*. (2010) efficiency is a very important factor for productivity growth. In an economy where resources are scarce and opportunity to use new technologies are limited, inefficiency studies indicated the possibility of raising productivity by improving efficiency without necessarily developing new technologies or increasing the resource base. The study determined the technical, allocative and economic efficiency of plantain *(Musa spp.)* farmers in Ondo State, Nigeria. Data were analyzed using the stochastic parametric technique. The findings indicated technical efficiency indices that varied from 20% to 87% with a mean of 61%, allocative efficiency varied from 14% to 83%, with a mean of 57% and economic efficiency varied from 3% to 67% with a mean of 35%.

The study of Mahdi *et al.* (2010) revealed that farm size, age of the household head, the number of year of schooling, and the type of irrigation scheme, crop choice and the irrigation methods applied showed a significant impact on the sub-vector efficiency for water.

According to Obare *et al.* (2010) Irish potato production in Kenya has been on the decline, yet a potato is a major staple and a source of cash from sales. Using the dual stochastic efficiency decomposition technique and a two-limit Tobit model, the paper established that Irish potato production in Nyandarua North district was characterized by decreasing returns to scale with a mean allocative efficiency of 0.57%. It was further established that farming experience, access to extension and credit, together with membership in a farmers' association positively and significantly influenced allocative efficiency.

Lee and Tyler (1978) have estimated stochastic frontiers and predicted farm level efficiencies using these estimated functions and then regressed the predicted efficiencies upon firm-specific variables such as managerial experience, ownership characteristics etc. in an attempt to identify some of the reasons for differences in predicted efficiencies between firms in an industry.

Ugwumba (2010) used the parametric and non-parametric statistics to investigate the allocative efficiency of 'egusi' melon production inputs in Owerri West Local Government Area of Imo State, Nigeria. The results of data analysis showed household size, cost of inputs and farm size as significant determinants of production output. Production output was also positively influenced by land, labour (family and hired), and fertilizer, capital and seed inputs. More so, computed allocative efficiency values showed that land (1.14), fertilizer (17.44) and seed (1.76) inputs were underutilized while family labour (0.64), hired labour (0.08) and capital (0.83) inputs were over utilized.

Asogwa *et al.* (2011) used the stochastic frontier models to analyze technical and allocative efficiency of Nigerian rural farmers. The study showed that technical and allocative efficiency in farm production among the farmers could be increased by 68 and 65 percent, respectively, through better use of available resources. This could be achieved through improved farmer-specific factors which include improved farmer education, improved farmer experience, attraction of young and male farmers into farm productions.

According to Chiona (2011) smallholder maize farmers in Zambia experience very low levels of technical and allocative efficiency. The average technical efficiency stood at 15% with only 0.23% of the farmers being efficient while allocative efficiency stood at 12% with only 0.27% of the farmers being efficient. The results also revealed that the use of hybrid seed, farm size, household size, access to extension services and education attainment of the household head were significant determinants of economic efficiency.

Ike and Udeh (2011) examined the relative allocative efficiencies in input use by credit user and non credit user small-scale poultry farmers in Delta State, Nigeria. Relative elasticities of production and returns to scale of the mentioned poultry farmers were examined. A stochastic frontier production function model was used to analyse the data. The findings indicated that none of the poultry farmer groups allocated any production input optimally. The credit user poultry farmers were found to over utilize hired labour, family labour and under utilized feed input as well as veterinary services. The non credit user farmers over utilized three inputs namely; hired labour, family labour and capital and under utilized feed input.

Nwaru *et al.* (2011) also confirmed that household size, access to credit, membership to cooperatives and farming experience are the variables positively and significantly related to allocative efficiency. The coefficients for farm size and gender were negatively signed indicating that female farmers were more allocatively efficient than their male counterparts. The analyses were done within the framework of stochastic frontier function of primary data from a random sample of 120 farmers.

Laha and Kuri (2011) measured allocative efficiency and its determinants in agriculture practiced in West Bengal by implementing the cost minimization principle using Data Envelopment Analysis. The variable that was found to paly a significant role in influencing allocative efficiency was the choice of tenurial contracts. Among the tenurial contracts, fixed rent tenancy was observed to be the most efficient mode of cultivation. The household head's level of education, operated land, inter-linkage of factor markets and availability of credit facilities were some of the other factors which were found to have significant bearing on the level of allocative efficiency in West Bengal agriculture.

Zahidul *et al.* (2011) examined the technical, economic and allocative efficiency of agricultural microfinance borrowers and non-borrowers in rice farming in Bangladesh using Data Envelopment Analysis of survey data obtained in 2009. Inefficiency effects were modelled as a function of farm–specific and institutional variables. The mean technical, allocative, and economic efficiencies were found to be 72%, 66%, and 47% respectively in the pooled sample under variable returns to scale specification.

2.4 Summary of the literature review

Previous studies investigated the technical and allocative efficiency of small-scale farmers using the Cobb-Douglas production function and the stochastic frontier production function model. The studies were done on various commodities e.g. maize, wheat, cotton, etc. The literature reviewed indicated different mean technical efficiencies of the farmers on different study areas. The factors affecting the technical and allocative efficiency of farmers were revealed in the literature review.

CHAPTER THREE

AGRICULTURAL SECTOR IN SOUTH AFRICA

3.1 Introduction

This chapter presents a brief description of the agricultural sector in South Africa. It describes the study area and the agricultural sector within the study area.

3.2 Agricultural sector in South Africa

South Africa comprises of a dual agricultural economy: a well-developed commercial sector and a predominantly subsistence sector. About 12% of the country can be used for crop production. The country has a high potential arable land of 22% and approximately 1.3 million hectares under irrigation. An agricultural activity ranges from intensive crop production and mixed farming. (DoA, 2007).

South Africa is divided into a number of farming regions according to climate, natural vegetation, soil type and farming practices. The unavailability of water was found to be the most important factor limiting agricultural production in the country. Rainfall is distributed unevenly across the country with almost 50% of water being used for agricultural purposes (Aliber, 2003). One of the largest agricultural industries in South Africa is the grain industry which produces between 25% and 33% of the country’s total gross agricultural production.

Primary agriculture contributes about 3% to South Africa’s gross domestic product (GDP) and about 7% to formal employment. However, there are strong linkages into the economy such that the agro-industrial sector comprises about 12% of GDP. For the past five years, agricultural exports had contributed on average about 6.5% of total South African exports, maize being among the exported products (DoA, 2003).

3.3 Description of the crop selected by the study

Maize is classified as the largest locally produced field crop and the most important source of carbohydrates in the Southern African region. More than 9000 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. The local consumption of maize amounts to about 8mt and the surplus are exported to different countries (DoA, 2007).

Maize is produced mainly in North West Province, Free State, Mpumalanga Highveld and KwaZulu-Natal Midlands. 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, 82% was white maize and 18% yellow maize. During the same period, Mpumalanga produced 20% of the total commercial maize production whose 25% was white maize and 48% yellow maize (Baloyi *et al.* 2011).

3.4 Small-scale farmers in South Africa

Small-scale agriculture is regarded as the production of crops and livestock on a small piece of land without using advanced and expensive technologies. It can be argued that farming on family piece of land, on traditional lands and smallholdings on the periphery of urban areas falls in this category. This type of farming is usually characterised by intensive labour and in most cases, animal traction, limited use of agrochemicals and supply to the local or surrounding markets. Small-scale agriculture plays a dual role of being a source of household food security as well as income from sale of surplus. However, some claim that small-scale agriculture is less efficient in output as compared to commercial agriculture (Kirsten and Van Zyl, 1998).

According to DoA (2003) the small-scale agriculture enhances local economic development as it is a source of employment and keeps most of the income circulating locally as the market is predominantly localised. The small-scale agriculture plays an important role by feeding the household thereby contributing to food security. Despite this importance, small-scale farming is slowly becoming less practised due to a number of factors such as reliance on limited technical and financial support, indifference among the youth to farming, government policies that are in most cases not area-specific and reliance on other livelihood sources such as formal employment and social grants. The other problem is that agricultural technological institutions have been sidelined in the agrarian agenda. Therefore, they are not making a meaningful impact in the sector.

Lipton *et al.* (1996) found that small-scale farming has increased employment and generate income in many other developing countries. In middle-income countries with economic and labour profiles similar to those of South Africa, agriculture accounts for 15% of the GDP and employs 25% of the labour force. South African agriculture is only a marginal force in the economy, accounting for 5% of the GDP and employing only 14% of labour.

According to DAFF report (2011) the Department of Agriculture, Forestry and Fisheries (DAFF) aims to increase its support to new and existing small-scale farmers, working in close collaboration with the provinces to achieve its targets. In the 2011/12 financial year, 15 000 small-scale farmers were targeted. A grant of over R1 billion was allocated to the nine provinces. The Comprehensive Agricultural Support Programme (CASP) has been reprioritised to respond timeously to the demands of the Land and Agrarian Reform Project (LARP). The LARP is aimed at accelerating and aligning land and agrarian reform in South Africa.

