

**ANALYSIS OF PRODUCTION EFFICIENCY AND PROFITABILITY OF
MAIZE FARMERS IN GIWA LOCAL GOVERNMENT AREA OF KADUNA
STATE, NIGERIA**

BY

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DECLARATION

I hereby declare that this dissertation titled “**Analysis of Production Efficiency and Profitability of Maize Farmers in Giwa Local Government Area of Kaduna State, Nigeria**” has been written by me and it is a record of my research work. No part of this dissertation has been presented in any previous application for another degree or diploma in this or any other institution. All borrowed information have been duly acknowledged in the text and a list of references provided.

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CERTIFICATION

This thesis dissertation “**Analysis of Production Efficiency and Profitability of Maize Farmers in Giwa Local Government Area of Kaduna State, Nigeria**”, by Adedayo Olufunsho MOMOH, meets the regulations governing the award of the Degree of Master of Science in Agricultural Economics of the Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This dissertation is dedicated to God Almighty and my family.

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ABSTRACT

This study investigated the production efficiency and profitability of maize farmers in Kaduna State, Nigeria. The broad objective of this study was to determine the production efficiency levels and profitability of maize farmers in the study area. A multi-stage sampling technique was employed to collect exclusively primary data from 190 maize farmers from seven wards in Giwa LGA of Kaduna State using a well-structured questionnaire. The statistical tools used to conduct the analysis were descriptive statistics, constant and variable return to scale, DEA for both production and cost functions, Tobit regression model and gross marginal method. The descriptive analysis revealed that maize farming was dominated by young and educated male headed households with family responsibilities. Majority were primarily experienced small scale farmers depending on improved variety for the production of the enterprise. Although they were members of farmers' association, their level of access to credit was as limited as that of their contact with extension agents. The analysis of production efficiency revealed different sources of inefficiency. Farm size was also found to be another important source of inefficiency in maize production as only 26% of the farm households was observed to produce at the optimal scale. Small, medium and large scale farmers had a scale efficiency score of 0.43, 0.88 and 0.63 respectively. In terms of allocative efficiency, 0.58% of the sampled households were found to be allocatively efficient with majority and minority being the medium and small scale farmers respectively. Economically, less than a quarter of the sampled farm households were efficient with the majority being the small scale farmers followed by the large scale farmers. The profitability analysis revealed that maize enterprise is a profitable business. Specifically, by investing ₦1 per hectare, a return of ₦2.27 was realized with no significant difference across the scale efficient and inefficient farmers. Maize production in the study area is not constraints free. It was observed that fertilizer scarcity was the most important challenge in maize production followed by inadequate rainfall and capital as well as price fluctuations. Recommendations for the study include: accessibility of credit to maize farmers through reduction of interest rate and education of farmers in the use of such credit for more and significant impact, extension agents should not only raised their number of visits with maize farmers but equally ensuring that their recommendations are being adopted and properly implemented, and lastly, farmers' association should review the aim of their organizations and also insist on sharing ideas and experience in production and marketing of maize for better returns

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Nigeria is a middle income, mixed economy and emerging market, with expanding financial, service, communications and technology, and entertainment sectors. It is ranked twenty-sixth in the world in terms of Gross Domestic Product (GDP), and is the largest economy in Africa (National Bureau of Statistics (NBS), 2014). Nigeria is also on track to become one of the 20 largest economies in the world by 2020 (African Union Commission (AUC), 2014). Although, Annon (2009) noted that the petroleum sector powered the country's economy in recent years as petroleum exports accounted for 20% of GDP, 95% of total export earnings and close to 85% of federal government revenue, Nigeria's agricultural sector contribution to GDP in 2012 increased and became the highest (40%) followed by the service, manufacturing, oil and other sectors with contribution levels estimated to be 30%, 15%, 14% and 1% respectively (NBS, 2012). In 2013, latest records from the National Bureau of Statistics revealed a decline in the performance of the agricultural sector. However, the sector was still the highest contributor to nominal GDP with a contribution level of 21.97%, followed by the trade sector which contributed 17% (Yemi, 2014).

Nigeria is the largest market in sub-Saharan Africa with a population of more than 150 million people out of which about 82 million are dwelling in rural areas as at 2011, and a population growth rate estimated at 3% annually (Food and Agriculture Organisation (FAO), 2014). Its total food and agricultural imports have continued to climb in recent years and in 2008 specifically, were valued at approximately \$4.0 billion with wheat accounting for \$925 million of the \$1.04 billion total U.S agricultural exports to

Nigeria. Demand for other grains such as maize, sorghum, millet, is also very high currently (Annon 2009).

Agriculture is an important sector of the economy with high potentials for employment generation, food security and poverty reduction. However, these potentials have remained largely untapped which has led to the dwindling performance of the agricultural sector both domestically and in the international trade over the years. The agricultural sector in Nigeria is primarily subsistence-based, employs about 70% of the population and contributes about 40% to the GDP (Makarfi and Dandago, 2013). Crop production accounts for about 85 % of agricultural activities, with livestock and poultry accounting for 10 %, and fisheries and forestry, 5 % (Annon, 2009). The status of Nigeria in terms of agriculture has diminished globally. According to the ministry of agriculture (2011), this is due to the fact that other countries have maintained their dominance through strong marketing organizations that linked the farmers to markets and provided support in the form of improved planting material, fertilizer, credit and rural infrastructure. Some of the countries that experienced growth in their agricultural sector due to agricultural transformation are Malawi, Kenya, Brazil, China, Indonesia and Thailand to cite only these. Nigeria is expected to emulate these countries through its own Agricultural Transformation Agenda (ATA).

ATA is an initiative adopted by the Government of Nigeria (GON) to increase agricultural productivity in order to revamp the agricultural sector, ensure food security, diversify the economy, enhance foreign exchange earnings and drastically cut food imports by 2020. A number of important commodities such as maize, cassava, rice, sorghum, cocoa, cotton, dairy, beef, leather, poultry, oil palm, fisheries as well as

agricultural extension services are considered by ATA in order to grow the agricultural sector and to generate employment (Ministry of Agriculture, 2011).

Introduced in Nigeria in the sixtieth century, maize has been the fourth most consumed cereal crop during the past two decades, below sorghum, millet and rice (Food and Agriculture Organization of the United States (FAOSTAT, 2012). Nigeria is the tenth largest producer of maize in the world, and the first largest maize producer in Africa, followed by South Africa (International Institute of Tropical Agriculture (IITA, 2012). While maize is grown in the entirety of the country (both yellow and white varieties), the North Central region is being observed as the main producing area. In effect, in the last nine years, Kaduna State is found to be the only state producing an average of more than 600 thousand metric tonnes (Okoro and Ujah 2009). Factors such as land, fertilizer and improved seeds are identified as crucial to ensure greater output (Ministry of Agriculture, 2011). While these factors play an important role in the success or failure of a farm household, none has as profound an impact as productivity and efficiency do (Berchtold, 2014).

Empirical evidences suggest that improving the productivity of smallholder farmers is important for economic development because smallholder farmers provide a source of employment and a more equitable distribution of income (Bravo-Ureta and Evenson, 1994). Productivity without efficiency is usually very expensive and lack of efficiency affects all businesses. Inefficiencies in larger business can go unnoticed due to the availability of excess resources. Smaller businesses may not survive or fail to grow due to the costs of inefficiencies regardless of the nature of their business. Five types of efficiencies can be identified in the literature namely overall efficiency also known as

economic efficiency, overall technical efficiency, pure technical efficiency, scale efficiency and allocative efficiency.

The extent to which a farm household can take advantage of returns to scale by altering its size towards optimal scale is very important since technical efficiency is influenced by both scale efficiency - which is due to size of farm - and non-scale efficiency also known as pure technical efficiency - which is due to poor allocation of resources (Brazdik, 2006). There is a close relationship between the notion of return to scale and cost of production. In effect, increasing return to scale suggests that average cost of production is decreasing. This is important as the return to scale status of a farm would determine whether or not its size is optimal. The application of non-parametric approach in efficiency analysis is more suitable to analyzing production efficiency in developing countries where the availability of data is limited and production technologies are less understood (Brazdik, 2006). Data Envelopment Analysis (DEA) among others is one of the prominent non-parametric approaches for efficiency analysis.

1.2 Statement of the Problem

A food consumption survey showed that maize was the most often consumed staple in Nigeria, with 20% of the population eating it at least once a week (International Institute of Tropical Agriculture, 2009). However, in recent years, rice has become the most consumed food in Nigeria (United States Agency for International Development (USAID), 2012). The dependence of Nigeria on imported cereal crops such as wheat and rice due to the dominance of its demand over the local production is a significant threat to its economy. Reliance on maize as a substitute to these cereal crops becomes necessary at least to ensure food security. The average yield of maize in Nigeria has increased over the years, its yield's level (18,096 kg/ha) is still low when compared to

the world average of 18.3 tonnes/ha. It is even lower when compared to average yield from other African countries like Cameroon, Ivory Coast and Egypt with average yield of 20,795 kg/ha, 19,544 kg/ha and 77,723 kg/ha, respectively (FAO, 2014).

The major goal of any production system is the attainment of an optimally high level of output with a given amount of effort or input (Rahman, 2013). It is estimated that by 2050, the demand for maize in developing countries will double. By 2025, it will become the crop with the greatest production globally and in developing countries (International Maize and Wheat Improvement Center (CIMMYT) and IITA, 2010). An improvement in the understanding of the source of inefficiency in production and its relationship with factors at both the individual and farm-levels can greatly aid policy makers in creating efficiency, enhancing policies as well as judging the efficacy of the present and past government reforms in the agricultural sector (Zalkuwi and Dia, 2010). However, most of the studies in performance analysis, in general, of maize production in Kaduna State in recent years, to be specific, have relied on parametric approaches – stochastic frontier analysis - and were therefore unable to separate pure technical efficiency levels from scale efficiency levels. This can be detrimental in a situation whereby policies are designed to improved farmers technical efficiency while the major source of inefficiency is due to the size of farm households. In other words, if scale inefficiency is present, then its negligence can impact seriously on the ability of a farm household to survive or keep up with competition as the average cost of production is expected to be increasing in a situation of decreasing return to scale.

To ensure competitiveness of Nigeria's maize internationally, controlling costs is essential in the competitive agricultural market situation that exists in Nigeria, where

the potential for output price manipulation by individual farm firms is very limited. Smallholder farmers are constrained by many problems including poor access to modern inputs and credits, poor infrastructure, inadequate access to markets, land and environmental degradation (climate change), inadequate and unused research and extension services (Manyong *et al.*, 2003). These challenges, on the other hand, are exacerbated by rural poverty which is found to be the bane confronting smallholder farmers. Many studies in performance enhancement in maize production in Nigeria (Oladunni *et al.*, 2013; Zalkuwi and Dia, 2010), using non-parametric methods made abstraction of any possible difference in input, output or profitability that might exist among farm households as a result of their difference in scale efficiency status. Any observed significant difference due to scale efficiency is worth pointing out as it will generate more convincing evidence on whether or not smallholder maize farmers in the study area should actually alter their scale of production to take advantage of market opportunities.

It is against this background that the study conducted an economic analysis of production efficiency in maize production using a non-parametric approach to efficiency measurement in Kaduna State. This study therefore attempts to answer the following research questions:

- i. What are the socio-economic characteristics of the maize farmers in the study area?
- ii. what are the efficiency levels of maize farmers in the study area?
- iii. what is the return to scale in maize production in the study area?

- iv. what is the relationship between socio-economic characteristics of maize farmers and their levels of production efficiency in the study area?
- v. what are the profit differentials between scale efficient and inefficient maize farmers in the study area?
- vi. what are the constraints being faced by maize farmers in the study area?

1.3 Objectives of the Study

The broad objective of this study was to determine the production efficiency levels and profitability of maize farmers in the study area. The specific objectives were to:

- i. describe the socio economic characteristics of maize farmers in the study area,
- ii. estimate the efficiency levels of maize farmers in the study area,
- iii. estimate the return to scale in maize production of large, medium and small scale farmers,
- iv. determine the relationship between the socio-economic characteristics of maize farmers and their levels of production efficiency,
- v. estimate the profit differentials between scale efficient and inefficient maize farmers,
- vi. describe the constraints faced by maize farmers in the study area.

1.4 Justification for the Study

Profit maximization is one of the common objectives of business enterprises and it is grossly dependent on how production resources are harnessed (Afolabi, O. I., Adegbite, D. A., Ashaolu, O. F and Akinbode S.O, 2013). Knowing approximately what quantity

of inputs to use to produce a given quantity of output or knowing the level of output to produce given the available inputs is crucial not only for profit maximization but equally for sustainability as having such information in advance will ensure equilibrium between demand and supply and therefore producer and consumer satisfaction. Data Envelopment Analysis (DEA) is a method that separates technical and scale efficiencies from price efficiency, enabling it to locate methods of improving profitability of farm household that already appear relatively profitable based on accounting measures reflected in an income statement (Sherman and Zhu, 2006). This study is particularly important as it will enable a more detailed analysis of individual farm households' performance. Moreover the results of this study will be more pragmatic than those based on parametric approaches as they will generate significant recommendations that would not necessary require the interventions of policy makers before being implemented through the identification of peer farmers within the sample under consideration.

For the inefficient farms, the causes of inefficiency may be either inappropriate scale or misallocation of resources. Inappropriate scale suggests that the farm household is not taking advantage of economies of scale, while misallocation of resources refers to inefficient input combinations (Ogunniyi and Oladejo, 2011). This study is important as it will help determining whether or not farm size is an issue in the production of maize in the study area. It will attempt to equally identify ways of responding to some of the challenges faced by maize farmers and proffer solution-based data to smallholder maize farmers in Kaduna State. Moreover, the outcomes of this study will generate information for policy makers, governmental and non-governmental organizations and all those who are yet to embark on maize enterprise in Kaduna state to design and develop effective framework for sustainable livelihood strategies and policies.

1.5 Statement of Hypotheses

- i. there is no significant relationship between socio-economic characteristics and the levels of production efficiency in maize production in the study area.

- ii. there are no significant profit differentials between scale efficient and inefficient maize farmers in the study area.

CHAPTER TWO

LITERATURE REVIEW

2.1 Origin, Uses and Production Trend of Maize in Nigeria

Maize (*Zea mays L.*), a name which is a likely derivative of "*mahis*", meaning "source of life" and also called corn, is one of the most crucial and strategic cereal crops not only in Africa and the developing world but also in developed countries. In addition to food and feed, maize has wide range of industrial applications as well; from food processing to manufacturing of ethanol. The world production of the crop exceeded an average of 673 million tons over the period 1992 to 2012 with America having the highest average production share (53.5%) followed by Asia (28%), Europe (11.4%) Africa (7.1%) and Oceania (0.1%) FAO (2014). Over the same period, even though, Sugarcane was the highest crop produced in the world, maize, occupying the third position in the world's crop production, was the most produced cereal crop in the world in general and in Africa in particular.

Nigeria is the tenth largest producer of maize in the world, and the largest maize producer in Africa, followed by South Africa (IITA, 2012; USAID, 2010; FAO, 2014). An important cereal crop in Nigeria, Maize is produced in all the states of the Federation. It has been in the diet of Nigerians for centuries. It started as a subsistence crop and has gradually become more important crop. It has now risen to a commercial crop on which many agro-based industries depend on as raw materials.

Maize is, on average, the 5th most produced agricultural commodity in the period of 2005-2010, becoming the 3rd most produced crop (by quantity) in the country during 2009 and 2010, after cassava and yams. Most of the production aims to the domestic market, since a negligible part of the production is formally exported (FAOSTAT, 2012). Following the ban imposed by the federal government between examining

production, the average yield growth exceeded 3% between 2000 and 2014 (Table 2.1)

Table 2.1: Maize Production trend in Nigeria from 2000 to 2012

Year	Output (tonnes)	Yield (tonnes/ha)	Growth Rate (%)
2000	891,426	1.30	
2001	903,854	1.40	7.68
2002	576,000	1.49	6.43
2003	612,812	1.50	0.67
2004	655,714	1.60	6.69
2005	576,500	1.66	3.72
2006	577,000	1.82	9.54
2007	579,000	1.70	-6.23
2008	677,170	1.96	14.79
2009	538,458	2.20	12.21
2010	705,700	1.85	-15.75
2011	740,000	1.53	-17.42
2012	765,000	1.81	18.44

Source: FAOSTAT (2014)

Average Yield Growth Rate=3.4

2.2 Efficiency and Productivity

Efficiency and productivity are very similar and cooperating concepts but not equal even though, in the efficiency literature many authors do not make any difference them. For instance, Sengupta (1995) and Cooper, Seaford and Tone (2000) defined both productivity and efficiency as the ratio between output and input. Lovell (1993) defines the efficiency of a production unit in terms of a comparison between observed and optimal values of its output and input. The comparison can take the form of the ratio of observed to maximum potential output obtainable from the given input, or the ratio of minimum potential to observed input required to produce the given output. In these two comparisons the optimum is defined in terms of production possibilities, and efficiency is technical. A couple of efficiency parameters can be identified in the efficiency literature namely: overall technical efficiency, pure technical efficiency, allocative efficiency, economic (overall productive) efficiency and scale efficiency.

2.2.1 Overall technical efficiency (*OTE*)

It refers to the achievement of the maximum potential output from given amounts of inputs, taking into account physical production relationships (Forsund, F. R., C.A.K. Lovell, and P. Schmidt, 1980). It can be measured within two main frameworks: input and output-oriented. In an input-oriented framework, technical efficiency gives the potential input reduction that a farm could apply without reducing its output level. In an output-oriented framework, technical efficiency gives information about the potential output increase that a farm could implement without increasing its use of inputs. In the case of constant returns to scale, both orientations give close results. On the contrary, in the case of variable returns to scale (increasing or decreasing) an additional component, scale efficiency, must be taken into account in the calculation of technical efficiency.

2.2.2 Scale efficiency (*SE*)

Scale efficiency measures the optimality of a farm's size; it determines whether a given farm operates where average and marginal products are equal (Forsund *et al.*, 1980). Scale inefficiency takes two forms- either increasing or decreasing returns to scale. A farm displays increasing returns to scale (*IRS*), also known as economies of scale, if it is too small for its scale of operation. Unit costs decrease as output increases. In contrast, a farm will display decreasing returns to scale (*DRS*) if it is too large for the volume of activities that it conducts. Unit costs increase as output increases.

2.2.3 Pure technical efficiency (*PTE*)

The efficiency measures obtained from Banker, Charnes and Cooper (*BCC*) model are popularly known as pure technical efficiency (*PTE*) scores and devoid of scale efficiency effects.

2.2.4 Allocative efficiency (*AE*)

It measures the distance between the farm and the point of maximum profitability, given market prices of inputs and outputs. In other words, the allocative efficiency shows whether the use of different proportions of production factors guarantees the attainment of maximum production with a particular market price (Forsund *et al.*, 1980).

2.2.5 Overall /economic efficiency (*OE/EE*)

It is the product of technical and allocative efficiency (overall efficiency). It can be interpreted as the potential reduction in production costs (cost efficiency) or the potential increase in revenue (revenue efficiency) that a farm could apply in order to operate at the point of technical and allocative efficiency. Economic efficiency enables conclusions to be drawn on whether the farm operates at optimal or suboptimal size. A farm that is economically efficient should by definition be both technically and allocatively efficient (Rahman, 2013).

2.3 Levels of Production Efficiency in Maize Production in Nigeria

In a study of the measurement of technical efficiency of maize production using parametric and non-parametric methods in Oyo state, Nigeria by Ogunniyi and Ajao (2011) the overall technical efficiency was 0.659 and 0.326 based on Stochastic Frontier Analysis (*SFA*) and Data Envelopment Analysis (*DEA*) respectively. Under the prevailing conditions, about 11% and 40% of farms were identified as fully technically efficient under Constant Return to Scale (*CRS*) and Variable Return to Scale (*VRS*) specification respectively. The observed difference between *CRS* and *VRS* measures of technical efficiency further indicated that some of the farmers did not operate at an

efficient scale and improvement in the overall efficiencies could be achieved if the farmers adjusted their scales of operation. Globally, the mean efficiency scores estimated using different approaches (*SFA* and *DEA*) were unequal. This makes sense as each model is developed under different assumptions. However, the efficiency scores estimated via *DEA* were less than those estimated via Stochastic Frontier Analysis (*SFA*). This result was consistent with the belief that given the fact that any deviation from the frontier is attributed to inefficiency in the *DEA* model, the generated efficiency scores would be less than those obtained through *SFA*.

2.4 Factors Affecting Production Efficiency Levels

Hassan (2014) studied the relationship between socioeconomic factors of poultry egg farmers and their level of scale efficiency in his PhD dissertation entitled *Analysis of Profitability and Production Efficiency of Poultry Egg Enterprise in Kaduna State, Nigeria*. The results of his analysis revealed a significant relationship between the model and the levels of scale efficiency of commercial poultry egg production. Four socioeconomic factors were considered namely level of education, farming experience, membership of association and amount of credit used. All the factors were positively related to scale efficiency levels and therefore consistent with the a priori expectation. Their overall effect on scale efficiency levels was significant at 1% level of probability. However, only education and farming experience significantly influenced scale efficiency levels at 1 and 10% respectively.

2.5 Return to Scale in Maize Production in Nigeria

Zalkuwi *et al.* (2010) conducted an analysis of economic efficiency of maize production in Ganye local Government Area Adamawa state, Nigeria. Based on parametric approach to efficiency analysis, stochastic frontier Cobb-Douglas production function model was fitted into the data to study the relation between the inputs and output and

between the socioeconomic characteristics of farmers and their inefficiency levels. Fisher test was then used to test the type of return to scale involved in the production of maize in the study area. The results revealed that maize production in the study area exhibited an increasing return to scale as the estimated return to scale was found to be 1.252. In other words there were economies of scale in maize production in the study area.

In a study entitled resource-use efficiency among small scale irrigated maize producers in Northern Taraba State of Nigeria, Gani and Omonona (2009) estimated a Cobb-Douglas production function of maize using 120 maize farmers. The sum of the elasticities of output with respect to the various inputs considered was 0.961 suggesting that maize production in the study area exhibited a decreasing return to scale.

Ogundari, Ojo and Ajibefun (2006) adopted a parametric approach to study the Economies of Scale and Cost Efficiency in Small Scale Maize Production: Empirical Evidence from Nigeria. Both the stochastic frontier Cobb-Douglas production and cost functions were estimated using 200 maize farmers. The results revealed that there was a relative presence of economies of scale among the farmers suggesting that an average farm in the sampled area produced at a minimum cost considering the size of the farm which was an indication that they were operating in stage II of production surface (stage of efficient utilization of resource).

2.6 Cost and Return in Maize Production in Nigeria

Mohammed, Ayanlere, Ibrahim, and Lawal (2013) assessed the profitability of maize production in a study entitled Economic Analysis of Maize Production in Ogori/Magongo Local Government Area of Kogi State, Nigeria. The results revealed that total revenue realized through the sale of maize output was ₦64, 525. The Gross

margin per hectare was ₦19, 688 suggesting that maize was profitable in the area. Further analysis on the return on investment showed that maize had a profitability index of 0.43 indicating that the farmers earn 0.43 on every naira invested into production. The implication of the finding was that maize production was profitable in the study area with about 43% turn over on investment, however there was room for improvement if resources were to be utilized efficiently.

Ugwumba and Omojola (2012) studied the allocative efficiency and profitability of maize production inputs in Oru East Local Government Area of Imo State, Nigeria. The net farm income method was used to assess maize production profitability in the study area. The result revealed that farmers realized a net farm income and net return on investment values of ₦1,511,905 and 0.86 respectively. The net return on investment value of 0.86 implied that the farmers returned 86 kobo for every 100 kobo invested in maize production. By this result, maize production in the area was profitable.

2.7 Analytical review

This section deals with some important models that will be employed in the analysis of data for this research work.

2.7.1 Modeling efficiency: parametric and non-parametric approaches

Estimation of a production frontier differs depending on the assumptions made about the outer bound of the frontier, which may be deterministic or stochastic, while the technique for estimation may be parametric, or non-parametric. Currently, the stochastic frontier and the deterministic non-parametric methods are the primary approaches and these involve econometric methods and mathematical programming respectively (Coelli, 1995).

2.7.2 Data envelopment analysis (DEA)

DEA is a non-parametric mathematical programming approach to frontier estimation. It involves the use of linear programming methods to construct a non-parametric piecewise surface (frontier) over the data, so as to be able to calculate efficiencies relative to this surface (Coelli, 1996). Unlike the parametric (statistical) approach that relies on functional form, *DEA* is a data based-method. Since the seminal work of Farrell (1957) presented to the Royal Statistical Society, a significant body of literature has been directed towards the estimation of the frontier models of production technology and calculation of the efficiency measures for the producing agents as well as the industries (Elyas and Seyed, 1993). Two basic models of *DEA* will be considered in this review namely Charnes, Cooper and Rhodes (*CCR*) model and Banker, Charnes and Cooper (*BCC*) model.

2.7.2.1 *The charnes, cooper and rhodes (CCR) model: input/output oriented framework*

The Charnes, Cooper and Rhodes (1978) proposed a model which had an input orientation and assumed constant return to scale. The model is also known as Constant Return to Scale model. According to Coelli (1996) technical efficiency estimated using input-oriented model is equal to that estimated using output-oriented model under constant return to scale assumption. Therefore we will present only the input-oriented model of Charnes, Cooper and Rhodes.

Assume there is data on K inputs and M outputs on each of N farm households also called Decision Making Units (*DMU*) in the *DEA* literature. For the i^{th} *DMU* these are represented by the vectors x_i and y_i respectively. The $K * N$ input matrix X and the $M * N$ output matrix Y represent the data of all the N farm households (*DMU*'s). The

purpose of *DEA* is to construct a non-parametric envelopment frontier over the data points such that all observed points lie on or below the production frontier. For each

DMU we would like to obtain a measure of all outputs to all inputs, such as $u'y_i/v'x_i$,

where u is a $M * 1$ vector of output weights and v is a $K * 1$ vector of input weights. To

select optimal weights we specify the mathematical programming problem:

$$Max_{u,v} \left(\frac{u'y_i}{v'x_i} \right) \dots\dots\dots (1)$$

$$St \quad \frac{u'y_j}{v'x_j} \leq 1, j = 1 \dots N$$

$$u, v \geq 0$$

This involve finding u and v such that the efficiency measure of the i^{th} *DMU* is maximized, subject to the constraints that all efficiency measure is less or equal to 1.

The above program is unbounded. In order to circumvent this issue, the following model can be considered

$$\begin{aligned} & \dots\dots\dots (2) \\ St & \dots\dots\dots, \\ & \dots\dots\dots, \\ & \dots\dots\dots, \end{aligned}$$

Equation (2) is called the multiplier form of equation (1). Using the duality transformation in linear programming, one can derive an equivalent envelopment form of this problem.

$$\begin{aligned} & \theta \min_{\theta} \quad (3) \\ \text{St} & \quad \theta \leq 1 \\ & \quad \theta \geq 0 \end{aligned}$$

Where

θ Objective function (a scalar) that represents the minimum level to which the use of inputs can be reduced without altering the output level. It is the overall technical efficiency score (*OTE*) for the DMU (Rahman, 2013)

If $\theta = 1$, then DMU lies on the frontier and it is therefore technically efficient (Farrell, 1957)

If $\theta < 1$, then DMU lies beneath the frontier and it is therefore technically inefficient (Farrell, 1957)

θ vector of constants

Equation (3) is the envelopment form of equation (2) and is the form to solve.

2.7.2.2 The banker, charnes and cooper (BCC) model: input oriented framework

Also known as Variable Return to Scale model (*VRS*), *BCC* model is appropriate when *DMU's* are not operating at their optimal scale (Coelli, 1996). Failure to operate at optimal scale might be due to imperfect competition, constraints on finance, etc... (Coelli, 1996). Banker, Charnes and Cooper (1984) suggested an extension of the *CRS* *DEA* model to account for variable return to scale (*VRS*) situation. The use of *CRS* specification when not all *DMU's* are operating at optimal scale will result in the measures of technical efficiencies which are confounded by scale efficiencies (*SE*). The use of the *VRS* specification will permit the computation of Technical Efficiencies (*TE*) devoid of these scale effects. The linear programming problem to solve in this context can be written as:

$$\begin{matrix}
 \boxed{x} & \dots\dots\dots & (4) \\
 \text{St } \boxed{x} & & \\
 \boxed{x} & & \\
 \boxed{x} & & \\
 \boxed{x} & & \\
 \text{Where:} & & \\
 \boxed{x} \quad \boxed{x} & \text{vector of ones} &
 \end{matrix}$$

2.7.2.3 The banker, charnes and cooper (BCC) model: output oriented framework

The output-oriented models of *BCC* are very similar to their input-oriented *VRS* counterparts.

$$\begin{matrix}
 \boxed{x} & \dots\dots\dots & (5) \\
 \text{St } \boxed{x} & & \\
 \boxed{x} & & \\
 \boxed{x} & & \\
 \boxed{x} & & \\
 \text{Where;} & & \\
 \boxed{x}, & &
 \end{matrix}$$

\boxed{x} = proportional increase in outputs that could be achieved by the \boxed{x} DMU, with input quantities held constant.

\boxed{x} Output *TE* score which varies between 0 and 1

After estimating the *VRS DEA* one can assess whether the derived *VRS DEA* TE also called pure technical efficiency is different from the one generated from *CRS DEA*. Any observed difference between these two measures indicates the presence of scale inefficiencies in production. Mathematically,

That is, scale efficiency is the ratio of *CRS TE* to *VRS TE* (Pure technical efficiency).

The presence of scale inefficiency can be due to either increasing or decreasing return to scale.

If implies scale efficiency or constant return to scale.

If the implication is that scale inefficiency that can be due to either increasing or decreasing return to scale. The type of scale inefficiency can be determined by running another program with non-increasing return to scale (*NIRS*) imposed. That is,

The *VRS DEA* program can be altered by replacing by . According to Cesaro, L., Marongiu, S., Arfini, F., Donati, M., Capelli, M.G. (2009) if:

, then the units are producing at decreasing return to scale.

, then the units are producing at increasing return to scale.

, then the units are producing at constant return to scale.

It is worth noting that the choice of appropriate orientation is dependent upon whether or not DMU's have more control over inputs or output (Coelli, 1996). Thus, in agriculture it will be more reasonable to choose the output-oriented framework over the input oriented framework since farmers are naturally expected to maximize their output with given amount of inputs.

2.7.2.4 *DEA economic efficiency (EE) and allocative efficiency (AE) under CRS*

DEA EE and *DEA AE* are estimable only when input prices are available. Thus, in the presence of price of inputs and outputs one can consider achieving behavioral objective

by solving a cost minimization problem and profit maximization problem respectively. It is worth noticing that *DEA EE* and *DEA AE* are estimable only under input-oriented framework. In order to estimate economic efficiencies of *DMU's* assuming *CRS*; one should initially run equation (3), then the following cost minimization problem should be run.

$$\begin{aligned} & \min \theta \\ \text{St } & \theta \sum_{i=1}^m p_i x_{ij} - \sum_{r=1}^s q_r y_{rj} \\ & \theta \sum_{i=1}^m p_i x_{ij} - \sum_{r=1}^s q_r y_{rj} \\ & \theta \sum_{i=1}^m p_i x_{ij} - \sum_{r=1}^s q_r y_{rj}, \end{aligned} \quad (7)$$

Where

- θ Vector of input prices
- θ^T Transposed form of vector of input prices
- $\theta^T x_j$ Cost minimizing vector of input quantities for the j *DMU*, given the input prices θ and the output quantities y_j . The economic efficiency would then be calculated as follows

$$\theta^T x_j$$

In words, *DEA EE* is the ratio of minimum cost to observed cost. *DEA* Allocative efficiency (*AE*) can then be estimated as

$$\frac{\theta^T x_j}{\theta^T x_{j0}}$$

In words, *DEA AE* is the ratio of *EE* to *TE*.