3.5 Description of the study area

The study on technical and allocative efficiency of small-scale maize farmers was conducted in Tzaneen municipality, Mopani district of Limpopo province. The Limpopo province is situated in the Northern part of South Africa. It is adjacent to the North West province, Gauteng and Mpumalanga province and shares boarders with Botswana, Zimbabwe and Mozambique. The province covers an area of 12.3 million hectares accounting for 10.2 percent of the country's total surface area. This is proportionally the largest rural population in the country; its capital city is Polokwane, formerly called Pietersburg (GTEDA, 2010).

Limpopo Province was formed from the northern region of the Transvaal Province in 1994 and initially named Northern Province, which was remained the name until June 2003, when the name of the province was formally changed to the name of its most important river on the border with Zimbabwe and Botswana after deliberation by the provincial government. The Limpopo Province is known as the second poorest province in South Africa. It is divided into five districts, namely, Mopani, Capricorn, Sekhukhune, Vhembe and Waterberg districts, (GTEDA, 2010). The study used data from Mopani district which is located in the North-Eastern part of the Limpopo Province

According to Mchau (2002) the province has a few high potential areas for dry land crop production and many opportunities for extensive ranching and irrigated fruit and crop production. The province has an area of about 13,8 million ha, 10% being arable, natural grazing (veld) accounts for another 67%, with forestry at 0.9% and a total of 12.7 is unclassified and includes land unsuitable for agriculture.

The dry lands in the West and North of the Province are principally set aside for extensive livestock farming and game ranching with some cropping and mixed farming enterprises in the better areas. More intensive commercial field crop farming is mainly confined to the South Central Plains. The Northeast is characterized by subsistence farming. Susceptibility to drought and the scarcity of water pose a threat to stability and future development of agriculture in the province. Agriculture, nonetheless, remains vital for the future well being of the economy of the Limpopo Province (Mchau, 2002).

3.5.1 Limpopo Province

According to a report by Stats SA (2002) the Limpopo Province is known as the largest producer of vegetables. The province's production of vegetables contributes an average of approximately 22% to the gross income from agriculture and more or less 18% to the total gross income of vegetables in South Africa. A survey of large and small-scale agriculture indicated an estimation of 245 000 fruit farming and 349 000 vegetable crops operating in South Africa. Of these 138 000 fruit farms operations of 56.3% and 87 000 vegetable crops operations of 24% were found in the Limpopo Province. The production of vegetables was the most prominent with an average of 49.1% followed by citrus fruits with 25.9% and subtropical fruits with 15.5%.

The production of citrus and subtropical fruit contributed about 64% to the gross income from citrus and subtropical fruit in South Africa and the production of tea contributed 21%. Different vegetables are grown in small homes garden e.g. tomatoes, pumpkins, watermelons, beetroot, carrots and maize. Some households have some fruit tress like mangoes, peach, citrus and banana. Home gardens in Limpopo province can contribute up to 20% of horticultural production (Stats SA Report, 2002).

Agricultural contribution to the gross domestic products (GDP) varied between 1% in some magisterial districts and 30% in others over the past five years. In the Northern district, Musina was the largest contributor, followed by Letaba Municipality. In Phalaborwa, Ellisras, Thabazimbi, Warmbaths, Thohoyandou and Giyani agriculture's contribution to the GDP has been less than 10% (Mchau, 2002).

With regard to agricultural activities, Limpopo Province is somewhat competitive in its production. Large quantities of fruit and vegetables are exported from the province. Any kind of subtropical fruit flourishes in the eastern half of the province. There are numerous fields of avocados, mangos, paw-paws, litchis and tomatoes. Cotton and potatoes are also major products while citrus and tea plantations are common in the central and northern areas. Livestock rearing and hunting are practiced in the drier western and northern regions. Several livestock farms have been converted to private game farms in recent years, mirroring a national trend (Young, 2007).

The Limpopo Provincial Government is keen to develop the manufacturing capacity of the province. The aim is to create value within Limpopo and also curb the challenge of unemployment. Limpopo has one of the highest levels of poverty within South Africa. Although Limpopo has several agro-processing businesses, the prominent ones being Pioneer Foods, McCain, Granor Passi, Kanhym, Westfalia and Enterprise Foods, this sector still has enormous potential to grow. Limpopo Employment Growth and Development Plan (LEGDP) places as top priority value-added processing and manufacturing. The key sectors where Limpopo has a competitive advantage are mining, agriculture, agro-processing and tourism. It is in these sectors that the focus of promoting value addition lies (Young, 2007).

According to Mchau (2002) farmers in Limpopo Province can be classified into four main groups; commercial, progressive, small-scale and resource-poor. Over 60% of the farmers have been placed in the last category with the majority being females. Another 28% are described as small-scale while less than 1% is listed under large-scale commercial farmers. About 8% of the total number of farmers is viewed as progressive. This means about 90% are either resource-poor or small-scale farmers.

Small-scale farmers grow mostly cereals; the commercial sector concentrates on intensive cash crops or extensive livestock. The commercial farming systems in the province may broadly be described in the following: Extensive livestock farming with game ranching, and some with vegetable growing in the low rainfall areas, vegetable growing with certain fruit crops in either the high rainfall areas or supported by irrigation from a river system. In the Limpopo basin some farmers grow vegetables with field crops such as wheat, soya beans and cotton while others grow avocado, macadamia, litchi, mango in a small area of land with an intermediate rainfall (Mchau, 2002).

Limpopo Province is the second-largest producer of potatoes in the country, accounting for 19% of South Africa's total production. The province is also one of the country's largest guava, banana, papaya and tea producers. The province is home to the largest cotton fields and biggest ginnery as it produces the highest quality in South Africa. Agriculture has also stimulated the ancillary development of a growing range of processed products, such as fruit juice and concentrates. Considerable success lies in the areas of processing and packaging, as well as the exportation of beef, pork, chicken, eggs, fruit and vegetables. The province therefore avails jobs opportunities in the fruit and vegetables processing and packaging industry. There is also potential for additional production of sunflower, soya beans and maize under dry-land conditions (Mchau, 2002).

Large and small-scale farmers in Limpopo province are joining the movement to eliminate or reduce chemical fertilizers and pesticides in the cultivation of their crops through the introduction of organic farming in the province. Organic farming is emerging as a potentially lucrative new industry in Limpopo, spurred by floating demand for chemical-free products. The Limpopo Export Advisory Committee (LEAC) is placing special emphasis on promoting organic products, and has already sponsored local farmers to attend major exhibitions in South Africa and Germany as observers. The market for organic goods has grown considerably. Woolworths, for example, said that since it introduced organic produce in 2001, sales of these products have on average increased by 75% each year (Mchau, 2002).

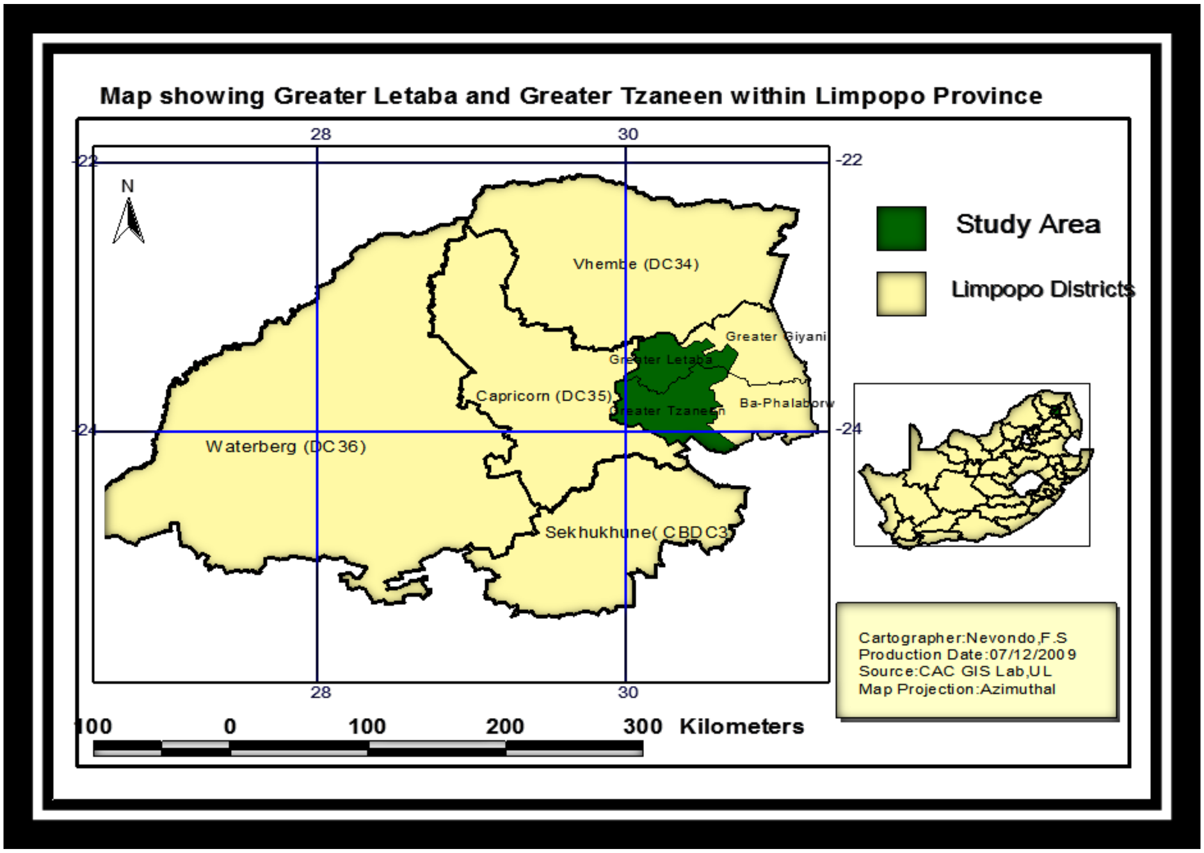

Figure 3.1: Map of the study area (Greater Tzaneen Municipality)

3.5.2 Mopani district municipality

Mopani district of Limpopo province lies in the heart of South Africa's lowveld, a region renowned for its unspoilt bush and abundant game. It is the most famous of all wildlife destinations in South Africa. It is the home of the iconic baobab tree, the great Olifants River Valley and the world famous Kruger National Park. It is unmistakably bushveld and features dozens of different wild life experiences. Its position seems strategic as it is easily accessible to people from any part of the province. On the west it borders Sekhukhune district, on the western side is Capricorn district, the beautiful towns of Tzaneen, Modjadji 'skloof, Phalaborwa and Giyani are key to the economy of Mopani. The district consists of the following local municipalities: Greater Letaba, Greater Tzaneen, Greater Giyani and Ba-Phalaborwa (Mopani District Report, 2007).

Giyani Municipality is the administrative capital of the district and is key to the local economy; the public sector is one of the largest employers in the district. The key sectors in Mopani district are agriculture and mining. Mopani has an established food manufacturing industry in canned, preserved and dried fruit production and vegetable juices. Mopani borders the Kruger National Park and the tourism sector offers many opportunities (Mopani District Report, 2007).

3.5.3 Tzaneen municipality

The Tzaneen Municipality is situated in the eastern quadrant of Limpopo Province. The area encompasses the towns of Tzaneen, Nkowankowa, Lenyenye, Letsitele and Haenertsburg and includes 125 rural villages, concentrated mainly in the South-east and North-west. Almost 80% of households reside in the rural villages. The municipality stretches from Haenertsburg in the West to Rubber vale in the East and from Trichardtsdal in the South to just South of Modjadjiskloof in the North. Almost two thirds of land is privately owned and used mainly for commercial farming; one third is under the custodianship of tribal authorities and a negligible amount is municipal commonage, a situation that complicates development planning (Mopani District Report, 2007).

While the municipality with its wealth of natural attractiveness and resources (rivers and streams, dams, indigenous forests, citrus plantations and tourist attractions) has tremendous potential for development, the performance of the trade sector (wholesale, retail, catering and accommodation) has tended to show sluggish growth rates. There are indications that the tourism sector has grown considerably but tourism demand is still well below what could be expected from an area with such outstanding natural potential. The municipality is currently engaged in developing the tourism sector and has established a tourism centre to provide information about tourism attractions (GTEDA, 2010).

According to GTEDA (2010), the area consists of naturally evergreen mountains and forests, the ZZ2 Tomato Empire and of course the Modjadji nature reserve where the cycad plants are found in abundance. The land of Modjadji the rain queen is an impressive setting of ancient baobab trees, untouched bushveld, mountain ranges and an abundance of wild creatures.

The Tzaneen municipality is a subtropical area filled with indigenous and exotic plants. The area lies at the foot of the Northern Drakensberg Mountain in the heart of a forestry area and in South Africa’s richest sub-tropical fruit farming region. The valley of Tzaneen yields Valencia oranges and grapefruit such as star ruby. Macadamia nuts are also a common crop in the area, with the town producing the majority of the country’s mangoes, bananas, avocados, pears, paw-paws, tea and coffee. The Tzaneen Municipality also contributes substantially to the total production of timber, citrus and litchis. The surrounding mountain slopes are heavily forested with pine and blue gum plantations and close on forty sawmills operate in the area.

The Letsitele area is also found in Tzaneen Municipality, the name Letsitele is derived from the name of the Letsitele River. Agricultural development in the area started in 1914. The Letaba River is the main source of water to the area and most of the agricultural development is dependent on it. The Letsitele farming community represents the largest citrus production in the country, high quality Valencia oranges and the best quality Taxes Star Ruby grapefruit in the world are produced in Letsitele (Mchau, 2002).

A big fruit juice factory adds additional values to the area's produce, a variety of vegetables are also produced around Letsitele. The Tzaneen Municipality is well endowed with natural resources necessary for economic growth, with fertile land, abundant water supplies and sub-tropical climate. The local economy is diversified with the service sector contributing approximately 26% to the Gross Geographic Product (GGP), agriculture 21%, manufacturing 20%, trade and catering 14% (Mchau, 2002).

3.6 Summary of the Agricultural sector

This is a brief summary of the agricultural sector in South Africa, the agriculture in Limpopo province and the study area. Agricultural sector comprise of well-developed commercial sector and a predominantly subsistence sector. About 12% of the country can be used for crop production as it is arable. The largest agricultural industry in South Africa is grain. The country consists mainly of the small-scale crop producers and livestock farming on a very small piece of land without advanced technologies.

The Limpopo Province consists mainly by the small-scale farmers, whom contribute to South Africa's GDP. The most commonly produced crop in Limpopo province is maize, the most source of carbohydrates and it is used for consumption purpose to ensure food security in the household. The province is known as the largest producer of vegetables and fruits. It is known as the second-largest producer of potatoes in the country. Farmers in Limpopo province are classified into commercial, progressive, small-scale and resource poor.

The study was conducted in Tzaneen municipality of Mopani district. The area is subtropical with indigenous and exotic plants. Macadamia nuts, maize, mangoes, litchis, bananas, etc are produced in this area. Tzaneen municipality is endowed with natural resources and fertile land. The area consists of few rivers e.g. Letaba River which is the main source of water and the farmers entirely depend on it for irrigation purpose.

CHAPTER FOUR

RESEARCH METHODOLOGY

4.1 Introduction

This chapter provides the description of the analytical techniques employed in the study and the data set. The analytical techniques consist of the Cobb-Douglas production function and the logistic regression model. It describes in detail the variables that are considered to analyse the technical and allocative efficiency of small-scale maize farmers in Tzaneen municipality. The data set consists of the data collection, questionnaire design and the interview procedure. The detailed description of the two models and the data set is explained below.

4.2 Cobb-Douglas production function

In economics, the Cobb–Douglas production function is widely used to represent the relationship of output and two inputs. The Cobb-Douglas form was developed and tested against statistical evidence by Charles Cobb and Paul Douglas during 1900–1947. The Cobb-Douglas production function was used to estimate the efficiency level of farmers

The empirical estimation of efficiency is normally done with the methodology of the Cobb-Douglas production function. The model has the advantage of allowing simultaneous estimation of the farmers as well as the determinants of technical efficiency (Battese and Coelli, 1992). The measures of technical efficiency provide an indication of the potential gains in output if inefficiencies in production were to be eliminated.

Efficiency is an important economic concept and is very important in assessing a producer's performance. Measuring efficiency and productivity could explore hypotheses concerning the sources of efficiency or productivity differentials. Identification of sources is essential to the institution of public and private policies designed to improve performance (Lee and Tyler, 1978).

General consideration

A number of variables are known to affect agricultural production. As a result it was very important to employ model which relate production of farmers to these variables for better understanding of the functional relationships. A production function relating output to input was adopted by this study. The Cobb-Douglas production function was used to analyse the variables that have effect on maize production, this analytical technique was used to determine the technical efficiency of small-scale maize farmers in Tzaneen municipality of Mopani distrct.

The most general expression of the Cobb-Douglas production function is,

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

Where Y stands for output, L measures labour input and K measures capital input, A is the constant that represent the technology of the society that generated the observations upon which the parameters of the function were to be estimated. Parameter (A) might also be thought of as the combined impact of inputs that are considered to be fixed on the production function. α and β are the output elasticities of labour and capital, respectively. These values are constants determined by available technology.