2.7.2.5 *DEA economic efficiency and DEA allocative efficiency under VRS*

If we assume *VRS*, equation (4) should be estimated rather than equation (3) in the first stage to obtain technical efficiency. Equation (7) should then be estimated in the second

stage to obtain the minimum cost of production. Finally equation (8) and (9) will be used to estimate *DEA EE* and *DEA AE* respectively.

2.8 The Concept and Measurement of Return to Scale (RTS)

According to a standard definition in economics, *RTS* express the relation between a proportional change in inputs to a productive process and the resulting proportional change in output. If an $n\%$ rise in all inputs produces an n per cent increase in output, there are constant returns to scale (*CRS*). If output rises by a larger percentage than inputs, there are increasing returns to scale (*IRS*). If output rises by a smaller percentage than inputs, there are decreasing returns to scale (*DRS*).

Mathematically, suppose that we are using some vector of inputs \mathbf{x} to produce a vector of outputs \mathbf{y} and we decide to scale up or down all inputs by some amount λ . Let us assume that the technology employed by a given firm can be smoothed and represented by the production function $f(\mathbf{x})$ which represents its production process.

A technology exhibits increasing return to scale if $f(\lambda \mathbf{x}) > \lambda f(\mathbf{x})$ for all $\lambda > 1$.

A technology exhibits decreasing return to scale if $f(\lambda \mathbf{x}) < \lambda f(\mathbf{x})$ for all $\lambda > 1$.

A technology exhibits constant return to scale if $f(\lambda \mathbf{x}) = \lambda f(\mathbf{x})$ for all $\lambda > 0$; that is the production function $f(\mathbf{x})$ is homogeneous of degree 1.

2.9 Censored Data/Observations

In some data sets we do not observe values above or below a certain magnitude, due to a censoring or truncation mechanism. A sample contains censored data/observations if the only information about some of the observations is below or above a specified value

also called threshold (Peng, 2010). Data can be left, right and interval censored. A left censored data is one that is known only to be less than some value, e.g. per capita expenditure < \$1.25. A right censored data is one that is known only to be more than some value e.g. per capita expenditure > \$1.25. A value is interval censored if it is reported as being within a specified interval, e.g. \$1 < per capita expenditure < \$1.25.

Technically, y_i is censored when we observe y_i^* for all observations, but we only know the true value of y_i for a restricted range of observations. Values of y_i in a certain range are reported as a single value or there is significant clustering around a value, say 0.

If $y_i < c$ or $y_i > c$ for all y_i , then y_i is censored below or left censored.

If $y_i < c$ or $y_i > c$ for all y_i , then y_i is censored above or right censored.

We usually think of an uncensored y_i the true value of y_i when the censoring mechanism is not applied. We typically have all the observations for $y_i < c$ but not $y_i > c$.

2.10 Modeling Censored Data: Tobit /Censored Regression Model

Statistical methods for dealing with censored data have a long history in the field of survival analysis and life testing (Kalbeisch and Prentice, 1980). In the context of policy implications, it is more important to determine for instance what influences efficiency (or to which variables it is related) than simply measuring it (Dina and Peter, 2009). It is known that data on production efficiency levels in general lie between 0 and 1 and are therefore interval censored based on the above definitions. Tobit model estimation was originally developed by Tobin (1958) to fit such data. The model can be presented as follows.

Let y be a continuous non-negative dependent variable representing the level of efficiency of a farm household and X an independent variable (vector). To model the relation between the observed y and X we consider a latent variable y^* that is subject to constraint. A change in X affects y only through its effect on y^* . The Tobit model can be defined in terms of the latent variable as

Suppose y^* is observed only if $y^* > 0$. Then the observed y will be defined as

$$y = \begin{cases} y^* & \text{if } y^* > 0 \\ 0 & \text{if } y^* \leq 0 \end{cases}$$

Where

$$y^* = X\beta + \epsilon$$

X Matrix of independent variables

β Matrix of regression coefficients including intercept term

It is worth noted that y^* represent the true value of y when it is below or above some thresholds but is unobservable because of censoring.

2.11 Profitability Analysis: Concept and Measurement of Profit

Only the most profitable survive in today's business climate. While companies strive to boost sales, cut costs, and increase market share – no business model can withstand a lack of profit. The word profitability is composed of two words, namely; profit and ability. Sometimes, the terms profit and Profitability are used interchangeably. But in real sense, there is a difference between the two. Profit is an absolute term, whereas, the profitability is a relative concept. However, they are closely related and mutually interdependent, having distinct roles in business. Profit refers to the total income earned

by the enterprise during the specified period of time while profitability refers to the operating efficiency of the enterprise (“Profitability analysis”, 2009). Profitability means ability to make profit from all the business activities of an organization, company, firm, or an enterprise. It shows how efficiently the management can make profit by using all the resources available in the market. In order to evaluate the profitability of a farm household, two fold analyses can be undertaken, namely; profitability analysis from the management point of view and profitability analysis from the shareholders’ point of view. However for the purpose of this study only the former will be considered.

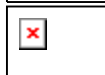
2.11.1 Profitability from the point of view of management

Three important ratios are usually considered at this point: Gross Profit/Margin (*GP*) ratio, Net Operating Profit (*NOP*) to Net Revenue ratio, and Return on Capital Invested (*RCI*).

2.11.1.1 Gross margin ratio (GMR)

It expresses the relationship between gross profit and net revenue. The main objective of computing this ratio is to determine the efficiency with which operations are carried on.

The ratio can be expressed mathematically as



Gross Margin Ratio



Gross Margin = Total Revenue – Operating Cost



Net Revenue = Total Revenue after tax

A high ratio of gross Margin to net revenue is a sign of good moment as it implies that the operating cost is relatively low while the revenue is either constant or increasing.

2.11.1.2 Net margin/income ratio (NMR)

Profit being an absolute figure fails to indicate the adequacy of income or changes in

efficiency resulting from financial and operational performance of an enterprise.

The *NMR* expresses the relationship between net operating profit and net sales. It is the excess of gross profit over non operating expenses and depreciation. This ratio helps to find out the profit arising out of the main business. In other words this ratio helps to determine the efficiency with which affairs of business are being managed. A high ratio indicates the improvement in the operational efficiency of the business and vice versa.

Mathematically

<input type="checkbox"/>	
<input type="checkbox"/>	Net Margin Ratio
<input type="checkbox"/>	Net Margin = Gross Margin – (Non-operating expenses + Depreciation)
<input type="checkbox"/>	Net Revenue = Total Revenue after tax

2.11.1.3 *Return on ₦1 invested (ROI)*

This is the most important ratio for testing profitability of a business. It measures satisfactorily the overall performance of a business in terms of profitability. This Ratio expresses the relationship between profit earned and capital employed to earn it. It is more appropriate for evaluating the efficiency of internal management. It indicates how well the management has utilized the funds supplied by the owners and creditors. In other words, this ratio intends to measure the return on one naira invested. It can be expressed mathematically as

<input type="checkbox"/>	
<input type="checkbox"/>	Return on ₦1 invested
<input type="checkbox"/>	Total Cost of production

A high value of is an indication of better performance

CHAPTER THREE

METHODOLOGY

3.1 The Study Area

This study was conducted in Giwa Local Government Area of Kaduna State which is located between latitude 11° N and 12° E of the prime meridian. It has an area of 2,066 km² and an estimated population of 286,427 (Oguntolu, 2005). Kaduna state is located in the savannah ecological region of Nigeria, with a cultivable area of about 34,000 km², the actual area cultivated is 32,320 km² from an estimated land area of about 43,000km² (Oguntolu, 2005).

The typical weather is mostly characterized by constant dry and wet seasons. The rains begin in April/May and stops around October, while the dry season begins in late October and ends in March of the following year. Relative humidity varies between 20% and 40% in January, and 60% and 80% in July. The mean annual high temperature also varies between 28° and 34°. Upland farming is practiced by farmers in Giwa LGA. There are 23 Local Government Areas in Kaduna State from which Giwa LGA will be purposively selected. The cropping system in the area is dominated by mixed cropping, although sole cropping is practiced. In addition, significant parts of the population are involved in livestock keeping which depend on grazing (Oguntolu, 2005). The Nomadic Fulanis predominantly do the livestock rearing.

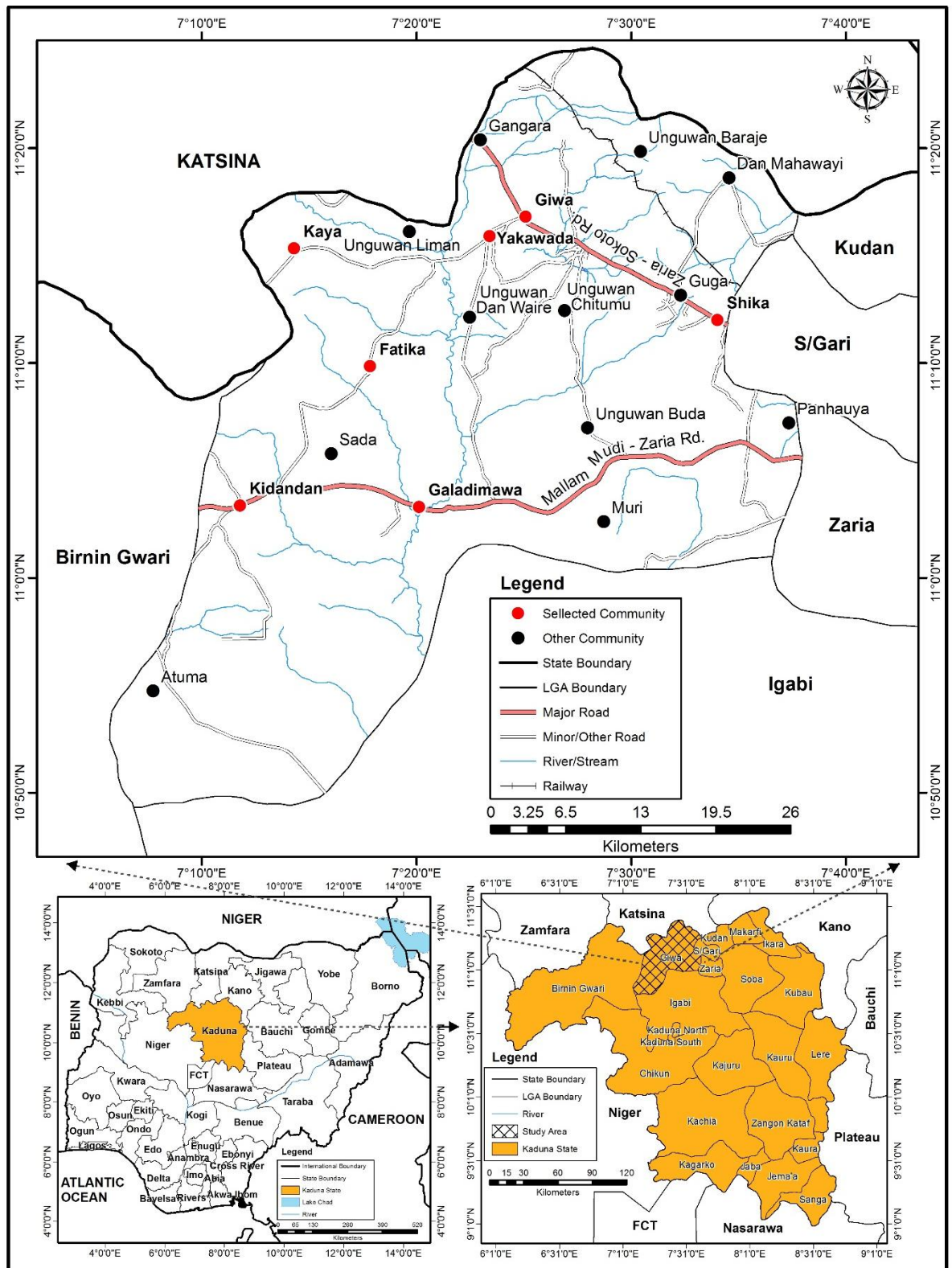


Figure 1: Map of Giwa L.G.A showing Selected Communities

Source: Adapted from the Administrative Map of Kaduna State

3.2 Sample Size and Sampling Technique

Giwa Local Government Area was purposively selected for this research because of prevalence of maize producers in the area. Based on the list of maize farmers obtained from the Agricultural Development Programme, a multi-stage sampling procedure was applied to the population of maize farmers from the area under study. In the first stage, seven wards were purposively selected based on the intensity of maize production in the study area. The wards include Shika, Giwa, Likoro, Galadima, Yakawada, Hayin Madara and Kidandan. Secondly, a community was randomly selected from each of the wards. In the second stage, 10 percent of maize farmers were randomly selected from a sample frame of 1,900 maize farmers using simple random sampling technique, and interviewed from each ward to make up a sample of 190 farmers.

3.3 Data Collection

Primary data was collected from maize farmers using a survey method involving the administration of well structured questionnaires. The socio-economic data collected include sex of respondent, age, household size, marital status, farming experience, and formal education levels. Production information collected include size of farmland owned, land tenure system, size of land under maize production, type of labor used in production, varieties of seed planted, amount of seed planted, fertilizer application, and seasonal yields. Amount of credit, access to extension services and amount of fertilizers used. The output data includes the total value of maize produced by adding cash receipts from selling farm products plus those consumed at home and given out as gifts while the input data include land size (ha), labor (man days), quantity of seeds (kg), quantity

of fertilizers (kg), and cost of simple farm tools such as cutlass, hoes and other farm implements. For the cost function analyses, output data includes the total input cost of production, while input data includes the cost of labor, average cost of fertilizer, average cost of seeds, average cost of agro chemicals, and average cost of simple farm tools. Data about constraints faced by maize farmers and suggestions to increase their outputs were collected. Data for the 2013/2014 cropping season was collected.

3.4 Analytical Technique

This section deals with the different analytical techniques and empirical specification of the models that were used for the analysis of the different objectives of the study. The analytical tools include Data Envelopment Analysis models, Tobit regression model, Gross margin analysis, T-statistics, F-statistics and descriptive statistics.

3.4.1 Descriptive statistics

This was used to describe the socio-economic characteristics of maize producers and their constraints to maize production in the study area in objectives i and vi. This involves the use of frequency distribution, mean and standard error to describe the constraints being faced by maize farmers.

3.4.2 Data envelopment analysis (DEA) models

A set of DEA models was run to determine production efficiency levels objective ii.

3.4.2.1 The charnes, cooper and rhodes (CCR) model

This enabled the estimation of the overall technical efficiency in objective ii. The empirical model is specified as follows

$$\begin{matrix}
 \boxed{\times} & \dots\dots\dots & (14) \\
 \text{St} \boxed{\times} & &
 \end{matrix}$$

x

x

Where;

- x Overall technical efficiency (OTE)
- x Column vector of Weights (Multipliers of inputs)
- x Quantity of maize output harvested by the x farmer (kg)
- x Column Matrix of maize output for all the farmers in the sample
- x Column Matrix of inputs for all the maize farmers in the sample
- x Column Matrix of Inputs for the x maize farmer
- x Quantity of seeds used by the x maize farmer (kg)
- x Quantity of fertilizer used by the x maize farmer (kg)
- x Quantity of insecticide used by the x maize farmer (litre)
- x Farm size used by the x maize farmer (ha)
- x Amount of both owned and hired labour used by the x maize farmer (man-day)
- x and $i = 1 \dots 190$

3.4.2.2 The input-oriented banker, charnes and cooper (BCC) model

This model enabled the estimation of the pure technical efficiency scores in objective ii.