Two important properties of Cobb-Douglas production function (Coudere and Marijse, 1991) are; α and β are elasticities of production with respect to labour and capital

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

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

Output elasticity measures the responsiveness of output to a change in levels of either labour or capital used in production, ceteris paribus. For example if α = 0.15, a 1% increase in labour would lead to approximately a 0.15% increase in output.

Further, if: α + β = 1, the production function has constant returns to scale: Doubling capital K and labour L will also double output Y. If α + β < 1, returns to scale are decreasing, and if α + β > 1, returns to scale are increasing. Assuming perfect competition and α + β = 1, α and β can be shown to be labour and capital's share of output.

The Cobb-Douglas production function has a number of limitations. The major criticism of the Cobb-Douglas function is that it cannot represent the three stages of neo-classical production function. It represents one stage at a time. In addition, the elasticity of production for the Cobb-Douglas type of production function is constant, irrespective of the amounts of each input that are used. The Cobb-Douglas production has a limited effect on empirical efficiency measurement.

The Cobb-Douglas production function was not developed on the basis of any knowledge of engineering, technology, or management of the production process. It was instead developed because it had attractive mathematical characteristics, such as diminishing marginal returns to either factor of production and the property that expenditure on any given input is a constant fraction of total cost. Crucially, there are no micro foundations for it (Coudere and Marijse, 1991).

Despite its well-known limitations, Cobb-Douglas production function possess advantages, these advantages are due to the fact that it can handle multiple inputs in its generalized form. Unconstrained Cobb-Douglas function further increases its potential to handle different scales of production. The Cobb-Douglas function was chosen because of its ease of interpretation of returns to scale.

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

$Y = aX_1^{\beta 1}X_2^{\beta 2}X_3^{\beta 3}X_4^{\beta 4}X_5^{\beta 5}X_6^{\beta 6}u$

Where; Y = Total farm output of maize (in tons)

: X_1 = Land devoted (hectares)

:X_2 = Family and hired worker days used in production maize

(Man days)

:X_3 = Capital (tractor hours)

:X_4 = Fertilizer used (in kg)

:X_5 = Seed used (in kg)

:X_6 = Expenses on pesticides, irrigation water and chemicals (Rands)

:u = Disturbance term

:$\beta_{1,..........}\beta_6$ are elasticities to be estimated

and: a = Constant value

Model specification

In order to be able to use the Ordinary Least Squares procedure for estimating, the function is linearised using logarithm and gives the following regression specification:

$$Ln(Y) = ln(a)+ In\beta_1X_1 + In\beta_2X_2 +In\beta_3X_3 + In\beta_4X_4 + In\beta_5X_5 +In\beta_6X_6 + u$$

Where: Output (Y) is the total quantity of maize produced per season it is measured in kg per hectare.

Land (X_1) is the area of the farm(s) devoted to the production of maize. It is measured in hectares.

Labour (X_2) is the total of maize activity. It is expressed in adult equivalent days per hectare and is the sum of family labour and hired labour. Male and female labour is counted equally. Family members who do not spend most of their holidays on the farm are not considered.

As for capital (X_3) Coudere and Marijse (1991)'s argument was used. There is not much variation in the types of equipment these farmers possess. They all used tractors, to present capital, a tractor's hours are used.

Fertilizer (X_4) includes both basal and top dressing fertilizers. Although some farmers use animal manure, this has also been included as long as the farmer knows how many kilograms have been used (it is measured in kilograms).

Seed (X_5) both certified and home produced (recycled seeds) are considered and measured in kilograms.

Cost (X_6) estimated as amount of money invested in maize production, fertilizer and irrigation water expenses are included and measured in Rand.

4.3 Allocative efficiency analysis

According to Chukwuji *et al*. (2006) allocative efficiency analysis is done by estimating a Cobb-Douglas function using Ordinary Least Squares (OLS), followed by computing the value of marginal products (VMP) for each factor of production, which is then compared with the marginal input cost (MIC). Using the coefficient estimates from the analysis, the marginal product (MP) of the i^{th} factor

X is calculated as MP = $\frac{\partial y}{\partial xi}$ = $\beta \frac{Y}{Xi}$ but AP = $\frac{Y}{Xi}$

Where, Y is the geometrical mean of maize output (mean of natural logarithm), X_i is the geometrical mean of inputs, β_i is the OLS estimated coefficient of input. The value of the marginal product of input (VMP) can be obtained by multiplying marginal physical product (MP_i) by the price of output (P_y). Thus, allocative efficiency (AE) = $\frac{VMP}{Pi}$ but P_i = marginal cost of the i^{th} input.

According to Grazhdaninova and Lerman (2004) as cited by Kibirige (2008) allocative efficiency is determined by comparing the value of marginal product of input (VMP_i) with the marginal factor cost (MIC_i). Since farmers are price takers in the input market, the marginal cost of input i approximates the price of the factor i, P_{xi} Hence if $VMP_i > P_{xi}$, the input is underused and farm profit can be raised by increasing the use of this input. Conversely, if $VMP < P_{xi}$, the input is overused and to raise farm profits its use should be reduced. The point of allocative efficiency (maximum profit) is reached when $VMP_i = P_{xi}$.

4.4 The logistic regression model

The logistic regression model was used to estimate socio-economic factors affecting the efficiency of small-scale maize farmers in Tzaneen municipality. The model was chosen because its dependent variable is binary and can only take two values, it allows one to estimate the probability of a certain event occurring.

The operational logit model can be written as follows:

$$\text{Logit}(p) = \text{In}(p/1\text{-}p) = \alpha + \beta_1 X_1, + \ldots\ldots. + \beta_k X_k, U_i$$

The ratio p/1-p is the odds ratio

P_i = probability that a farmer is productive.

$1\text{-}P_i$ = probability that a farmer is not productive.

X_i = various independent variables.

β_i = estimated parameters.

U_i = disturbance term.

$$Ln(PRDT) = \beta_o + \beta_1 GENF + \beta_2 AGEF + \beta_3 FEDU + \beta_4 IRWA + \beta_5 FICM + \beta_6 FEXP + \beta_7 MPRD + \beta_8 FSIZ + \beta_9 HHS + \beta_{10} TRAC + \beta_{11} FERT + \beta_{12} PHSD + \beta_{13} EXTV + \beta_{14} CRDT + \beta_{15} OWNL + U_{i.}$$

According to Molepo *et al.* (2011), the likelihood ratio can be defined as the ratio of the likelihood of an event occurring in one group to the likelihood of it occurring in another group, or to a sample-based estimate of that ratio. These groups represent productive and non-productive farmers. If the probabilities of the event in each of the groups are p1 (first group) and p2 (second group) then the likelihood ratio is: where qx=1-px. The likelihood ratio of 1 (one) indicates that the condition or event under study is equally likely in both groups. The likelihood ratio greater than 1 (one) indicates that the condition or event is more likely in the first group, while the likelihood ratio less than 1 indicates that the condition or event is less likely in the first group. The likelihood ratio must be greater than or equal to zero (Molepo *et al*. 2011).

Table 4.1: Definition of variables

Variables	Description of variables	Units
	Dependent variable	
PRDT	1,if a farmer is productive, 0,otherwise	Dummy
	Independent variables	
GENF	1,if a farmer is a male, 0,otherwise	Dummy
AGEF	1, if the farmer is between 18 and 35 years, 0, if the farmer is 35 years and above	Dummy
FEDU	1,if the farmer has a formal education, 0, otherwise	Dummy
IRWA	1, if farmer has access to irrigation water, 0, otherwise	Dummy
FICM	1,if farmer receive off-farm income, 0, otherwise	Dummy
FEXP	1,if farmer has farming experience,0, otherwise	Dummy
MPRD	1, if farmer produces 400 kg of maize or less per hector, 0, if farmer produces more than 400 kg of maize per hector.	Dummy
FSIZ	Farm size	Ha
HHS	Family size	Number
TRAC	1,if farmer use tractors, 0, otherwise	Dummy
FERT	1,if farmer apply fertilizer, 0,otherwise	Dummy
PHSD	1,if farmer purchase hybrid seed, 0,otherwise	Dummy
EXTV	1,if farmer receive extension visits, 0, otherwise	Dummy
CRDT	1,if farmer have access to credit, 0, otherwise	Dummy
TPDW	1,if farmer own the land, 0, otherwise	Dummy

In statistics, the logistic regression model is a type of regression analysis used for predicting the outcome of a categorical (a variable that can take on a limited number of categories) criterion variable based on one or more predictor variables. The probabilities describing the possible outcome of a single trial are modelled as a function of explanatory variables, using a logistic function. The logistic regression model measures the relationship between a categorical dependent variable and usually a continuous independent variable by converting the dependent variable to probability scores (Hosmer and Lemeshow, 2000).

The logistic regression model can be binomial or multinomial. Binomial or binary logistic regression refers to the instance in which the observed outcome can have only two possible types (e.g. “yes” vs “no”). Regularly, the outcome is coded as “0” and “1” in binary logistic regression as it leads to the most straight forward interpretation. The target group (referred to as a “case”) is usually coded as “1” and the reference group (referred to as a “non-case”) as “0” (Hosmer and Lemeshow, 2000).

In linear regression the squared multiple correlations, R^2 are used to assess goodness of fit as it represents the proportion of variance in the criterion that is explained by the predictors. In logistic regression analysis, there is no agreed upon analogous measure but there are several competing measures each with limitations. One limitation of the likelihood ratio R^2 is that it is not monotonically related to the odds ratio, meaning that it does not necessarily increase as the odds ratio increases and does not necessarily decrease as the odds ratio decreases (Hosmer and Lemeshow, 2000).

According to Agresti (2002) the Cox and Snell R^2 is an alternative index of goodness of fit related to the R^2 value from linear regression. The cox and snell and the Nagelkerke R^2 are the two statistics which may be used to measure the usefulness of the model. The cox and snell R^2 usually attains a maximum value of less than 1, therefore the Nagelkerke R^2 is an adjusted vision of cox and snell R^2 and it covers the full range from 0 to 1 as such it is often preferred.

The pseudo R^2 statistics requires a careful interpretation. It is referred to as the pseudo R^2 because the indices of fit do not represent the proportionate reduction in error as the R^2 in linear regression does. Linear regression assumes homoscedasticity, that the error variance is the same for all values of the criterion. Logistic regression will always be heteroscedastic, the error variances differ for each value of the predicted score. For each value of the predicted score there would be a different value of the proportionate reduction in error (Agresti, 2002).

According to Hosmer and Lemeshow (2000) in linear regression, the regression coefficients represent the change in the criterion for each unit change in the predictor. In logistic regression, however, the regression coefficients represent the change in the logit for each unit change in the predictor. In linear regression, the significance of a regression coefficient is assessed by computing a *t*-test. In logistic regression, there are a couple of different tests designed to assess the significance of an individual predictor, most remarkably, the likelihood ratio test and the Wald statistic.

Alternatively, when assessing the contribution of individual predictors in a given model, one may examine the significance of the Wald test. The Wald statistic, analogous to the *t*-test in linear regression, is used to assess the significance of coefficients. The Wald statistic is the ratio of the square of the regression coefficient to the square of the standard error of the coefficient and is asymptotically distributed as a chi-square distribution (Hosmer and Lemeshow, 2000).

Although several statistical packages (e.g. SPSS) report the Wald statistic to assess the contribution of individual predictors, the Wald statistic is not without limitations. When the regression coefficient is large, the standard error of the regression coefficient also tends to be large increasing the probability of error. The Wald statistic also tends to be biased when data are sparse (Hosmer and Lemeshow, 2000).

4.5 Data collection

This study used primary data which was collected through field survey and structured questionnaire. The first part of the structured questionnaire dealt with socio-economic information such as the gender of the farmer, the age of the farmer, education level of the farmer, size of the household etc. The second part of the questionnaire dealt with the production information such as land, labour, fertilizer use and seed. The last part of the questionnaire dealt with market information such as access to market where farmers inputs and sell the produce.

4.5.1 Sampling procedure

This study selected 10 villages, namely, Modjadji village, Ga-masoma, Ga-wally, Mogapeng, Hwetji, Nwamitwa village, Lephepane, Mariveni, Petanenge village and Pharare village to represent small-scale maize farmers in Tzaneen municipality. The sampling frame was 500 farmers, 200 were males and 300 were females. Gender was used as strata to randomly select 75 males and 75 females from the 10 villages.

4.6 Questionnaire design

The questionnaire was designed to capture information regarding farmer productivity in maize. To acquire more accurate and reliable information to test the hypotheses of the study, the questionnaire was designed in such a way that it would not consume much of the respondents' time (maximum 1h: 15 minutes). The questions were closed ended while others were open ended to allow the respondents to give more relevant information.

4.7 Interview procedure

The interview was conducted with the assistance of my colleagues, master students from the University of Limpopo. Before the interview could begin, arrangements were made with the community leaders and the questionnaire was discussed with the enumerators. At the beginning of the interview, the procedure was thoroughly explained to the respondent. After the respondent granted the enumerator permission to commence then the interview would start.

CHAPTER FIVE

EMPIRICAL RESULTS AND DISCUSSION

5.1 Introduction

This chapter presents the characteristics of the sampled farmers and a brief summary of the results from the descriptive analysis as described in chapter four. It presents the empirical result from the Cobb-Douglas production function and the logistic regression model. The results are presented in a tabular form and interpreted individually.

5.2 Descriptive results from the logistic regression analysis

Table 5.1 Descriptive results

Variable	Options	Frequency
Age	➢ Between 18 and 35 years ➢ Above 35 years	45% 55%
Education level	➢ Formal education ➢ No formal education	85% 15%
Off-farm income	➢ Receive off-farm income ➢ No off-farm income	43% 57%
Farm size	➢ 0.5 ha ➢ 0.75 ha ➢ 1 ha	57% 12% 30%

Source: Author's analysis (2014)

5.2.1 Age of the farmer

The results show that the majority of the maize farmers in Tzaneen municipality are old, this was highlighted by 55% of the farmers being above 35 years old. The results revealed that 45% of the farmers are between 18 and 35 years old. Age plays an important role in farming as the older farmers tend to have more experience in farming.

5.2.2 Education level of the farmer

The results show that 85% of the farmers in Tzaneen municipality had formal education, whereas only 15% had no formal education. Education plays an important role in enabling farmers to make informed decisions based on production process.

5.2.3 Farmer's off-farm income

The results of this study show that 43% of the farmers in Tzaneen municipality receive off-farm income, whereas 57% do not receive off-farm income. This indicates that majority of the farmers depend on farming for income generation. Access to off-farm income may affect the production process, since farmers without off-farm income could have difficulty in purchasing some of the important inputs like fertilizer and hybrid seed which are necessary in the production of maize.

5.2.4 Farm size

The results indicate that 57% of maize farmers cultivated an area of 0.5 ha, followed by 30% with 1ha and 12% with 0.75ha. It is evident from the results that small-scale farmers in Tzaneen municipality have access to small size of arable land.

5.3 Descriptive results from the Cobb-Douglas production function.

Table 5.2 Descriptive variables

Variables	Mean	Standard deviation
Land (ha)	1.140	0.248
Fertilizer(kg)	53.38	29.513
Seeds (kg)	30.25	12.007
Expenses	2362.00	835.443
Family size	6.71	2.189

Source: Author's analysis (2014)

The descriptive results in Table 5.2 show that on average 30.25 kg of seeds were used in the production of maize. This implies that small-scale maize farmers in Tzaneen municipality are over utilizing seeds, because on average 20 kg of seeds is expected to be applied on 1 hectare. The results further highlight that expenses on maize production was about R2 362.00 per hectare. The average fertilizer used per hectare was 53.38. The average family size was about 6.71, which can be rounded to seven members per household. This indicates that small-scale maize farmers have an easy access of family labour. Land revealed the mean average of 1.140.

The standard deviation measures the concentration of data around the mean. The smaller the standard deviation implies the more concentration of data to the mean and the large standard deviation means that the values in the data set are further away from the mean. The results in table 5.2 revealed the lowest standard deviation of land to be 0.248 implying that the concentration of data was close to mean. The variables like fertilizer, seed, expenses and family size revealed the largest standard deviation of 29.513, 12.007, 835.443 and 2.189 respectively, indicating that the concentration of data was far from the mean.

The Cobb-Douglas production function and the logistic regression models were used to assess the level of technical and allocative efficiencies and to identify socio-economic factors affecting the efficiency of small-scale maize farmers in Tzaneen municipality, respectively. Table 6.2 below, presents the results from the Cobb-Douglas production function as described in chapter four.

Table 5.3: Empirical results from Cobb-Douglas production function

Variables	Coefficient of elasticities	Standard error	t-ratio
Constant	3.320	180.578	
Land (ha)	0.541***	0.609	4.321
Seeds (kg)	0.205***	0.007	-1.173
Fertilizer (kg)	0.083***	0.004	0.045
Capital	0.354***	0.623	0.808
Expenses (rand)	-0.102***	0.035	-0.083
Sum of bs	1.081		
Adjusted R^2	0.58		

***Sig at 1%

Source: Author's analysis (2014)

5.4 Discussion of results

The estimation of the production function resulted in adjusted R^2 value of 0.58 for small-scale maize farmers in Tzaneen municipality. This implies that variables included in the model were able to explain 58% of the variation in maize production. According to Coudere and Marijse (1991), as quoted by Mushunje and Belete (2001), an adjusted R^2 of 0.54 is a fairly good result for the regression using cross-sectional data. The error term was found to be 0.42, indicating that the Cobb-Douglas production function model does not fully represent the actual relationship between the inputs used in maize production and the total output.