The model can be empirically specified as follows.

$$\begin{aligned}
 & \text{Minimize } \theta \\
 \text{St } & \theta z_i \leq \sum_{j=1}^n \lambda_j z_{ij} \\
 & \sum_{j=1}^n \lambda_j x_{ij} \leq x_{oi} \\
 & \sum_{j=1}^n \lambda_j = 1 \\
 & \lambda_j \geq 0, \quad j = 1, \dots, n
 \end{aligned} \tag{15}$$

Where;

- Overall technical efficiency (OTE) under VRS assumption
- Column vector of Weights (Multipliers of outputs)
- Quantity of maize output harvested by the farmer (kg)
- Column Matrix of maize output for all the farmers in the sample
- Column Matrix of inputs for all the maize farmers in the sample
- Column Matrix of observed inputs for the maize farmer
- Quantity of seeds used by the maize farmer (kg)
- Quantity of fertilizer used by the maize farmer (kg)
- Quantity of agrochemicals used by the maize farmer (litre)
- Farm size used by the maize farmer (ha)
- Amount of both owned and hired labour used by the maize farmer (man-day)
- and $i = 1 \dots 190$

3.4.2.3 The ratio of to

This enabled the estimation scale efficiency levels in objective ii, mathematically it can be written as

$$\frac{\text{Scale efficiency level of the } \text{maize farmer}}{\text{Technical efficiency level of the } \text{maize farmer under CRS}}$$

- Scale efficiency level of the maize farmer
- Technical efficiency level of the maize farmer under *CRS*
- Technical efficiency level of the maize farmer under *VRS*

3.4.2.4 DEA economic efficiency (EE) under VRS

The economic efficiency level in objective ii for each farmer was estimated in two steps.

Step 1: Estimation of the Cost-minimizing vector of inputs for the maize farmer

$$\text{Minimize } \sum_{j=1}^n w_j x_{ij} \dots \dots \dots (17)$$

St $\sum_{j=1}^n w_j y_{rj} \geq y_{ri}$

<input type="text"/>
<input type="text"/>
<input type="text"/>

Where;

- Vector of input prices incurred by the farmer
- Price of seed incurred by the farmer for the production of maize (₦)
- Price of fertilizer incurred by the farmer for the production of maize (₦)
- Price of agrochemicals incurred by the farmer for the production of maize (₦)
- Price of land incurred by the farmer for the production of maize (₦)
- Price of the amount of both owned and hired labour used by the maize farmer (₦)
- Column vector of Weights (Multipliers of outputs)
- Quantity of maize output harvested by the farmer (kg)
- Column Matrix of maize output for all the farmers in the sample
- Column Matrix of inputs for all the maize farmers in the sample
- Cost-minimizing vector of inputs for the maize farmer
- Cost-minimizing quantity of seeds to be used by the maize farmer (kg)
- Cost-minimizing quantity of fertilizer to be used by the maize farmer (kg)
- Cost-minimizing quantity of agrochemicals to be used by the maize farmer (litre)
- Cost-minimizing Farm size to be used by the maize farmer (ha)
- Cost-minimizing amount of both owned and hired labour used by the maize farmer (man-day)
- and $i = 1 \dots 190$

Step 2: Estimation of the economic efficiency level of the maize farmer

<input type="text"/>

Where

- Economic efficiency level of the maize farmer
- Transposed vector of inputs incurred by the maize farmer
- Cost-minimizing vector of inputs for the maize farmer
- Column Matrix of observed inputs for the maize farmer

3.4.2.5 Allocative efficiency (AE) under VRS

The estimation of allocative efficiency level of each maize farmer in objective ii was obtained through the following ratio

$$\frac{\text{AE}}{\text{EE}} = \frac{\text{TE}}{\text{AE}}$$

Allocative efficiency level of the maize farmer
 Economic efficiency level of the maize farmer
 Technical efficiency level of the maize farmer under VRS

3.4.3 Non-increasing return to scale BCC model

This model was used to estimate the return to scale of each maize farmer in objective iii.

The model can be specified as follows:

$$\text{Min } \theta$$

St $\theta z_j \leq \sum_{i=1}^n x_{ij} \lambda_i$

$$\sum_{i=1}^n \lambda_i = 1$$

$$\lambda_i \geq 0$$

Where;

- Overall technical efficiency under NIRS assumption
- Column vector of weights (Multipliers of outputs)

- Quantity of maize output harvested by the farmer (kg)
- Column Matrix of maize output for all the farmers in the sample
- Column Matrix of inputs for all the maize farmers in the sample
- Column Matrix of observed inputs for the maize farmer
- Quantity of seeds used by the maize farmer (kg)
- Quantity of fertilizer used by the maize farmer (kg)
- Quantity of agrochemicals used by the maize farmer (litre)
- Farm size used by the maize farmer (ha)
- Amount of both owned and hired labour used by the maize farmer (man-day)
- and $i = 1 \dots 190$
- represents the non-convexity assumption. If,
- , then the units are producing at decreasing return to scale.
- , then the units are producing at increasing return to scale.
- , then the units are producing at constant return to scale.

3.4.4 Tobit regression model

It was used to determine the relationship between socio-economic characteristics of maize farmers their levels of production efficiency in objective iv. The empirical model can be specified as follows:

$$\begin{aligned}
 & \text{if } \\
 & \text{if } \\
 & \text{if }
 \end{aligned}$$

Where

$$Y_{ij} = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \beta_3 X_{i3} + \beta_4 X_{i4} + \beta_5 X_{i5} + \beta_6 X_{i6} + \beta_7 X_{i7} + \beta_8 X_{i8} + \beta_9 X_{i9} + \beta_{10} X_{i10} + U_i$$

Where;

Y_{ij} = Observed production efficiency level of the maize farmer

Y^*_{ij} = Latent variable measuring the true production efficiency level of the maize farmer

Where;

X_{i1} = Dummy Variable for tenure status (1= farmer is an owner-operator; 0 = otherwise)

X_{i2} = Dummy Variable for gender of respondent (1= farmer is male; 0 = female)

X_{i3} = Years of schooling completed by the maize farmer

X_{i4} = Number of people in the household of the maize farmer

X_{i5} = Number of working family members in the farm household of the maize farmer

X_{i6} = Age of the maize farmer

X_{i7} = Number of years the farmer has been producing maize.

X_{i8} = Area planted to maize by the farmer

X_{i9} = Total income obtained from non-agricultural sources

X_{i10} = Number of years of contact with extension agents

$i = 1 \dots 190$

When

, Overall technical efficiency level of the maize farmer

, Pure technical efficiency level of the maize farmer

, Scale efficiency level of the maize farmer

, Allocative efficiency level of the maize farmer

, Economic technical efficiency level of the maize farmer







3.4.5 Gross margin model


This was used to estimate the profit differentials between scale efficient and inefficient maize farmers in objective v. The model can be presented as follows:



Where;

 Gross margin of the  maize farmer

 Total revenue of the  maize farmer (Value of output sold) in naira

 Total cost of production (operating + depreciation) of maize output incurred by

the  smallholder farmer

3.5 Hypothesis Testing


3.5.1 One-way anova model


3.5.2 T-test statistics

The t-statistic was used to test hypothesis i of the study. The t-statistic is expressed as follows:



Where;

 Estimated t-value

 Average gross margin

Standard error of GM

3.5.3 F-test statistics

The F-statistic was used to test hypothesis ii of the study. The F-statistic is generally expressed as follows:

Where:

Estimated F-value

Explained Sum of Squares

Residual Sum of Squares

Degree of freedom

Number of independent variables including the intercept

Number of observations

3.6 Definition, Measurement and a Priori Expectation of the Independent Variables

3.6.1 Gender

It captures the difference in productive efficiency level between male-headed and female-headed farm households. It is a dummy variable taking the value of 1 if a farmer is male and 0 if female. In Nigeria, males and females have differential access to agricultural services in favour of males. Besides, household heads are normally males and a female becomes head of a household in the absence of a surviving male who is old enough to be head of household. Given this situation, females are likely to have

fewer years of experience as household heads compared to their counterparts. Furthermore, Quisumbing (1994) reported that there has been a great disparity between women and men in the size of landholdings. Or the size of farm can affect productive efficiency. On this basis, it is expected that farm households headed by males would be more efficient compared to those headed by females. Thus, gender is hypothesized to be positively associated with productive efficiency.

3.6.2 Age

It represents a household head's age and it is measured in years. Household head's age is an important factor that influences productive efficiency levels (. The head of a household takes production management decisions on behalf of the household. It can be either positively or negatively related to productive efficiency levels. It is expected that older household heads would have more experienced and would be more efficient in crop production than their counterparts (Abatania, Hailu and Mugeru, 2012). On this basis, age is expected to have a positive influence on productive efficiency levels. However it is often presumed that younger farmers with a longer planning horizon and who are willing to take risk are more likely to try innovative practices (Polson and Spencer, 1991). These innovations are likely to make younger farmers would have greater productive efficiency than their counterparts. In such a situation age would have a negative effect on technical efficiency.

3.6.3 Age squared

It captures the possible non-linearity between age and productive efficiency levels. It is measured as the square of a farmer's age. It is expected to be of different sign from that

of age. Specifically, if age is positive, age squared is expected to be negative therefore implying that younger farmers are more experienced than their counterparts up to a certain threshold beyond which any increase in age would cause younger farmers to be less efficient than their counterparts. In the contrary, if age is negative then age squared would be expected to be positive therefore suggesting that as age increases productive efficiency levels decreases suggesting that up to a threshold where any additional increase in age would translate to an increase in productive efficiency.

3.6.4 Education level

The level of education of the household head can influence productive efficiency levels. It captures the differences in productive efficiency levels across formally and non-formally educated maize farmers. It is a dummy variable taking 1 if household head is formally educated and 0 otherwise. Education level has been found to be positively related to technical efficiency levels by a number of researchers (Ng'ombe and Kalinda, 2015; Mburu, Ackello-Ogutu and Mulwa, 2014). In effect, education constitutes an asset which determines credit access through on-farm efficiency (Feder *et al.*, 1988). Credit, on the other hand, is pertinent for changes in productivity and promotion of standard of living by breaking vicious cycle of poverty by the small scale farmers (Ololade and Olagunju, 2013).

3.6.5 Household size

It represents the number of members of a farm household living under the same roof and eating from the same pot. Household members can provide the needed family labour force for farm production (Ali, Parikh and Shah, 1994; Iheke, 2008). In Nigeria, household sizes are large on average (Ohajianya, 2012; Dimelu *et al.*, 2009; Mitiku,

2014). However, the influence of large family size on productive efficiency can be either positive or negative. Large household size can positively influence productive efficiency levels if it guarantees the availability of family labour for farm operations to be accomplished on time (Ali, Parikh and Shah, 1994; Aye and Mungatana, 2012; Iheke, 2008). Contrarily, large household size can negatively influence productive efficiency levels if the increase in household size is associated with reduction of farm investments due to increase in family consumption expenditures (Oyewo, 2011). Thus, the sign of household size on productive levels is hypothesized to be inconclusive.

3.6.6 Membership farmers' association

Farmers' association may be beneficial to its members as it can enable its members to acquire better prices for their products and as well as the provision of goods and services to members at lower costs through bulk purchasing and bulk service arrangements (pecuniary economies). It takes the value of 1 if a farmer is a member of any farmers' association and 0 otherwise. Membership of farmers' association is an important factor that influences the adoption of new technologies through the acquisition of credit (Sebopetji and Belete, 2009; Chauke, Motlhatlhana, Pfumayaramba and Anim, 2013). Specifically, membership of farmers' association influences technical efficiency positively (According to Iheke, (2008); Okike, 2000 and Onyenweaku and Ohajianya, 2005). Thus, membership of farmers' association is hypothesized to be positively related to productive efficiency levels.

3.6.7 Credit access

It represents the difference in productive efficiency levels between farmers with access to credit and those without access to credit. It takes the value of 1 if a farmer has access to credit and 0 otherwise. The importance of credit in agricultural productivity cannot be over-emphasized. It increases the ability of poor household with little or no savings to

acquire inputs (Iheke, 2008). Agricultural credit enhances productivity and promotes standard of living by breaking vicious cycle of poverty of small scale farmers. It is therefore hypothesized to be positively related to productive efficiency.

3.6.8 Extension contact

It controls for the difference in productive efficiency levels between farmers having contact with extension agents and those without contact with extension agents. It is measured as 1 if a farmer has contact with extension agents and 0 otherwise. In the literature, extension contact has been proven to be important in terms of increasing the likelihood to adopt improved varieties. Kassa, Kakrippai and Legesse (2013) showed that extension contact had greater impact on adoption of improved maize variety in West Harerghe zone of Ethiopia than factors such as land and livestock ownership. Extension contact is, thus, hypothesized to influence productive efficiency levels positively.

3.6.9 Improved variety

Improved variety represents the production efficiency levels' differential between the adopters and the non-adopters of improved maize seed variety. It is a dummy variable taking 1 if a farmer adopts an improved maize seed variety and 0 otherwise. Improved variety has a significant impact on productivity and income (Awotide, Diagne and Omonona, 2012; Dontsop *et al.*, 2011). It is, thus, expected to increase productive efficiency levels.

3.6.10 Farm size

It is a three dummy variables where the first dummy variable takes 1 if a farmer has less or equal to 6 ha (small scale) and 0 otherwise. The second dummy variable takes 1 if a

farmer has between 7 and 10 ha (medium scale) of land and 0 otherwise and finally, the third dummy variable takes 1 if a farmer has more than 10 ha (large scale) of land. However, the first dummy will be dropped in order to avoid the dummy trap and will therefore serve as the benchmark category for comparability. Land is a significant input in agricultural production. It is aimed at capturing the effect of scale production on efficiency. A review by Lundvall and Battese (2000) establish a varied relationship between farm size and technical inefficiency in developing countries using the frontier production function. In this study, it is observed that in most cases, farm size had a positive effect on productive efficiency levels. It is believed that economies of scale are more likely to be observed in larger farms than in smaller ones. However, farmers operating smaller farms tend to use their land more intensive and more efficiently than their counterparts, all things being equal (Mburu, 2014). Thus, it is hypothesized that small scale farmers would be more technically efficient than their counterparts while in terms of allocative and economic efficiency the opinion is inconclusive.

3.6.11 Distance to market

It is the distance measured in kilometers that separate a farmer's farm and its nearest possible market. The longer the distance to the nearest market, the more expensive the costs of inputs used which would, in return, cause the allocation of resources to be sub-optimal. Moreover, longer distance might constraint farmers to be conservative in terms of using traditional inputs rather than the purchased ones. Distance is therefore hypothesized to be negative related to productive efficiency.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Socio-Economic Characteristics of the Respondents

4.1.1 Gender

Table 4.1 presents the distribution of the respondents based on gender. The result of the analysis showed that majority of the maize farm households were male headed representing about 87% of the sampled farmers. As pointed out by Onuk, Ogara, Yahaya and Nannim (2010), this can be attributed to the fact that men always have more right to land as a productive resource than women. Quisumbing (1994) reported that there has been a great disparity between women and men in the size of landholdings. Moreover, he explained that the mode of women participation in agricultural production varies with the land-owning status of households. The finding of this study is consistent with the work of Fakayode *et al.* (2004) who observed that almost all Fadama maize farm households (95.5%) were male-headed.

Table 4.1 Distribution of the respondents based on gender

Gender	Frequency (n=190)	Percentage
Male	165	86.84
Female	25	13.16
Total	190	100

4.1.2 Age

Table 4.2 shows the distribution of the respondents based on age brackets. The youngest maize farmer was 18 years old while the average farmer was about 41 years old. Moreover, the modal age brackets was 30-41 with 88% of the household heads having less than or equal to 64 years old. This means that majority of the maize farmers were within the working age bracket. Put differently, according to FAO (1998), it can be said that maize farmers in the study area were relatively young and falling within their economically active age. Other implication is that maize farmers in the study area could be more effective in land husbandry activities such as weeding, land preparation,

digging and planting since these tasks require physical efforts which could positively influence their technical efficiency level. The finding is in conjunction with a good number of studies in the literature on maize production (Fakayode *et al.*, 2004; Onojah, Aduba, and Oladunni, 2013; Onuk *et al.*, 2010; Tchale and Sauer, 2007).