5.5 Elasticity of production

More emphasis was directed to the elasticity of variables. Elasticity of production is known as the percentage change in output when that variable input is varied, in simple terms it measures the sensitivity of dependent variable to a change in independent variable. This is calculated by dividing the marginal physical product (MPP) and the average physical product (APP).

5.5.1 Land

The results show land elasticity of 0.54, land was found to be positively significant at 99% level. This implies that land is sensitive towards the production of maize, since a 1% increase will lead to 0.54% increase in maize production. This implies that access to land is the important factor in the production of maize. The results concur with the findings of other studies such as Baloyi *et al.* (2011) and Amos (2007).

5.5.2 Seed

The elasticity of seed was found to be 0.205, it was positively significant at 99% level towards the production of maize. The results show that seed used per hectare was sensitive towards maize production, since a 1% increase in seed will lead to 0.205% increase in maize production. The results concur with the study of Oyewu (2011), which found seed to be sensitive towards the production of maize.

5.5.3 Fertilizer

The results reveal the elasticity of fertilizer to be 0.08, fertilizer was positively significant at 99% level. The results imply that fertilizer is sensitive towards the production of maize, since an increase in 1% will lead to 0.08% increase in maize production. The results concur with the findings in the study of Ogundari (2008) and Baloyi *et al*. (2011).

5.5.4 Capital (Tractor hours)

Tractor was used as a proxy to estimate capital. The elasticity of capital was found to be 0.35. Capital was positively significant at 99% level towards the production of maize. The results revealed that capital is sensitive towards maize production, since an increase in 1% will lead to an increase of 0.35% in maize production. The results concur with the study of Ugwumba (2010).

5.5.5 Expenses of production

The elasticity of expenses was -0.102, this indicates that small-scale maize farmers in Tzaneen municipality operate in the stage three of the neo-classical production, which indicates that farmers are over-utilizing money in the production of maize. The expense was found to be negatively significant at 99% level, implying that a 1% increase in the expenses of production will lead to -0.102% decrease in maize production.

5.6 Return to scale

The return to scale was found by adding the value of betas (β), it indicates what would happen to output of maize if all inputs were to increase simultaneously. The sum of betas (β) is then used as an indicator of return to scale. The constant return to scale occur when the sum of the coefficients equals to 1 (one), below 1 (one) indicates decreasing return to scale and for increasing return to scale the value should be above 1 (one) (Mushunje and Belete, 2001).

The results in Table 5.3 above shows that small-scale maize farmers in Tzaneen municipality experience increasing return to scale, this is shown by the coefficient of 1.08. It implies that the cost per unit of input used in the production of maize by the small-scale farmers in Tzaneen municipality is less than the return from that output of maize.

5.7 Technical and allocative efficiency analysis

5.7.1 Allocative efficiency analysis

The marginal value product of input (MVP) should be equal to one for the farmer to be allocatively efficient. The results in Table 5.4 below indicate that farmers in Tzaneen municipality are allocatively efficient in the utilization of land, whereas the variables like seed, pesticide, fertilizer, capital and expenses were found to be over utilized by farmers; implying that farmers are allocatively inefficient in the production of maize. The results concur with the study of Ugwumba (2010) and Ogundari (2008) who revealed that farmers were over utilizing variables such as capital, fertilizers and seeds.

Table 5.4 Allocative efficiency results

Variables	Co-efficient of elasticity	AE = VMP÷P_i
Land	0.541	1.08
Seeds	0.205	0.41
Fertilizer	0.083	0.17
Capital	0.354	0.71
Expenses	-0.102	-0.204

Author's calculations (2014)

The results of the frequency distribution of technical and allocative efficiency are presented in table 5.5 below.

Table 5.5: Technical and allocative efficiency index values

No of farmers	Technical efficiency	Allocative efficiency
1 – 50	0.389	0.51
51 – 70	0.923	0.32
71 – 100	0.857	0.19
101 – 120	0.782	0.40
121 – 150	0.623	0.55
Mean efficiency	**0.71**	**0.39**

Author's calculations (2014)

The estimated mean technical and allocative efficiency varied with a value of 0.71 and 0.39. The mean allocative efficiency shows that farmers in Tzaneen municipality are not fully efficient in the allocation of inputs, but they are technically efficient in the production of maize.

5.8 The logistic regression analysis

Table 5.6 below presents the results from the logistic regression analysis. It provides the analytical information on socio-economic factors affecting the technical and allocative efficiency of small-scale maize farmers in Tzaneen Municipality.

Table 5.6 Logistic regression analysis

Variables	Co-efficient	Standard Error	Wald statistics	Significance
GENH	-1.789**	0.900	3.946	0.049
AGEH	0.765	0.712	1.154	0.283
HHED	1.050*	0.332	8.029	0.070
IRWA	0.588***	4.377	14.365	0.000
HICM	-2.717***	1.015	7.171	0.007
FEXP	2.736***	1.094	6.248	0.012
MPRD	0.000	0.000	0.134	0.714
FSIZ	3.566*	1.879	3.602	0.058
TRAC	-0.391	0.800	0.239	0.625
FERT	-0.656	0.870	0.569	0.451
PHSD	0.742***	0.880	0.711	0.009
EXTV	0.851***	1.318	6.695	0.010
CRDT	2.130**	1.749	1.483	0.044
TYPDW	0.294	0.919	0.102	0.749
Constant	-40.441	19.021	0.000	0.999
-2 log Likelihood	65.28			
Chi-Square	7.09			
Pseudo R square	0.61			
Error term	0.39			

*Sig at 10%, **Sig at 5%, ***Sig 1%
Source: Author's analysis (2014)

The principal assumption on which the likelihood ratio is based, states that there are socio-economic factors affecting the efficiency of small-scale maize farmers in Tzaneen municipality of Mopani District. The probability of farmers to be productive is directly related to the level of education (HHED), gender of the household head (GENH), accessibility of irrigation water (IRWAT), household off-farm income (HICM), experience in farming (FEXP), farm size of the household (FSIZ), purchase of hybrid seed (PHSD), extension visits (EXTV) and access to credit (CRDT).

The results in Table 5.6 above indicate the chi-square value of 7.09. The estimation of the socio-economic factors affecting the efficiency resulted in the R^2 value of 0.61. It means that inputs used or the independent variables that are included in the model were able to explain 61% of the variation. The statistical model was unable to explain 39% of the relationship between output and input.

5.8.1 Gender of the farmer

The results in Table 5.6 above show that gender of the farmer was negatively significant towards the efficiency of maize farmers in Tzaneen municipality. The significant level was found to be 95%, therefore an increase in gender of the farmer the efficiency is likely to reduce. The coefficient of gender was found to be -1.789 implying that an increase in 1% will lead to a decrease in efficiency by -1.789. The results concur with the study of Ekunwe and Emokaro (2009) who found negative impact between efficiency and gender of the farmer.

5.8.2 Education level of the farmer

Education is a variable that is expected to improve managerial input and lead to better decisions in farming (Bifarin *et al.* 2010). The results in Table 5.6 show that education level of the farmer is positively significant towards the efficiency level. The results indicate the significant level of 90%, implying that the efficiency of the farmer is likely to increase as the educational level of each farmer improves. The coefficient of education was found to be 1.05 indicating that an increase in 1%, education will rise by 1.05. The results concur with the study of Kalirajan and Shard (1985); Wier (1999); Wier and Knight (2000) who found a strong and positive relationship between educational level and efficiency of the farmer.

5.8.3 Access to irrigation water

The small-scale maize farmers should have access to enough irrigation water for production activities to take place efficiently. The results in Table 5.6 above show that access to irrigation water is positively significant at 99% level towards the efficiency of the farmer. Access to irrigation water was found to be 0.59 implying that an increase in 1%, access to irrigation water will rise by 0.59. It implies that an increase in access to irrigation water the efficiency level is likely to increase. The results concur with the study of (Khan *et al.* 2011).

5.8.4 Experience in farming

The results in Table 5.6 above show that experience in farming is positively significant towards the efficiency of the farmer, the significant level was found to be 99%. It is assumed that the more the experience the farmer gain, the efficiency level is likely to increase. Experience in farming was found to be 2.74 implying that an increase in 1%, experience in farming will rise by 2.74. The results concur with the study of Dadzie and Dasmani (2010) who found a positive relationship between the experience in farming and the efficiency of farmers.

5.8.5 Farmer's off-farm income

The results in Table 5.6 above revealed that off-farm income was negatively significant towards the efficiency of farmers with a significant level of 99%. It implies that when off-farm income increases, the efficiency level of the farmer is likely to reduce. Off-farm income was found to be -2.72 implying that an increase in 1%, off farm income will decrease by -2.72. The results of this study concur with the study of Ali and Flinn (1987); O'Neill and Mathews (2000).