Table 4.2: Distribution of the respondents based on age brackets

Age cohorts	Frequency (n=190)	Percentage
18-29	27	14.21
30-41	96	50.53
42-53	37	19.47
54-64	18	9.47
>64	12	6.32
Total	190	100
Average	41	
Standard deviation	11.87	

4.1.3 Education Level

The distribution of the respondents based on education level is presented in Table 4.3. The finding showed that about 18% of the sampled household heads had no formal level of education. In other words, 82% of the maize farm households were headed by formally educated people with majority (38.95%) having primary education followed by those with tertiary education (22.11%) and finally those with secondary education (21.05%). On average, the household heads had about 7 years of education with a standard deviation of 5.39. The implication is that the education level of the respondents could be important in improving their productivity since human capital proxy by education is expected to be positively correlated with the level of efficiency. Following Onojah *et al.* (2013) it can be said that the educational status of the respondents was enough to provide them with the ability to read and write, handle and interpret messages relating to their farm operations in the instruction manuals on input and machinery uses, and also enable them to appreciate extension services. Their level of education could

equally prove important in influencing their decision relative to the adoption of innovative methods of farming and technology. The result is in conformity with the studies of Ahmed, Suleiman and Aminu (2013); Fakayode *et al.* (2004); Onojah *et al.* (2013); and Onuk *et al.*, (2010) who observed that majority of maize farmers in their respective study area were formally educated.

Table 4.3: Distribution of the respondents based on educational level

Educational Level	Frequency (190)	Percentage
No formal	34	17.89
Primary	74	38.95
Secondary	40	21.05
Tertiary	42	22.11
Total	190	100
Average	7	
Standard Deviation	5.39	

4.1.4 Household Size

Table 4.4 presents the distribution of the respondents based on household size. The results showed that 22.11% of the respondents had a family size ranging between 0-3 members while 15.74% had more than ten people in their households. About 41% of maize farm households had a family size ranging between 4-7 people which represented the modal household size category. The average maize farm household was composed of seven people with a standard deviation of 4.61. Manual labour is observed to be a significant production input in smallholder agriculture which can influence productivity through increase in efficiency. Family size represents the number of persons that depend on the income generated from the farm and, thus, is likely to influence the farmer's attitude towards managing the farm. If the family is solely dependent on income generated from the farm, farms with large households are likely to be motivated to strive for greater productivity and efficiency of input use (Lall, Norman, and Langemeier, 2001). The finding is consistent with the study of Ahmed *et al.* (2004) who observed that 77.5% of maize farm households in Kura LGA of Kano were composed

of less than ten people.

Table 4.4: Distribution of the respondents based on household size

Household size	Frequency (n=190)	Percentage
0-3	42	22.11
4-7	77	40.53
8-10	43	22.63
>10	28	14.74
Total	190	100
Average	7	
Standard Dev.	4.61	

4.1.5 Farming Experience

Table 4.5 presents the distribution of the respondents based on farming experience. The results showed that 13.68% of the respondents had maize farming experience ranging between 0-5 years while 41.58% had more than 15 years of maize farming experience which represented the modal maize farming experience category. The average maize farming experience was about 17 years with a standard deviation of 10.15. This implies that maize farmers were quite experienced in the production of maize in the study area. Experience which is often correlated with age has the ability to enhance people's efficiency in terms of allocation of resources (allocative efficiency), implementation of agronomic practices and reduction of risks through acquisition of better understanding of production practices and marketing. The finding is consistent with the study of Onuk *et al.* (2010) who observed that about 65% of maize farmers in Mangu Local Government Area of Plateau State had more than 10 years of maize farming experience.

Table 4.5: Distribution of the respondents based on maize farming experience

Household size	Frequency (n=190)	Percentage
0-5	26	13.68
6-10	41	21.58
11-15	44	23.16
>15	79	41.58
Total	190	100
Average	16.98	

4.1.6 Access to Credit

Credit or loan is an important policy instrument that provides incentives to producers to expand their scale of operation. In the words of Anon (2009), loan is a crucial input that can be used to establish and expand farm sizes thereby increasing production. Evidence in Table 4.6 revealed that majority (72.11%) of the respondents had no access to credit. It can be inferred by saying that maize farmers in the study area do not enjoy financial support from financial institutions/agencies. It could be that maize farm households were poor in assets that could served as collateral to earn loan since financial institution such as bank and other lending agencies appears either not accessible or have stringent condition attached to their services such as high interest rate and hiding charges thereby making it inaccessible (Onojah *et al.*, 2013). The study is consistent with the work of Onojah *et al.* (2013) who observed that majority (89.2%) of maize farmers in Nigeria depended solely on their personal savings to finance their production and marketing activities.

Table 4.6: Distribution of the respondents based on access to credit

Access to credit	Frequency (n=190)	Percentage
Access	53	27.89
No Access	137	72.11
Total	190	100

4.1.7 Extension Contact

Like loan, extension contact is another policy measure that has been shown to be a statistically significant in explaining the adoption decision of innovative practices and technologies (Matthews-Njoku *et al.*, 2009). The finding in Table 4.7 that showed 68.42% of the farmers did not have contact with extension agents. This means that the

level of contact of maize farmers with extension agent was low and therefore it could that farmers in the study area would not be exposed to new findings disseminated by researchers through extension workers. Consequently, those in contact with extension would be expected to have higher efficiency scores with respected to contact with extension agents. The finding is in tandem with the results of Iyagba and Anyanwu (2012) who found out that 84.5% of smallholder cassava farmers in Oyigbo LGA of Rivers State had no contact with extension agents.

Table 4.7: Distribution of the respondents based on extension contact

Extension contact	Frequency (n=190)	Percentage
Contact	60	31.58
No contact	130	68.42
Total	190	100

4.1.8 Association Membership

Membership of cooperative society affords farmers the opportunity of sharing information on modern production techniques, purchasing inputs in bulk as well as exchanging labour (Onubogu *et al.*, 2013). Evidence in Table 4.8 showed that 58.95% of maize farmers were members of one form of association or the other. Although, the proportion of farmers that were members of any form of association was greater than that without association membership, the difference was not sufficiently high. In other words, association membership was not prevalent among maize farmers in the study area. This could have a negative influence on their capacity to acquire loan from financial institutions such as banks. The result is somewhat consistent with the finding of Onojah *et al.* (2013) who observed that maize farmers that were members of an association were more than their counterparts.

Table 4.8: Distribution of the respondents based on association membership

Association Membership	Frequency (n=190)	Percentage
Yes	112	58.95
No	78	41.05
Total	190	100

4.1.9 Improved Variety

Table 4.9 below shows the distribution of the respondents based on the type of seed used. The result revealed that 63.68% of the respondents used improved variety while 36.32% used local variety as planting inputs. The implication of the finding is that maize farmers in the study area relied more on improved variety as planting raw materials. Improved varieties are high yielding, early maturing and disease resistant. It is believed that adopting new agricultural technology, such as the High Yielding Varieties (HYV), that led to the Green Revolution in Asia could lead to significant increases in agricultural productivity in Africa and stimulate the transition from low productivity subsistence agriculture to a high productivity agro-industrial economy (World Bank, 2008). It can therefore be suggested that adopters of improved maize seed variety could have higher land productivity than their counterparts. The finding is consistent with the result of Onojah *et al.* (2013) who observed that 80% of maize farmers in Nigeria used improved seed variety.

Table 4.9: Distribution of the respondents based on type of seed used

Improved Variety	Frequency (n=190)	Percentage
Yes	121	63.68
No	69	36.32
Total	190	100

4.1.10 Main Occupation

The result from Table 4.10 indicates that the majority (64.74%) of the respondents were mainly farmers. The implication is that farming is the main source of income and food

security of maize farmers in the study area. The result equally suggests that 35.26% of maize farmers in the study area who are not mainly engaged in maize farming could be less effective in their allocation and utilization of their resources aim at producing maize. This is because this fraction of the population of maize farmers is likely to spend less time on farm. Onojah *et al.* (2013) pointed that farmers engaging in other activities often time do not re-invest properly into the farming enterprise as they usually tend to diversify their income into the various activities they engaged in. The finding is consistent with the study of Onojah *et al.* (2013) who observed that 77.5% of maize farmers in Nigeria were full-time farmers.

Table 4.10: Distribution of the respondents based on main occupation

Farming	Frequency (n=190)	Percentage
Yes	123	64.74
No	67	35.26
Total	190	100

4.1.11 Land Size

Land expansion is still regarded as an important source of agricultural growth in Nigeria. Based on the classification provided by Akinyosoye (2006), Apata, Folayan, Apata and Akinlua (2011) and Olayide, Eweka and Bello-Osagie (1980), three types of maize farmers were identified in the study area namely small, medium and large scale maize farmers. Evidence in Table 4.11 revealed that majority (79.47%) of farmers were small scale maize farmers with land size less than or equal to 6 ha while the minority (9.47%) were medium scale maize farmers with land size ranging between 6 to 9.99 ha. Farmers are often encouraged to increase their scale of operations in order to take

advantage of economies of scale and sometimes economies of scope. This would ensure greater competitiveness in agricultural markets where output manipulation by an individual farm is very limited. An implication of the finding is that small scale maize farmers in the study area may have difficulties accessing loans which in turn may also inhibit their ability to adopt relevant improved technologies. However, small farmers are better able to utilize efficiently small blocks of land and are more likely to practice intensive farming and fulfill market niches for special farm products.

Table 4.11: Distribution of the respondents based on land size category

Land size Category	Frequency (n=190)	Percentage
Small scale	151	79.47
Medium scale	18	9.47
Large scale	21	11.05
Total	190	100

Note: ≤ 6 ha=Small scale, >6 & <10 ha =Medium scale and ≥ 10 ha = Large scale.

4.2 Pure Technical, Scale, Allocative Economic and Overall Efficiency Analysis

4.2.1 Pure technical efficiency analysis

Table 4.12 shows the distribution of pure technical efficiency scores of the respondents across farmer's categories. By pooling the data together, the result showed that 53.2% of the respondents were pure technically efficient. Based on farmer's categories the result showed that medium scale farmers had the highest percentage of pure technical efficiency (100%) followed by the large scale farmers (76.2%) and lastly the small scale farmers (44.4%). Moreover, no medium and large scale farmers achieved less than 50% of their potential level of pure technical efficiency while 8 small scale farmers (5.3%) were found to have achieved less than 50% of their potential level of pure technical efficiency. On average, the level of pure technical efficiency was highest among the

medium scale farmers (1) followed by that of large scale farmers (0.89) and lastly that of the small scale farmers (0.85).

The test of the difference in the variances of pure technical efficiency across the three categories of farmers was found to be insignificant. Accordingly, the estimate of the difference-in-means of pure technical efficiency was tested and was found to be statistically significant at 1% level of probability. The implication of the analysis of pure technical efficiency among the respondents is that, after accounting for scale effect, farmers operating between 6 and 10 hectares of land were more able than those operating less than 6 hectares of land and more than 10 hectares of land to generate the maximum possible quantity of maize output given the quantity of inputs used and the available technology. However, the result showed that the majority of maize farmers (53.2%) were pure technically efficient. The difference across the three categories of farmers could be explained by the fact that medium scale farmers had more effective family labour at their disposal compared to the other groups of farmers. According to Oladeebo and Oluwaranti (2012) large households when depending more on farm income tend to equally strive more in crop production process and therefore are expected to be more efficient than their counterparts in order to obtain the maximum possible benefits from the scarce resources at their disposal. The result is somewhat consistent with the findings of Ngeno *et al.* (2012) who observed that small scale farmers were less technically efficient than the medium and large scale farmers.

Table 4.12: Means and distribution of pure technical efficiency levels of maize farmers by farm size in Giwa LGA

Distribution	Small scale (n1=151)	Medium scale (n2=18)	Large scale (n3=21)	Total (n=190)	Diff. test
---------------------	-------------------------------------	-------------------------------------	------------------------------------	--------------------------	-------------------

	Freq.	%	Freq.	%	Freq.	%	Freq.	%
<=0.1	0	0	0	0	0	0	0	0
0.10-0.20	0	0	0	0	0	0	0	0
0.20-0.30	0	0	0	0	0	0	0	0
0.30-0.40	0	0	0	0	0	0	0	0
0.40-0.50	8	5.3	0	0	0	0	8	4.21
0.50-0.60	13	8.61	0	0	5	23.8	18	9.47
0.60-0.70	8	5.3	0	0	0	0	8	4.21
0.70-0.80	28	18.5	0	0	0	0	28	14.7
0.80-0.90	23	15.2	0	0	0	0	23	12.1
0.90-0.99	4	2.65	0	0	0	0	4	2.11
1	67	44.4	18	100	16	76.2	101	53.2
Total	151	100	18	100	21	100	190	100
Mean	0.85		1		0.89		0.87	6.75***
Variance	0.03		0		0.04		0.03	1.22
Standard Dev.	0.17		0		0.21		0.17	
Minimum	0.43		1		0.53		0.53	
Maximum	1		1		1		1	

Note :< = 6 ha=Small scale, >6 &<10 ha =Medium scale and >=10 ha = Large scale. F-statistics were computed to assess the equality of means and standard deviations. *** = Significant at 1% level of probability.

4.2.2 Scale efficiency analysis

Table 4.13 shows the distribution of scale efficiency scores of the respondents across farmer's categories. From the entire data the result showed that 21.6% of the respondents were scale efficient. Based on farmer's categories the result showed that medium scale farmers had the highest percentage of scale efficient farmers (67%) followed by the large scale farmers (47.6%) and lastly the small scale farmers (12.6%). Moreover, more than half of the small scale farmers (60.27%) were found to be scale inefficient against 11% and 42.85% for the medium and large scale farmers respectively. On average, the level of scale efficiency was highest among the medium scale farmers (0.88) followed by that of large (0.63) and small (0.43) scale farmers.

The test of the difference in the variances of scale efficiency across the three categories

of farmers was found to be statistically significant at 1% level of probability. Accordingly, the estimate of difference-in-means in scale efficiency across the three categories of farmers was tested and was found to be statistically significant at 1% level of probability. Only 41 farm households representing 21.6% were found to be scale efficient. The estimated scale efficiency ranged from 0.15 to 1 with an average of 0.5 across the entire data. Based on the type of farmers, the results showed that, on average, medium scale farmers were more scale efficient than both the small and large scale farmers. Moreover, more than half of the small scale farm households (60.27%) had less than the average scale efficiency of the entire data. Only 11% and 42.85% of the medium and large scale farmers respectively were found to have less than the average level of scale efficiency for all the farm households put together. The implication is that, irrespective of the categories of farmers, most of the farm households were scale inefficient. The mean scale efficiency of 0.43 for the small scale farmers implies that about 57% increase in maize output would have been realized if they had reached an optimal scale. The mean scale efficiency of 0.88 and 0.63 for the medium and large scale farmers respectively shows that 12% and 37% increase in maize output would have been realized by the medium and large scale farmers respectively if they had reached the optimal scale of production. The finding is consistent with the study of Murthy, Sudha, Hegde and Dakshinamoorthy (2009) who observed that medium scale farmers were more scale efficient in tomato production than the small and large scale farmers in Karnataka of India.

Table 4.13: Means and distribution of scale efficiency levels of maize farmers by farm size in Giwa LGA

Distribution	Small scale (n1=151)		Medium scale (n2=18)		Large scale (n3=21)		Total (n=190)		Diff. test
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	

<=0.1	31	20.5	0	0	0	0	31	16.3
0.10-0.20	34	22.5	0	0	5	23.8	39	20.5
0.20-0.30	12	7.95	0	0	2	9.52	14	7.37
0.30-0.40	10	6.62	0	0	2	9.52	12	6.32
0.40-0.50	4	2.65	2	11	0	0	6	3.16
0.50-0.60	14	9.27	0	0	2	9.52	16	8.42
0.60-0.70	4	2.65	2	11	0	0	6	3.16
0.70-0.80	2	1.32	2	11	0	0	4	2.11
0.80-0.90	13	8.61	0	0	0	0	13	6.84
0.90-0.99	8	5.3	0	0	0	0	8	4.21
1	19	12.6	12	67	10	47.6	41	21.6
Total	151	100	18	100	21	100	190	100
Mean	0.43		0.88		0.63		0.50	15.13***
Variance	0.12		0.04		0.15		0.37	0.011**
Standard Dev.	0.35		0.19		0.39		0.14	
Minimum	0.03		0.5		0.15		0.03	
Maximum	1		1		1		1	

*Note: < = 6 ha=Small scale, >6 &<10 ha =Medium scale and >=10 ha = Large scale. F-statistics were computed to assess the equality of means and standard deviations. *** = Significant at 1% level of probability.*

4.2.3 Allocative efficiency analysis

Table 4.14 shows the distribution of allocative efficiency scores of the respondents across farmer's categories. From the entire data the result showed that 22.6% of the respondents were allocatively efficient. Based on farmer's categories the result showed that medium scale farmers had the highest percentage of scale efficient farmers (77.8%) followed by the large scale farmers (38.1%) and lastly the small scale farmers (13.9%). The average allocative efficiency of the small, medium and large scale farmers was estimated to be 0.54, 0.91 and 0.55 respectively. The implication is that the small, medium and large scale farmers could still increase their output by 46%, 9% and 45% respectively if they allocate their resources optimally.

The range of allocative efficiency was estimated to be 0.96, 0.4 and 0.85 for the small scale, medium and large scale farmers while the overall range for the entire data was estimated to be 0.96. Moreover, the test of the difference in the variance of allocative efficiency across the three categories of farmers was found to be statistically significant at 1% level of probability. Accordingly, the test of the difference-in-mean allocative efficiency across the three groups of farmers was conducted and was found to be statistically significant at 1% level of probability. The implication of the finding is that tended to be high, especially among the medium scale farmers, there was a wide gap between the lowest and the highest allocative efficiency scores. This demonstrates that there is still great potential to increase output if inputs are properly allocated by maize farmers in the study area. The result is consistent with the study of Obare, Nyagaka, Nguyo and Mwakubo (2010) who found that maize farmers in Imo State had an average allocative efficiency of 0.65.

Table 4.14: Means and distribution of allocative efficiency levels of maize farmers by farm size in Giwa LGA

Distribution	Small scale (n1=151)		Medium scale n2=18)		Large scale (n3=21)		Total (n=190)		Diff. test
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	
<=0.1	14	9.27	0	0	0	0	14	7.37	
0.10-0.20	16	10.6	0	0	7	33.33	23	12.1	
0.20-0.30	14	9.27	0	0	0	0	14	7.37	
0.30-0.40	17	11.3	0	0	2	9.52	19	10	
0.40-0.50	10	6.62	0	0	4	19.05	14	7.37	
0.50-0.60	10	6.62	2	11.1	0	0	12	6.32	
0.6 0-0.70	8	5.3	2	11.1	0	0	10	5.26	
0.70-0.80	24	15.9	0	0	0	0	24	12.6	
0.80-0.90	10	6.62	0	0	0	0	10	5.26	
0.90-1.00	7	4.64	0	0	0	0	7	3.68	
1	21	13.9	14	77.8	8	38.1	43	22.6	
Total	151	100	18	100	21	100	190	100	
Mean	0.54		0.91		0.55		0.58		11.15***
Variance	0.10		0.03		0.14		0.11		10.48***

Standard dev.	0.32	0.17	0.38	0.33
Minimum	0.04	0.6	0.15	0.04
Maximum	1	1	1	1

*Note : <= 6 ha=Small scale, >6 &<10 ha =Medium scale and >=10 ha = Large scale. F-statistics were computed to assess the equality of means and standard deviations. *** = Significant at 1% level of probability.*

4.2.4 Economic efficiency analysis

Table 4.15 shows the distribution of economic efficiency scores of the sampled farm households. Economic efficiency was estimated as the product of pure technical efficiency, scale efficiency and allocative efficiency. From the entire data the result showed that 22.63% of the respondents were economically efficient. The economic efficiency had a range of 0.97 and a standard deviation of 34. This implies that there was a lot of variability among maize farmers in terms of economic efficiency. Musemwa *et al.* (2013), Sihlongonyane₁ *et al.* (2014) and many more authors have shown that the level economic efficiency is quite dispersed among maize farmers. The mean economic efficiency was estimated to be 0.53. This implies that an average maize farmer in the study area still has 47% of his/her potential to reached in order to maximize his/her output at the minimum possible cost.

Taking the analysis across the types of farmers, we can say that medium scale farmers, on average, had the highest economic efficiency score (0.91) followed by the large (0.53) and small (0.48) scale farmers. Moreover, only 15% of the small scale farmers achieved more than or equal to 90% of their potential economic efficiency level compared to the 77.8% and 38% of the medium and large scale farmers respectively. The implication of these findings is that small scale farmers have the highest room for improvement in terms of economic efficiency. For instance the average economically efficient small scale farmer still has 52% of his/her potential to maximize his/her maize

output at the minimum cost given the current level of inputs.

Table 4.15: Means and distribution of economic efficiency levels of maize farmers by farm size in Giwa LGA

Distribution	Small scale (n1=151)		Medium scale (n2=18)		Large scale (n3=21)		Total (n=190)		Diff. test
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	
<=0.1	14	9.27	0	0	5	23.81	19	10	
0.10-0.20	24	15.89	0	0	2	9.52	26	13.68	
0.20-0.30	14	9.27	0	0	0	0	14	7.37	
0.30-0.40	27	17.88	0	0	2	9.52	29	15.26	
0.40-0.50	2	1.32	0	0	4	19.05	6	3.16	
0.50-0.60	15	9.93	2	11.11	0	0	17	8.95	
0.60-0.70	12	7.95	2	11.11	0	0	14	7.37	
0.70-0.80	16	10.6	0	0	0	0	16	8.42	
0.80-0.90	4	2.65	0	0	0	0	4	2.11	
0.90-1.00	2	1.32	0	0	0	0	2	1.05	
1	21	13.91	14	77.78	8	38.1	43	22.63	
Total	151	100	18	100	21	100	190	100	
Mean	0.48		0.91		0.53		0.53		15.31***
Variance	0.1		0.03		0.16		0.11		11.50***
Standard dev.	0.31		0.17		0.4		0.34		
Minimum	0.03		0.6		0.08		0.03		
Maximum	1		1		1		1		

Note :< = 6 ha=Small scale, >6 &<10 ha =Medium scale and >=10 ha = Large scale. F-statistics were computed to assess the equality of means and standard deviations. *** = Significant at 1% level of probability.

4.2.5 Overall efficiency analysis

Table 4.16 shows the distribution of overall efficiency scores of the respondents. Following Lall, Norman and Langemeier (2001), overall efficiency was estimated as the product of pure technical efficiency, scale efficiency and allocative efficiency. From the entire data the result showed that the overall efficiency ranged from 0.01 to 1 with only 18.42% of them having reached 100% overall efficiency. This shows that the overall efficiency was very low with lot variability around the mean (0.29). For instance, the average efficient farmers can still improve his/her overall efficiency by 71% using the

same quantity of inputs.

The distribution of the overall efficiency of maize farmers across the type of farmers showed that the medium scale farmers had the highest percentage of farmers (66.7%) who reached 100% overall efficiency followed by the large scale farmers (38.1%) and lastly the medium scale farmers (9.93%). Moreover, the medium scale farmers had the best overall efficiency level (0.82), on average, followed large (0.45) and small (0.21) scale farmers respectively. The implication is that an average small, medium and large scale farmer still has 89%, 55% and 18% of his/her potential to achieve in order to become fully efficient respectively.

Table 4.16: Means and distribution of overall efficiency levels of maize farmers by farm size in Giwa LGA

Distribution	Small scale (n1=151)		Medium scale (n2=18)		Large scale (n3=21)		Total (n=190)		Diff. test
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	
<=0.1	92	60.9	0	0	7	33.3	99	52.11	
0.10-0.20	27	17.9	0	0	4	19.1	31	16.32	
0.20-0.30	9	5.96	0	0	2	9.52	11	5.79	
0.30-0.40	2	1.32	2	11.1	0	0	4	2.11	
0.40-0.50	2	1.32	4	22.2	0	0	6	3.16	
0.50-0.60	0	0	0	0	0	0	0	0	
0.60-0.70	0	0	0	0	0	0	0	0	
0.70-0.80	0	0	0	0	0	0	0	0	
0.80-0.90	0	0	0	0	0	0	0	0	
0.90-0.99	4	2.65	0	0	0	0	4	2.11	
1	15	9.93	12	66.7	8	38.1	35	18.42	
Total	151	100	18	100	21	100	190	100	
Mean	0.21		0.82		0.45		0.29		31.61***

Variance	0.09	0.07	0.2	0.14	7.37***
Standard dev.	0.31	0.27	0.45	0.37	
Minimum	0.01	0.38	0.01	0.01	
Maximum	1	1	1	1	

*Note : < = 6 ha = Small scale, >6 & <10 ha = Medium scale and >=10 ha = Large scale. F-statistics were computed to assess the equality of means and standard deviations. *** = Significant at 1% level of probability.*

4.3 Estimation of the Return to Scale in Maize Production

The results as indicated in Table 4.17 showed that majority of small scale maize farmers (79.47%) operated at an increasing return to scale while minority which is less than 8% operated at a constant return to scale. Majority of the medium scale farmers (66.67%) operated at a constant return to scale while the remaining 33.33% operated at an increasing return to scale. Finally, majority of the large scale farmers (52.32%) operated at an increasing return to scale while the remaining 47.62% operated at a constant return to scale. Return to scale is a long run concept that shows what happened to the output when all the inputs (variable and fixed) are proportionally and simultaneously increased by the same scalar. The implication of the findings is that among the small scale maize farmers the production process of maize exhibited both economies and diseconomies of scale while among those operating more than 6 ha of land (medium and large scale farmers), the production process of some exhibited economies of scale while for others there was no economies of scale. Moreover, it can be deduced mathematically that the technical relationship between inputs and maize outputs (maize production function) in the study area was not homogeneous since varied patterns of economies of scale were present in the data. It can also be inferred that small scale farmers would experience smaller average cost of maize production than the larger scale farmers in the study area, provided that all the inputs will be proportionately increased in the long run. In other

words, small scale farmers would be more competitive than the larger scale maize farmers, all things being equal. However, the increasing return to scale observed in the data irrespective of the scale of production shows that maize farmers can still improved their efficiency levels. The result was is consistent with the study of Amao, Adeagbo and Ogunjinmi (2013) who observed that the majority of maize farmers in Oyo State were operating small land (55.2%) where the production process exhibited discerning pattern of both economies and diseconomies of scale.

Table 4.17: Distribution of return to scale (RTS) of maize farms by farm size in Giwa LGA

RTS	Small scale (n1=151)		Medium scale (n2=18)		Large scale (n3=21)	
	Freq.	%	Freq.	%	Freq.	%
Constant	12	7.95	12	66.67	10	47.62
Decreasing	19	12.58	0	0	0	0
Increasing	120	79.47	6	33.33	11	52.38
Total	151	100	18	100	21	100

4.4 Distribution of Production Efficiency Levels of Maize Farmers Based on Socio-Economic Characteristics.

The results in Table 4.18 show that either male or female, on average, was not efficient in the production of maize in the study area. That is, on the average, both male and female farmers were not efficient in all the levels of production efficiencies (pure technical efficiency, scale efficiency, allocative efficiency, economic efficiency and overall efficiency). For instance, an average male farmer had a pure technical efficiency gap of 0.87; this implies that an average male farmer in the study area can still improve his level of pure technical efficiency by about 13% with the existing technology and level of inputs. This result is consistent with that of female farmers as it was found out that an average female maize farmer equally had a pure technical efficiency level of 0.87. If we consider the performance of maize farmers as measured by their overall

efficiency, it is evident that both male and female farmers had a very low level of overall efficiency as it was found out that the estimate was 0.25 and 0.3 for male and female respectively. A general observation is that either male or female farmers had a high level of pure technical efficiency level while their scale, allocative and economic efficiency levels were moderate with a low average level overall efficiency. Moreover, even though there was some variation in production efficiencies across male and female maize farmers in the study area, the variation was not statistically significant based on the t-statistic estimates. In other words, there was no gender effect in production efficiencies of maize farming in the study area.

Extension contact, association membership and main occupation had no effect in the production efficiency levels of maize in the study area. The results on the average show that the farmers in all the categories of extension contact, association membership and main occupation were not efficient. In terms of scale efficiency, there was significant difference at 10% level of probability between farmers with extension contact and those without. There was a 5% level of probability difference between farmers who were members of an association and those that were not. For allocative and overall efficiencies, there was a 10% significant difference between farmers whose main occupation was farming and those with other occupation as their main one.

Table 4.18: Descriptive analysis of production efficiency Based on selected socioeconomic characteristics

Socio-economic characteristics	Pure tech.eff	Scale Eff.	Allo. Eff.	Econ. Eff.	Over. Eff.
Gender					
Male	0.87	0.46	0.55	0.51	0.25
Female	0.87	0.50	0.58	0.53	0.30
T-test	0.01	-0.60	-0.55	-0.32	-0.57

Extension contact					
Yes	0.86	0.57	0.57	0.53	0.35
No	0.87	0.46	0.58	0.52	0.27
T-test	0.19	-1.97*	0.16	-0.13	-1.38
Association Membership					
Yes	0.87	0.55	0.57	0.52	0.32
No	0.86	0.42	0.59	0.53	0.25
T-test	-0.51	-2.32**	0.49	0.07	-1.35
Main Occupation					
Farming	0.86	0.53	0.55	0.49	0.28
Otherwise	0.88	0.44	0.64	0.59	0.31
T-test	0.52	-1.45	1.87*	1.89*	0.54
<hr/>					
Note: **P<0.05, *P<0.10					

4.5 Relationship between the Socio-Economic Characteristics of Maize Farmers and Their Levels of Production Efficiency

The two-sided Tobit models were used for the analysis as the efficiency scores were both left and right censored (ranged from 0 to 1) to determine the relationships between socio-economic characteristics and production efficiency. The choice of Tobit model further strengthened the fact that some values of the measures of efficiency were equal to 0 and 1, therefore preventing Tobit model estimates to converge to Ordinary Least Square (OLS) estimates (Judge *et al.*, 1988). Consequently, in order to facilitate the interpretations of the results given that in the Tobit model the dependent variable is a latent variable, marginal effects were equally estimated. The following gives the interpretations and discussions of the results from the different Tobit models.

4.5.1 Relationship between the socio-economic characteristics and pure technical efficiency

The results obtained from the Tobit analysis for the relationship between the socio-economic characteristics and pure technical efficiency levels are shown in Table 4.20. The estimate of the Likelihood Ratio (LR) Chi-squared test was 46.65 and was significant at 1% level of probability; the implication is that at least one of the predictors' regression coefficients was not equal to zero. In other words, the full model – it includes the socio-economic characteristics factors in addition to the intercept term - was better than the null model – it includes only the intercept term - in predicting pure technical efficiency levels of maize farmers. Differently put, the joint effect of the predictors was significant in explaining the total variability in pure technical efficiency levels. The Pseudo-R-squared was 0.25; this implies that 25% of the total variability in the pure technical efficiency levels of maize farmers was accounted for by the model. Dlamini, Masuku and Rugambisa (2012) similarly employed a two-sided Tobit model to estimate the factors affecting technical efficiency in maize production in Swaziland.

Their analysis produced a log likelihood estimate of 118.616, indicating that the explanatory variables better explain the technical efficiency of maize farmers.

Age, age squared, household size, medium scale, large scale and distance were found to be significant in explaining pure technical efficiency levels. The implication is that these factors were individually important in explaining the variation in pure technical efficiency of maize farmers. On the contrary, the factors such as gender, education, association membership, credit access, credit access, extension contact, improved variety were individually insignificant. In other words, these variables were not individually important in explaining variation in pure technical efficiency level.