5.8.6 Farm size

Farm size plays a significant role in the efficiency of farmers. The results in Table 5.6 above show that farm size was significant towards the efficiency of the farmer at 90% level. Farm size was found to be 3.57 indicating that an increase in 1%, farm size will rise by 3.57. The results concur with the study of Baloyi *et al.* (2010) and Dorward (1999).

5.8.7 Purchase of hybrid seed

The results in Table 5.6 above show that the use of hybrid seed was positively significant towards the efficiency level of the farmer, the significant level was revealed to be 99%. Purchase of hybrid seed was found to be 0.74 indicating that an increase in 1%, hybrid seed will rise by 0.74.

5.8.8 Extension visits

The results in Table 5.6 above show that the official visit to the farms by the extension officers was positively significant at 99% level. The extension visit was found to be 0.85 implying that an increase in 1%, extension visit will rise by 0.85. The results concur with the study of O'Neill and Mathews (2000) and Owens *et al.* (2001).

5.8.9 Access to credit

The impact of access to credit on farmer's efficiency level has been widely studied and produced ambiguous results. The results in Table 5.6 above show that access to credit was found to be positively significant towards the efficiency level of farmers at 95%. It implies that an increase in access to credit the efficiency of farmers is likely to improve. Access to credit was found to be 2.13 implying that an increase in 1% will lead to 2.13 increases in access to credit. The results concur with the study of Okike *et al.* (2001) and Bifarin *et al.* (2010).

5.9 Area of improvement with regard to operational management

The results in Table 5.1 reveal that small-scale maize farmers in Tzaneen municipality operate on a small piece of land, this is shown by the 57% of farmers having access to cultivate 0.5 ha. The results show that 85% of the farmers in Tzaneen municipality had formal education and the majority are above 35 years old.

The results in Table 5.6 show that age of the farmer and the ownership of dwelling were positively insignificant towards the efficiency level of the small-scale maize famer in Tzaneen municipality. Tractor use and fertilizer were found to be negatively insignificant towards the efficiency level of the farmer. This implies that the above mentioned variables do not affect the efficiency level of the small-scale maize farmers in Tzaneen municipality. The results from the analysis indicates that small-scale maize farmers in Tzaneen Municipality need to improve access to land, access to irrigation water and access to credit for the improvement in operational management of the farms.

CHAPTER SIX

Summary, Conclusion and Recommendation

6.1 Introduction

This chapter presents the summary, conclusion and recommendations of the study. It highlights the extent to which objectives and hypotheses posed at the beginning of the study have been addressed by the analysis.

6.2 Summary

The study set out to assess the level of efficiency in maize production among the small-scale farmers in Mopani district of Limpopo province. Since maize is the main staple food crop in Limpopo province, high productivity and efficiency in its production is critical in attaining food security in the province. A set of analytical techniques were used, namely, the Cobb-Douglas production function and the logistic regression model, whereby significant variables were identified.

The study used all the necessary official documents, statistics, data programmes as well as relevant literature to capture information on small-scale maize farmers in Tzaneen municipality of Mopani district. The theoretical literature reviewed in chapter two showed that there are few factors like age of the farmer, education level of the farmer and farm size, which affect the efficiency level of farmers.

The Cobb-Douglas production function results indicated that most of the variables were positively significant towards the production of maize, implying that a 1% increase in inputs will lead to 0.71% increase in efficiency of maize farmers in Tzaneen municipality. The analysed results in Table 5.5 revealed that farmers in Tzaneen municipality were technically efficient but allocatively inefficient in the production of maize. This was revealed by the mean technical efficiency value of 0.71% and the mean allocative efficiency value of 0.39%. The results revealed the sum of betas (β) being equal to 1.08 indicating that small-scale maize farmers in Tzaneen municipality experience increasing return to scale, although they are technically efficient in the production of maize. Further more the results in Table 5.4 revealed that seed, fertilizer, capital and expenses were inefficiently allocated in the production of maize.

The logistic regression model was used to identify the socio-economic factors affecting the efficiency level of the small-scale maize farmers in Tzaneen municipality. The findings from logistic regression model revealed variables that are positively significant towards the production of maize, these are: the level of education, experience in farming, access to irrigation water, purchase of hybrid seeds, access to credit and extension visits. However variables like gender of the household head and the farmer's off-farm income were found to be negatively significant towards the production of maize.

6.3 Conclusion

Hypothesis 1: The level of technical and allocative efficiency of small-scale maize farmers in Tzaneen municipality is low. The findings of this study in Table 5.5 reveals a high mean technical efficiency of 71%, while the allocative mean efficiency was found to be 39% therefore the study rejects the null hypothesis.

Hypothesis 2: There are no socio-economic factors affecting the efficiency of small-scale maize farmers in Tzaneen municipality. The hypothesis is rejected as the empirical results from logistic regression model revealed variables that are positively significant towards maize production in Tzaneen municipality. Variable that were found to be highly significant are: the level of education of the farmer, experience in farming, access to irrigation water, purchase of hybrid seed, access to credit and extension visits by the government officials. However, there is a need for improvement with regard to the operational management of the maize farmers in Tzaneen municipality.

Based on the empirical results from the analysis, the study concludes that small-scale farmers in Tzaneen municipality are technically efficient in the production of maize. There are socio-economic factors affecting the efficiency level of farmers.

6.4 Recommendation

The findings obtained in this study could be quite useful to policy makers. The recommendations discussed below are based on the findings of this study. Seed, fertilizer, capital and expenses were found to be inefficiently allocated, therefore, to overcome these problem small-scale maize farmers in Tzaneen municipality need more visits from the extension officers as well as training on inputs allocation.

The provision of easy, quick and adequate credit deserves to be a top priority on the agenda of policy makers since most small-scale maize farmers in Tzaneen municipality does not receive off-farm income. There is also a need for farmers to have access to enough arable land in order to increase production. The lema-letsema programme already exists in the government, this study recommends that the government should strengthen and roll-out the programme to reach small-scale farmers especially in rural areas. Small-scale farmers in South Africa and other developing countries contribute to employment creation and food security in the households; therefore it is important that government fully support such farmers.

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Appendix 1

Questionnaire

Analysing the technical and allocative efficiency of small-scale maize farmers in Tzaneen municipality of Mopani district: A Cobb-Douglas and Logistic regression approach

Department of Agricultural Economics and Animal Production

University of Limpopo

Turfloop Campus

Researcher: Maria Sylvia Mokgalabone

Enumerator's name: ....

Questionnaire no: ....

Name of municipality/ village: ....

Date of interview: ....

PART ONE: SOCIO-ECONOMIC INFORMATION

1. Respondent's name and surname?

   ....

2. Gender of the household head?

Male	Female
1	2

3. Age of the household head? (In years)

   ....

4. Marital status of the household head? (Allow only one answer)

Married	Divorced	Single	Widowed
1	2	3	4

5. The highest educational qualification of the household head? (Allow only one answer)

No formal education	Primary	Secondary	Tertiary	Abet
1	2	3	4	5

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

   ....

7. Sources of income? (Read the list and allow for more than one answer)

Salary	Farming	Pension	Grants
1	2	3	4

8. How much is the income of the household head? (Give an estimation)

<3000	3001-6000	6001-10000	>10001

9. Do you use credit facility?

Yes	No
1	2

9.1 If yes, how much do you usually get per annum? (Give an estimation)

....

9.2 Where do you get the credit? (Read the list and allow for more than one answer)

Financial institution	Relative or friend	Money lender	Output buyer	Supplier	Others
1	2	3	4	5	6

9.3 What do you use it for? (Allow for more than one answer)

Farming	General maintenance	food
1	2	3

9.4 Do you have any outstanding debts?

Yes	No
1	2

9.5 If yes, how are you intending to repay them? (Explain in detail)

....

PART TWO: PRODUCTION INFORMATION

1. How long have you been involved in farming? (In years)

   ....

2. Do you own the land you use for cultivation?

Yes	No
1	2

2.1 If yes, where did you get the land? (Do not read list and allow for one answer)

Traditional authority	Lease	Bought	Inherited	Others
1	2	3	4	5

3. When did you start ploughing maize? (In years)

   ....

4. What was the motive to start ploughing maize? (Do not read options and allow for more than one answer)

Income generation	Employment	Pastime	Home consumption	Others
1	2	3	4	5

5. How many hectares of land do you have? (Write only the number)
....
6. How many backs of maize do you usually produce per season? (Write only the number)...
7. How many hectares do you use to produce maize? (Write only the number)...
8. Do you normally hire labour for the production of maize?

Yes	No
1	2

8.1 If yes, how many labourers do you normally hire? (Write only the number)...

8.2 How much do you pay them for a day? (In Rands)
....

8.3 If no, how do you compensate for labour? (Explain in detail)
....

9. Do you normally hire tractor for ploughing?

Yes	No
1	2

9.1 If yes, how much does it cost per hour or per hectare? (In Rands)
....

9.2 If no, how do you compensate for a tractor? (Explain in detail)

....