The age of household head and the square of the age of household head were found to be statistically significant at 1% level of probability with a negative and positive relationship with pure technical efficiency respectively. Mathematically, it shows that pure technical efficiency was a quadratic function of age. Given the quadratic term of age in the equation, the average marginal effect of age on pure technical efficiency was -0.02. Technically, it means that if the average age of heads of household increases by 1 year, pure technical efficiency will be reduced by 0.02. This implies that younger heads of household are likely to be more technically efficiency in maize production than their counterparts. It could be that older farmers in the study area tend to be more conservative and less receptive to modern and newly introduced agricultural technology. Moreover, older farmers in general, are also physically weak and would not be able to put in as much energy as the younger ones do. The finding is consistent with the work of Abatania, Hailu and Mugeru (2012) who observed that age of the heads of household was quadratically related to technical efficiency in crop production in

Northern Ghana.

Household size was found to be statistically significant at 5% level of probability with a positive relationship with pure technical efficiency. Based on marginal effect, an addition of one member in a household would lead to an increase in pure technical efficiency of 0.03. This implies that households with more members would be more technically efficient than their counterparts. It could be that large households take advantage of their family labour to carry out farm activities on time. It could also be that maize farm households in the study area depend mainly on farm income and therefore households with larger members strive more in maize production activities in order to enhance their return. The result corroborates the study of Oladeebo and Oluwaranti (2012) who observed that large farm households were more technically efficient than their counterparts in cassava production in South Western Nigeria.

Medium and large farm sizes were found to be statistically significant at 5 and 10% level of probability with positive relationship with pure technical efficiency respectively. Based on marginal effect, the implication is that households operating medium or large scale farms are more technically more efficient than those operating small scale farms. The result was contrary to the a priori expectation. It could be that households operating small scale farms have less access to improved technology in relation to their counterpart due to inadequate access to credit. The result is consistent with the work of Dimelu *et al.* (2008) who observed that increase in the farm size of households headed by female increased technical efficiency in cocoyam production in Nsukka Agricultural Zone of Enugu State.

Distance to the nearest market was found to be significant at 5% with a positive

relationship with pure technical efficiency. The finding was contrary to the a priori expectation. The positive relationship between distance and pure technical efficiency may appear to be counterintuitive at first glance. Why should farmers' pure technical efficiency likely to be greater with distance? Boughton *et al.* (2007) found that market participation in cotton market is positively correlated with distance to the nearest tarred road. And their explanation was based on the fact that market participation is negatively correlated with off-farm income opportunities. Such opportunities become less remunerative as the cost of market access increases. Thus, it could be inferred that off-farm income opportunities in the study area are less and less remunerative among maize farmers as market access proxy by distance becomes more difficult which in turn encourage maize farmers to participate more in market for the generation of income which also affect their technical efficiency through specialization and exchange of ideas.

Table 4.19: Maximum likelihood estimates of the two-sided Tobit regression model for the socio-economic factors of maize farmers affecting their pure technical efficiency levels in Giwa LGA

Characteristics	Coefficients	Average Marginal Effects	Standard Error	T-value
Constant	2.23	NA	0.46	4.85***
Gender	-0.03	-0.03	0.08	-0.38
Age	-0.07	-0.02	0.02	-3.5***
Age Squared	0.001	NA	0.0002	5***
Education	0.09	0.09	0.09	1
Household size	0.03	0.03	0.01	3.33**
Association membership	0.07	0.07	0.06	1.17
Credit Access	0.001	0.0005	0.06	0.02
Extension Contact	-0.05	-0.05	0.08	-0.63
Improved Variety	-0.001	-0.001	0.05	-0.02
Medium scale	2.02	2.02	0.81	2.49**
Large scale	0.14	0.14	0.08	1.75*
Distance to market	0.01	0.01	0.004	2.5***
Goodness of fit				
Log likelihood	-71.66			
LR χ^2	46.65***			
Degree of freedom	11			
Pseudo R ²	0.25			
Number of Observations	190			

Note: ***P < 0.01, **P < 0.05 and *P < 0.10

NA = Not Available

4.5.2 Relationship between the socio-economic characteristics and scale efficiency

Table 4.20 presents the maximum likelihood estimates of the Tobit regression model for the socio-economic factors affecting scale efficiency. The LR chi-squared test estimate was 47.4 and was found to be statistically significant at 1% level of probability. The implication is that at least one parameters' estimate is statistically different from zero. In order words, the model was significant in terms of explaining variation in scale efficiency. The pseudo R-squared was 0.17; this implies that 17% of total variability in scale efficiency was accounted for by the model. Individually, only medium and large farm sizes were statistically significant in explaining scale efficiency. The result

indicates that maize farmers operating medium and large farm sizes were more scale efficient than those operating small farm size. However, the difference in scale efficiency was higher for those operating medium scale farms than those operating large scale farmers. Specifically, if a farmer who operates a small scale farm expands it to a medium scale, his level of scale efficiency will increase by 0.66, on average. On the other hands, if a farmer expands his small farm to a large scale farm, his scale efficiency will be increased by 0.27.

Table 4.20: Maximum likelihood estimates of the two-sided Tobit regression model for the socio-economic factors of maize farmers affecting their scale efficiency levels in Giwa LGA

Characteristics	Coefficients	Average Marginal Effects	Standard Error	T-value
Constant	-0.12	NA	0.48	-0.26
Gender	-0.001	-0.001	0.09	-0.01
Age	0.02	0.01	0.02	0.9
Age Squared	-0.0002	NA	0.0003	-0.76
Education	-0.03	-0.03	0.10	-0.28
Household size	-0.01	-0.01	0.01	-0.49
Association membership	0.04	0.04	0.08	0.51
Credit Access	-0.02	-0.02	0.07	-0.24
Extension Contact	0.10	0.10	0.09	1.02
Improved Variety	-0.004	-0.004	0.07	-0.06
Medium scale	0.66	0.66	0.12	5.42***
Large scale	0.27	0.27	0.10	2.64***
Distance	0.01	0.01	0.005	1.62
Goodness of fit				
Log likelihood	-114.0541			
LR χ^2	47.4***			
Degree of freedom	12			
Pseudo R ²	0.172			
Number of Observations	190			

Note: ***P<0.01; NA = Not Available

4.5.3 Relationship between the socio-economic characteristics and allocative efficiency

The maximum likelihood estimates of the Tobit model for the socio-economic affecting allocative efficiency are presented in Table 4.21. The model was found to be statistically significant at 1% level of probability based on the LR chi-squared test estimate (34.05). It was found to explain about 15% of the total variability in allocative efficiency as the Pseudo R-squared was estimated to be 0.17. Only three factors were significantly related to allocative efficiency namely age, age-squared and medium scale farms.

The results showed that allocative efficiency was a concave function of age. However, the net effect of age on allocative efficiency expressed by its average marginal effect was negatively. Therefore, it can be said that if age increases by one year, on average, allocative efficiency will be reduced by about 1%. The implication is that younger farmers were allocatively more allocatively efficient than their counterparts. Boughton *et al.* (2007) found that age is a concave function of maize market participation and that the net effect of age on maize market participation is rather counter-intuitively negative. Moreover, it is often admitted that older household heads would be more likely to have larger families and therefore would often participated less in market due to the increasing need for food security. Less market participation by farmers influences negatively their allocative efficiency as farmers specialize, interact less and are less informed about input prices. The finding is consistent with the study of Akinbode, Dipeolu and Ayinde (2011) who found that the age of heads of household had a concave effect on allocative efficiency in rice production in Ogun State.

The higher efficiency scores for farms with areas between six and ten hectares could be attributed to improvements in supervision of hired laborers (Musemwa *et al.*, 2013). Large farms which hire many laborers are likely to employ field officers or hired

laborers' supervisors. The employment of hired labour supervisors is likely to increase the productivity of hired labour and hence improving the efficiency of the farm as a whole. Furthermore, since the number of supervisors does not change with slight changes in the number of hired laborers, farmers who employ many hired laborers are likely to benefit from scale economies in hired labour supervision. Moreover, larger farms often take advantage of pecuniary economies by purchasing inputs in bulk which has the effect of reducing the average cost of production. The result was in concordance with the findings of Musemwa *et al.* (2013) who found that farm size was positively and continuously related to allocative efficiency of field crop production among resettled farmers in Zimbabwe.

Table 4.21: Maximum likelihood estimates of the two-sided Tobit regression model for the socio-economic factors of maize farmers affecting their allocative efficiency levels in Giwa LGA

Characteristics	Coefficients	Average Marginal	Standard	T-value
		Effects	Error	
Constant	1.63	NA	0.45	3.65***
Gender	0.03	0.03	0.09	0.33
Age	-0.06	-0.01	0.02	-2.73***
Age Squared	0.001	NA	0.0002	2.72***
Education	0.05	0.05	0.09	0.56
Household size	0.01	0.01	0.01	0.67
Association membership	-0.02	-0.02	0.07	-0.22
Credit Access	0.04	0.04	0.06	0.66
Extension Contact	0.01	0.01	0.08	0.13
Improved Variety	0.01	0.01	0.06	0.13
Medium scale	0.53	0.53	0.11	5.07***
Large scale	0.06	0.06	0.09	0.65
Distance	0.004	0.004	0.004	0.93
Goodness of fit				
Log likelihood	-99.89			
LR χ^2	34.05***			
Degree of freedom	12			
Pseudo R ²	0.15			
Number of Observations	190			

Note: *** P<0.01; NA = Not Available

4.5.4 Relationship between socio-economic characteristics and economic

efficiency

The estimated economic efficiency model for maize production presented in Table 4.22 was found to be statistically significant at 1% level of probability on the basis of the LR chi-squared test estimate. The implication is that at least one of the parameters' estimates was statistically significant in explaining the outcome variable. The Pseudo R-squared estimate of 0.18 showed that 18% of total variability in economic efficiency was accounted for by the model. Age, age-squared, medium farm size scale and distance to the nearest market were found to be the only important socio-economic factors explaining economic efficiency of maize production in the study area.

Age and age squared were found to be statistically significant at 1% level of probability with negative and positive effect on economic efficiency respectively. In other words, age had a concave effect on economic efficiency, that is, as age increases, economic efficiency decreases, however, at a decreasing rate. If the age of a household head increases by 1 year, the economic efficiency of the farm household would be reduced by 0.01 which is about 1%. The finding is consistent with the study of Akinbode *et al.* (2011) who found that age negatively influenced economic efficiency in rice farming in Ogun State.

Medium scale farm was found to be statistically significant at 1% level of probability with a positive effect on economic efficiency. The implication is that farmers operating medium farms were economically more efficient than those operating smaller or larger farms. As previously explained it could be that the supervision of hired labour within medium farms was quite effective and raised the efficiency of labour. Moreover, the cost of supervision being fixed could be spread over additional labour which would

reduce the average cost of production.

Distance to the nearest market was positively related to economic efficiency at 1% level of probability suggesting that as distance increases, economic efficiency increases. The finding is contrary to the a priori expectation. However, as previously mentioned it could be that the more complicated access to market is, the less remunerative off-farm activities are and the more farmers are engaged in farm activities which in turn affect their efficiency.

Table 4.22: Maximum likelihood estimates of the two-sided Tobit regression model for the socio-economic factors of maize farmers affecting their economic efficiency levels in Giwa LGA

Characteristics	Coefficients	Average Marginal Effects	Standard Error	T-value
Constant	1.75	NA	0.45	3.89***
Gender	0.001	0.001	0.09	0.01
Age	-0.07	-0.01	0.02	-3.50***
Age Squared	0.001	NA	0.0002	5.00***
Education	0.07	0.07	0.09	0.78
Household size	0.01	0.01	0.01	1.00
Association membership	0.004	0.004	0.07	0.06
Credit Access	0.01	0.01	0.06	0.17
Extension Contact	0.02	0.02	0.08	0.25
Improved Variety	0.004	0.004	0.06	0.07
Medium scale	0.60	0.60	0.11	5.45***
Large scale	0.11	0.11	0.09	1.22
Distance	0.01	0.01	0.004	2.50***
Goodness of fit				
Log likelihood	-100.52			
LR χ^2	43.11			
Degree of freedom	12			
Pseudo R ²	0.18			
Number of Observations	190			

Note: *** P<0.01; NA = Not Available

4.5.5 Relationship between the socio-economic characteristics and overall efficiency

The estimated overall efficiency model of maize production as presented in Table 4.23

was obtained by regressing the overall efficiency scores of maize farmers on their socio-economic factors. The results showed that the model was statistically significant in explaining overall efficiency as the LR chi-squared test estimate (59.18) was statistically significant at 1% level of probability; this implies that at least one of the parameters' estimates was statistically different from zero. The percentage of total variability in the overall efficiency that was accounted for by the model was estimated to be 22. Individually, medium farm size, large farm size and distance to the nearest market were the only significant factors affecting overall efficiency in maize production in the study area.

Medium and large farms were statistically significant at 1% level of probability with positive relationship with overall efficiency. The implication is that farmers operating medium and large maize farms have higher overall efficiency compared to those operating small farms. It is worth noting that the marginal effect of medium farm size (0.71) is greater than that of large farm size (0.3); it implies that farmers operating medium farms have more overall efficiency relative to those operating large farms. The result is consistent with the a priori expectation. However, the difference in overall efficiency between medium and large farm size could be explained by the fact that large farms are often not regarded as a linear replicate of smaller farms and therefore a high level of human capital and possibly training would be required to take advantage of the economies of size and scale. Or, the average level of education was observed to be 7 years which may not have been enough.

Table 4.23: Maximum likelihood estimates of the two-sided Tobit regression model for the socio-economic factors of maize farmers affecting their overall efficiency levels in Giwa LGA

Characteristics	Coefficients	Average Marginal Effects	Standard Error	T-value
Constant	0.51	NA	0.43	1.19
Gender	-0.01	-0.01	0.09	-0.11
Age	-0.02	-0.003	0.02	-1.00
Age Squared	0.0002	NA	0.0002	1.00
Education	0.04	0.04	0.09	0.44
Household size	0.01	0.01	0.01	1.00
Association membership	0.01	0.01	0.07	0.14
Credit Access	-0.03	-0.03	0.06	-0.50
Extension Contact	0.08	0.08	0.08	1.00
Improved Variety	-0.01	-0.01	0.06	-0.17
Medium scale	0.71	0.71	0.1	7.10***
Large scale	0.3	0.3	0.09	3.33***
Distance to market	0.01	0.01	0.004	2.50***
Goodness of fit				
Log likelihood	-102.56			
LR χ^2	59.18***			
Degree of freedom	12			
Pseudo R ²	0.22			
Number of Observations	190			

Note: *** P<0.01; NA = Not Available

4.5.6 Test of hypotheses

The hypotheses tested on the study are presented in Table 4.24. The first test was that (i) there is no significant difference between the socio-economic characteristics of maize farmers and their production efficiency. The test was found to be statistically significant as the socio-economic characteristics were found to significantly influenced the five estimates production efficiency under study namely, pure technical efficiency, scale efficiency, allocative efficiency, economic efficiency and overall efficiency at 1% level of probability except pure technical efficiency which was found to be significant at 10% level.

The second (ii) hypothesis was that there is no significant profit differential between

scale efficient and inefficient maize farmers in the study area. The test was insignificant, therefore implying that profits realized by scale efficient and inefficient farmers were not statistically different.

Table 4.24: Test of hypotheses

Hypotheses	Test-statistics	Test-statistics value	Decision
H0(1) ^a	F-test	1.66	Rejected
H0(1) ^b	F-test	3.88	Rejected
H0(1) ^c	F-test	3.05	Rejected
H0(1) ^d	F-test	3.76	Rejected
H0(1) ^e	F-test	5.52	Rejected
H0(1)	T-test	-0.16	Accepted

a = There is no significant difference between the socio-economic characteristics of maize farmers and pure technical efficiency. b = There is no significant difference between the socio-economic characteristics of maize farmers and scale efficiency. c = There is no significant difference between the socio-economic characteristics of maize farmers and allocative efficiency. d = There is no significant difference between the socio-economic characteristics of maize farmers and economic efficiency. e = There is no significant difference between the socio-economic characteristics of maize farmers and overall efficiency. H0 (2) = There is no significant profit differentials between scale efficient and inefficient farmers.