10. Do you apply fertilizer for the production of maize?

Yes	No
1	2

10. If yes, how many kilograms/kg do you apply per hectare? (Write only the number of kilograms)

....

10.1 How much do you spend on fertilizers? (In Rands)

....

10.2 If no, how do you compensate for the fertilizers? (Explain in detail)

....

11. Do you use manure?

Yes	No
1	2

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

Yes	No
1	2

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

....

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

....

13. How many kilograms/kg of maize seeds do you normally use per hectare? (Write only the number of kilograms)……………………………

14. Do you purchase hybrid seeds?

Yes	No
1	2

14.1 If yes, how much does it cost per kilogram/kg? (In rands)

....

15. Do you belong to any farmers' organisation?

Yes	No
1	2

15.1 If yes, which organisation do you belong to?

....

15.2 When did you join the organisation (In years)?

....

16. What problems do you have regarding maize production in your area?

....

17. Do you want to increase your production?

Yes	No
1	2

17.1 If yes, explain the reason you want to increase your output?

....

PART THREE: MARKETING INFORMATION

1. Do you have access to market?

Yes	No
1	2

2. What are your main market outlets? (Allow for more than one answer)

Hawkers	Contractors	Shops	Consumers
1	2	3	4

3. How much does it cost to market your products in relation to transport cost, packaging and others? (Estimate the amount)

   ....

4. How much does it cost to collect maize meal at the miller after processing? (In Rands)..

5. Do you meet the demand of the consumers?

Yes	No
1	2

5.1 If no, explain the reason why in detail?

   ....

6. Who are your main input suppliers (Allow for more than one answer)

Local shops	Stores in town	Co-operatives	Friends/family relatives	Stored last year
1	2	3	4	5

7. How much does it cost to reach the inputs market (In Rands)?

   ....

8. What problems do you normally experience with the suppliers?

   ....

9. Do you own any large equipment?

Yes	No
1	2

9.1 If yes, which one?(Allow for more than one answer)

Wheel barrow	Tractor	Motor bike	Implements	Others
1	2	3	4	5

9.2 If no, do you hire them?

Yes	No
1	2

9.3 At what price do you hire them out? ....

10. Does producing maize become profitable to you?

Yes	No
1	2

10.1 If yes, how? (Please explain in detail).

....

11. Which general comment would you like to make?

....

....

APPENDIX 2

CONSENT FORM

UNIVERSITY OF THE LIMPOPO

ETHICS COMMITTEE

APPLICATION FOR HUMAN EXPERIMENTATION

(Completed forms, preferably typed, should reach the Chairperson of the Ethics Committee at least one month before the experimentation is due to start. Projects where the researcher only receives human material for analysis without actually being involved with collection from the experimental group must still register in the normal way. Researchers who are involved with projects which have been approved by Ethical Committees of other Institutions should provide this Committee with the necessary information and provide it with a shortened protocol for approval)

PROJECT TITLE: Analysing the technical and allocative efficiency of small-scale maize farmers in Tzaneen municipality, Mopani district: A Cobb-Douglas and Logistic regression approach

PROJECT LEADER: Mr Johannes Jan Hlongwane

DECLARATION

I, the signatory, hereby apply for approval to execute the experiments described in the attached protocol and declare that:

1. I am fully aware of the contents of Social Science Research Ethics, Research at Grass Root 3rd edition (2003) and that I will abide by the guidelines as set out in that document (available from the Chairperson of the Ethics Committee); and

2. I undertake to provide every person who participates in any of the stipulated experiments with the information in Part II. Every participant will be requested to sign Part III.

Name of Researcher: Mokgalabone Maria Sylvia

Signature: _________________

Date: ___________________

For Official use by the Ethics Committee:

Approved/Not approved

Remarks:

Signature of Chairperson: __________________

Date: __________________

PROJECT TITLE: Analysing the technical and allocative efficiency of small-scale maize farmers in Tzaneen municipality, Mopani district: A Cobb-Douglas and Logistic regression approach

PROJECT LEADER: Mr Johannes Jan Hlongwane

APPLICATION FOR HUMAN EXPERIMENTATION: PART II

Protocol for the execution of experiments involving humans

1. Department: Agricultural Economics and Animal Production.
2. Title of project: Analysing the technical and allocative efficiency of small-scale maize farmers in Tzaneen municipality, Mopani district: A Cobb-Douglas and Logistic regression approach

3. Full name, surname and qualifications of project leader:
Mr Johannes Jan Hlongwane (Msc Agricultural Economics)

4. List the name(s) of all persons (Researchers and Technical Staff) involved with the project and identifies their role(s) in the conduct of the experiment:

Name:	Qualifications:	Responsible for:
Mokgalabone M.S	B. Agric. honours (Agricultural Economics)	Researcher

5. Name and address of supervising physician: N/A

6. Procedures to be followed: A structured questionnaire will be compiled by the researcher and administered to selected farmers in order to collect relevant information that will be analysed and used for the purpose of the study.

7. Nature of discomfort: None

8. Description of the advantages that may be expected from the results of the experiment,
The study will:
   a. Contribute towards a better understanding of socio-economic determinants of small-scale farmers in Tzaneen municipality.
   b. An understanding of those determinants will help agricultural policy makers to formulate policies that could help small-scale farmers to operate at the frontier level.
   c. The study will develop useful recommendations to increase efficiency level of small-scale farmers by highlighting the direction of input use and allocation.

Signature of Project Leader: ______________________

Date: __________________

PROJECT TITLE: Analysing the technical and allocative efficiency of small-scale maize farmers in Tzaneen municipality, Mopani district: A Cobb-Douglas and Logistic regression approach

PROJECT LEADER: Mr Johannes Jan Hlongwane

APPLICATION FOR HUMAN EXPERIMENTATION: PART II

INFORMATION FOR PARTICIPANTS

1. You are invited to participate in the following research project/experiment:

   Analysing the technical and allocative efficiency of small-scale maize farmers in Tzaneen municipality, Mopani district: A Cobb-Douglas and Logistic regression approach.

2. Participation in the project is completely voluntary and you are free to withdraw from the project/experiment (without providing any reasons) at any time. You are, however, requested not to withdraw without careful consideration since such action might negatively affect the project/experiment.

3. It is possible that you might not personally experience any advantages during the experiment/project, although the knowledge that may be accumulated through the project/experiment might be advantageous to others.

4. You are encouraged to ask any questions that you might have in connection with this project/experiment at any stage. The project leader and her/his staff will gladly answer your question. They will also discuss the project/experiment in detail with you.

5. Your involvement in the project, the researcher will collect information from small-scale maize farmers through face to face interviews using structured questionnaire. The interview will be carried out in such a way that privacy of the participants will be considered and their values and beliefs will not be violated.

   This section is to be drawn up by the researcher and must be submitted together with the application form.

   (*It is compulsory for the researcher to complete this field before submission to the ethics committee*)

UNIVERSITY OF LIMPOPO
ETHICS COMMITTEE

PROJECT TITLE: Analysing the technical and allocative efficiency of small-scale maize farmers in Tzaneen municipality, Mopani district: A Cobb-Douglas and Logistic regression approach

PROJECT LEADER: Mr Johannes Jan Hlongwane

CONSENT FORM

I, hereby voluntarily consent to participate in the following project: Analysing the technical and allocative efficiency of small-scale maize farmers in Tzaneen municipality, Mopani district: A Cobb-Douglas and Logistic regression approach

I realise that:

1. The study deals with the socio-economic factors affecting the efficiency of small-scale maize farmers in Tzaneen municipality.

2. The Ethics Committee has approved that individuals may be approached to participate in the study.

3. The experimental protocol, i.e. The extent, aims and methods of the research, has been explained to me;

4. The protocol sets out the risks that can be reasonably expected as well as possible discomfort for persons participating in the research, an explanation of the anticipated advantages for myself or others that are reasonably expected from the research and alternative procedures that may be to my advantage;

5. I will be informed of any new information that may become available during the research that may influence my willingness to continue my participation;

6. Access to the records that pertain to my participation in the study will be restricted to persons directly involved in the research;

7. Any questions that I may have regarding the research, or related matters, will be answered by the researchers;

8. If I have any questions about, or problems regarding the study, or experience any undesirable effects, I may contact a member of the research team;

9. Participation in this research is voluntary and I can withdraw my participation at any stage;

10. If any medical problem is identified at any stage during the research, or when I am vetted for participation, such condition will be discussed with me in confidence by a qualified person and/or I will be referred to my doctor;

11. I indemnify the University of Limpopo and all persons involved with the above project from any liability that may arise from my participation in the above project or that may be related to it, for whatever reasons, including negligence on the part of the mentioned persons.

SIGNATURE OF RESEARCHED PERSON ____________________________

SIGNATURE OF WITNESS __________________________________

Signed at________________________this__________ day of ______________2013