4.6 Estimation of the Profit Differentials between Scale Efficient and Inefficient Maize Farmers

Table 4.25 shows the profitability analysis of maize farming on a hectare of land in Giwa LGA. The result revealed that farmers, on average, spent about ₦ 109,033.08 and ₦ 8,285.70 on total variable and fixed costs respectively with no significant difference across scale the efficient and inefficient farmers. Therefore, the total cost of maize production was estimated to be ₦ 117,318.78 averagely per hectare of land. The average yield was estimated at 9,678.90 kg with revenue of ₦ 438,163.94. The gross margin was therefore estimated to be ₦ 329,130.86 while the net farm income was ₦ 320,845.16. Consequently, it was found that by investing ₦ 1 on maize production per hectare of land, a profit of ₦ 2.27 was generated and, thus, making the enterprise profitable. No significant difference was observed between scale efficient and inefficient farmers in

terms of profit. The results were consistent with the findings of Zalkuwi *et al.* (2010).

Table 4.25: Profit differentials between scale efficient and inefficient maize farmers

	Scale efficiency status			Total (190)	Diff. Test
	Efficient (n1=41)	Inefficient (n2=149)	Diff.		
	Value (₦/ha)				
A. Costs					
1. Variables Cost					
a- Seed (kg)	1,847.66	2,203.13	-355.47	2,126.43	0.46
b- Fertilizer (kg)	26,851.45	30,419.91	-3,568.46	29,649.87	0.60
c- Labour (Man-day)	71,864.30	67,139.39	4,724.91	68,158.98	-0.35
d- Herbicide (Litre)	3,248.21	4,924.75	-1,676.54	4,562.97	2.30
e- Pesticide (Litre)	2,997.60	4,957.83	-1,960.23	4,534.83	1.61
Total Variable Cost (TVC) = (a+b+c+d)	106,809.22	109,645.01	-2,835.79	109,033.08	0.14
2. Fixed Cost					
f- Land Renting	8,362.95	7,464.24	898.71	7,658.17	-0.50
g- Depreciation	850.00	1,150.00	-300.00	1,046.05	0.41
Total Fixed Cost (TFC) = (f+g)	8,802.48	8,143.50	658.99	8,285.70	-0.36
Total Cost (TC) = (TVC+TFC)	115,611.70	117,788.51	-2,176.80	117,318.78	0.10
B. Return					
h- Yield (kg/ha)	10,022.25	9,584.425	438	9,678.90	-0.13
i- Average Price (N/kg)	45.57	46.02	-0.45	45.27	0.12
Total Revenue (TR) = (h*i)	456,713.93	441,075.24	15,638.69	438,163.94	-0.13
Gross Margin (GM) = (TR-TVC)	344,192.10	321,654.10	22,538.00	329,130.86	-0.16
Net Farm Income (NFI) = (GM-TFC)	335,389.62	313,510.60	21,879.01	320,845.16	-0.16
Net Farm Income on N1 Invested = (TR/TC-1)	2.95	2.74	0.21	2.27	-1.39

4.7 Constraints Faced by Maize Farmers

Table 4.26 presents the distribution of the farmers based on the constraints being faced in maize production. Maize farming in the study area within the period of the survey was associated with several constraints. The major constraints identified during the study were ranked and presented in Table 4.16. The results revealed that fertilizer

scarcity was rated as the most significant constraint with about 24% of the farm households having agreed with the view. The fertilizer distribution in the study area is very much uncertain and vulnerable to seasonality of crop production. Artificial crisis is also an important factor in this context. This finding partly explains why farmers are still having a lot of room for improvement in production.

Inadequate rainfall ranked second as farmers claimed that the level of rainfall has reduced drastically over the years with a changing pattern. 21% of the respondents are of the view that over the years, there has been a decline in the amount of rainfall in the area. Inadequate capital ranked third in the constraints as the study revealed that the majority (72.11%) of the respondents had no access to credit. It can be inferred by saying that maize farmers in the study area do not enjoy financial support from financial institutions/agencies. It could be that maize farm households were poor in assets that could serve as collateral to earn a loan since financial institutions such as banks and other lending agencies appear either not accessible or have stringent conditions attached to their services such as high interest rates and hidden charges, thereby making it inaccessible. Price fluctuations ranked the fourth prevailing constraint to maize production in the study area. This attested to the fact that there is the absence of an effective price control board to control and regulate prices of farm produce in the study area. Inadequate laborers was observed to be the least important constraint to maize production.

The problem of inadequate rainfall raised by the farmers is consistent with the current perception about the impact of climate variability. Concerning the issue of poor capital, the current study equally confirms a number of works that showed that farmers in Sub

Sahara Africa are, on average, capital-poor.

Table 4.26: Distribution of the respondents based on constraints faced in maize production

Constraints	Frequency	Percentage
Fertilizer scarcity	146	23.59
Inadequate rainfall	130	21.00
Inadequate of capital	52	8.40
Price fluctuation	34	5.49
Theft	32	5.17
Lack of good seed	40	6.46
Pest and disease	88	14.22
Poor transportation	70	11.31
Inadequate laborers	27	4.36
Total	619*	100

Note: * = Multiple Response

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

The broad objective of this study was to determine the production efficiency levels and profitability of maize farmers in the study area while the specific objectives were to: estimate the overall technical, pure technical, scale, allocative and economic efficiency levels of maize farmers, estimate the return to scale in maize production of large, medium and small scale farmers, determine the relationship between the socio-economic characteristics of maize farmers and their levels of production efficiency, estimate the profit differentials between scale efficient and inefficient maize farmers, and finally to describe the constraints faced by maize farmers in the study area. In order to achieve these objectives, a multi-stage sampling technique was employed to collect exclusively primary data from 190 maize farmers from seven yards in Giwa LGA of Kaduna State using a well-structured questionnaire. The statistical tools used to conduct the analysis were descriptive statistics, constant and variable return to scale, DEA for both production and cost functions, Tobit regression model and gross marginal method.

The descriptive analysis revealed that maize farming was dominated by young and educated male headed households with family responsibilities. The majority were primarily experienced small scale farmers depending on improved variety for the production of the enterprise. Although they were members of farmers' association, their level of access to credit was as limited as that of their contact with extension agents.

The analysis of production efficiency revealed different sources of inefficiency. In terms of managerial skills, it was discovered based on the analysis of pure technical efficiency that 53% of maize farmers were pure technically efficient implying that the remaining

47% were inefficient in the maximization of their output. This observation was mostly consistent among the small scale farmers where only 44.4% were found to be pure technically efficient. Poor managerial skills were not found to be a source of inefficiency in maize production among medium scale farmers as all the medium scale farmers were found to be pure technically efficient. Although large scale farmers were more pure technically efficient than the small scale farmers, it was discovered that there was still a room for about 23.8% improvement. Farm size was also found to be another important source of inefficiency in maize production as only 26% of the farm households was observed to produce at the optimal scale. Small, medium and large scale farmers had a scale efficiency score of 0.43, 0.88 and 0.63 respectively. In terms of allocative efficiency, 0.58% of the sampled households were found to be allocatively efficient with the majority and minority being the medium and small scale farmers. Economically, less than a quarter of the sampled farm households were efficient with the majority being the small scale farmers followed by the large scale farmers. The overall efficiency level was consistent with the previous results on efficiency showing that small scale farmers had the smallest overall efficiency score followed by the large scale farmers.

The result of the analysis of economies of scale showed that maize production cannot be represented by a homogeneous production function in the study area as different patterns of economies of scale were found in the data. The analysis further showed that 52.38%, 33.33% and 79.47% of large, medium and small scale farmers operated at an increasing return to scale.

A significant relationship between the socio-economic characteristics of the sampled

households and their production efficiency was found in the data. Specifically, age, household size, farm size and distance to market were found to be important in explaining changes in pure technical efficiency. Age and farm size were found to affect both allocative and economic efficiency while only farm size among the socio-economic factors was found to affect both scale and overall efficiency.

The profitability analysis revealed that maize enterprise is a profitable business. Specifically, by investing ₦1 per hectare, a return of ₦ 2.27 was realized with no significant difference across the scale efficient and inefficient farmers. Maize production in the study area is not constraints free. It was observed that fertilizer scarcity was the most important challenge in maize production followed by inadequate rainfall and capital as well as price fluctuations.

5.2 Conclusion

From the result of the analysis, it can be inferred that maize is produced in small parcels of land of less than 6 ha by young, educated and experienced farmers. It could also be concluded that maize production in the study area is profitable with returns of ₦ 2.27 for every ₦ 1.00 Spent. Although, they are making considerable profit from their investments in the enterprise, their returns are still not being maximized given their low level of overall efficiency. Moreover, maize production in the study area was found to have a quiet a number of impediments such as fertilizer scarcity, inadequate rainfall, low capital and price fluctuations.

5.3 Recommendations

Based on the findings of the study, recommendations are made:

- i. The problem of low capital was observed to be one of the most important constraints to maize production. Moreover, its influence was ineffective as it was found not to be important in causing change in efficiency. Thus, credit should be made more accessible to maize farmers through reduction of interest rate and farmers should equally be educated in the use of such credit for more and significant impact.
- ii. Extension contact was also low and insignificant in predicting efficiency. Extension agents should not only raised their number of visits with maize farmers but equally ensuring that their recommendations are being adopted and properly implemented.
- iii. Although membership to farmers' association was at a moderate level, its influence on efficiency was insignificant. Farmers' association should review the aim of their organizations and also insist on sharing ideas and experience in production and marketing of maize for better returns.

5.4 Contribution of the Study to Knowledge

- i. The study showed that only 21.6% of maize farmers were scale efficient.
- ii. The average scale efficiency was estimated to be 0.5; this implies maize farmers are operating only at 50% of their optimal scale of production.
- iii. The study revealed that maize production exhibited both increasing and decreasing return to scale and therefore showing the inability of representing the production process by a homogeneous production function.

- iv. Medium scale farmers were estimated to be more efficient than both the medium and large scale farmers in terms of maximization of output, allocation of inputs at minimum cost. Moreover, they were found to be 100% scale efficient therefore more likelihood to have the least average cost of production.

- v. Maize production was found to be profitable. By investing by investing ₦1 per hectare, a return of ₦ 2.27 was realized with no significant difference across scale efficient and inefficient farmers.

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Appendix I: Research Questionnaire

Dear Respondent,

This questionnaire will be used by a student of the Department of Agricultural Economics and Rural sociology, Ahmadu Bello University, Zaria. Please, fill as appropriate. All information will be treated with confidentiality and strictly for the purpose of research. Thanks for your co-operation.

Section 1: Identification information

Village or Community:
Name of farmer (optional):
Tel. No. (optional):

Section 2: Socioeconomics Characteristics

Characteristics	Codes	Answer
1. Sex:	1= male, 2= female	
2. Age	Age in completed years	
3. Marital status	1= single, 2= married, 3= separated, 4= divorced, 5= widowed	
4. Family Size	No. of persons living with you and sharing your meals daily	
5. Level of education	Number of years of education	
6. Main activity	1= crop farming, 2= livestock rearing, 3= house chores, 4= commerce, 5= laborer, 6= civil servant, 7= others (specify)	
7. Secondary activity	1= crop farming, 2= livestock rearing, 3= house chores, 4= commerce, 5= laborer, 6= civil servant, 7= others (specify)	
8. How long have you been in maize farming?	Years of experience	
9. How many plots of land did you use for maize production during the last farming season?		
10. What was the main source of the plots used last year for maize production?	1= Inherited 2= Bought 3= Rented 4= Gift 5=Other (pls. specify):	
11. What was the size of the plots used? (specify the	Size: ha/plot Amount:	

amount) ₦/plot	
12. Did you use credit last year for maize production?	1= Yes, 2= No	
13. If yes, what was the amount of credit used last year?	Source	Amount (₦)
	1= Commercial Bank	
	2= Bank of Agriculture	
	3= Cooperative Societies	
	4= Money Lenders	
	5= Friends And Family	
	6= Others (Specify)	
14. Have you been visited by an extension agent since you started farming?	1= Yes, 2= No	
15. If Yes, How many times?		
16. In which of the following categories was the training based on last year?	1= Production 2= Processing 3= Marketing	
17 Do you belong to any association?	1=Yes 2= No	
18. Do you discuss issues related to maize production in that/those association(s)?	1=Yes 2=No	
19. For how long have you been in that/those association(s)? (years)		
20. What cropping system did you adopt for maize production last year?	1= Mono cropping 2= Mixed cropping 3= Intercropping 4= others (Specify)	
23. Do you have mobile phone?	1=Yes 2=No	
24. If yes, did you acquire any information about maize production through the phone?	1=Yes 2=No	
25. Do you have radio?	1=Yes 2=No	
26. If yes, did you acquire any information about maize production through the radio?	1=Yes 2=No	
27. Do you have television?	1=Yes 2=No	
If yes, did you acquire any information about maize production through the television set?	1=Yes 2=No	
28. Livestock ownership	1=Yes 2=No	

Section 4: On-farm and off-farm income (*Provide estimation*)

Source	Codes	Amount (₦)
1. Maize income	Value of maize sold	
2. Income derived from other produce	1= Guinea corn (processed and/or unprocessed)	
	2= Cowpea (processed and/or unprocessed)	
	3= Rice (processed and/or unprocessed)	
	4= Popcorn (processed and/or unprocessed)	
	5= Beans (processed and/or unprocessed)	
	6= Millet (processed and/or unprocessed)	
	7= Sweet potato (processed and/or unprocessed)	
	8=Others (Specify) (processed and/or unprocessed)	

Section 5: Inputs Used for maize production last year?

a. Land size

Number of plots	Size/plot (ha)	Amount spent for renting/plot (₦)

c. Seed acquisition

Type of Seed (local/improved)	Quantity (Kg)	Cost transportation (₦)	Value of quantity purchased (₦)

d. Fertilizer acquisition

Quantity (Kg)	Cost transportation (₦)	Value of quantity purchased (₦)

e. Herbicide acquisition

Quantity (Litre)	Cost transportation (₦)	Value of quantity purchased (₦)

f. Pesticide acquisition

Quantity (Litre)	Cost transportation (₦)	Value of quantity purchased (₦)

g. Labour input

1. Land preparation

Hired Labour			Family Labour		
No of people	Man-day	Cost (₦)	No of people	Man-day	Cost (₦)

2. Planting

Hired Labour			Family Labour		
No of people	Man-day	Cost (₦)	No of people	Man-day	Cost (₦)

3. Fertilizer Application

Hired Labour			Family Labour		
No of people	Man-day	Cost (₦)	No of people	Man-day	Cost (₦)

4. First Weeding

Hired Labour			Family Labour		
No of people	Man-day	Cost (₦)	No of people	Man-day	Cost (₦)

5. Second Weeding

Hired Labour			Family Labour		
No of people	Man-day	Cost (₦)	No of people	Man-day	Cost (₦)

5. Reconstruction of Ridges (Bankasa)

Hired Labour			Family Labour		
No of people	Man-day	Cost (₦)	No of people	Man-day	Cost (₦)

6. Harvesting

Hired Labour			Family Labour		
No of people	Man-day	Cost (₦)	No of people	Man-day	Cost (₦)

Section 6: Maize output and marketing

Characteristics	Codes	Answer
1. What quantity in total did you harvest last year?	Quantity: (kg) Amount: (₦)	
2. Did you sell any quantity last year?	1= yes, 2= No	
3. What quantity of maize did you sell last year?	Quantity: (kg) Amount: (₦)	
4. Where did you sell your maize produce last year?	1= Farm gate 2= Village market 3= out of the village 4= others	
5. What is the distance from your farm to the market where you sold your fresh produce? (estimate in km)		
6. What was the major means of transportation to get your output to	1= foot 2= bicycle	

the market?	3= motorbike	4= car	5= others	
7. What was the total cost of transportation associated with the sale of your produce?				

CONSTRAINTS OF MAIZE PRODUCTION

S/no	Constraints	Ranking according to severity 1=least severe, 2=moderately severe, 3= severe, 4= more severe, 5= most severe.	Coping Strategy
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Thanks for your Attention