ANALYSIS OF PRODUCTION EFFICIENCY AND POVERTY STATUS OF GROWTH ENHANCEMENT SUPPORT SCHEME OF MAIZE FARMERS IN FEDERAL CAPITAL TERRITORY, NIGERIA

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A DISSERTATION SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY, ZARIA, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF SCIENCE IN AGRICULTURAL ECONOMICS

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FEBRUARY, 2016

DECLARATION

I hereby declare that this thesis titled ‘‘**Analysis of Production Efficiency and Poverty Status of Growth Enhancement Support Scheme of Maize Farmers in the Federal Capital Territory, Nigeria**’’ has been written by me and it is a record of my research work. No part of this work has been presented in any previous application for another degree or diploma in this or any other institution. All borrowed information have been fully acknowledged in the text and a list of references was provided.

_____ _____

Okorie Agwu AMA Date

(Student)

CERTIFICATION

This dissertation titled ‘‘**Analysis of Production Efficiency and Poverty Status of Growth Enhancement Support Scheme of Maize Farmers in the Federal Capital Territory, Nigeria**’’ by Okorie Agwu AMA meets the regulations governing the award of Master of Science in Agricultural Economics of the Ahmadu Bello University, Zaria and is hereby approved for its contribution to knowledge and literary presentation.

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DEDICATION

Dedicated to my wife, Queen Esther, and to my children, Fidel, Frederick and Celine.

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TABLE OF CONTENTS

Content **Page**

TITLE PAGE……..…..i

DECLARATION……...…....i

CERTIFICATION……..……...…….....iii

DEDICATION…….……....iv

ACKNOWLEDGEMENS..…….…….....v

TABLE OF CONTENTS…….....vi

LIST OF TABLES……..……..……..…….....x

LIST OF FIGURES…….....xii

LIST OF APPENDICES……...……....xiii

ABSTRACT……...……...xiv

CHAPTER ONE..... 1

INTRODUCTION..... 1

1.1 Background of the Study 1

1.2 Problem Statement..... 3

1.3 Objectives of the Study..... 5

1.4 Justification..... 5

CHAPTER TWO..... 8

LITERATURE REVIEW..... 8

2.1 Overview of Maize Production in the World 8

2.2 Maize Production in Nigeria..... 9

2.2.1 Economic value of maize production..... 13

2.2.2 Problems/challenges of maize production in Nigeria 14
2.3 Growth Enhancement Support Scheme GESS) 15
2.4 Agricultural Productivity, Efficiency and Poverty Reduction 16
2.4.1 Technical efficiency 20
2.4.2 Allocactive efficiency 23
2.4.3 Economic efficiency 25
2.5 Profitability Analysis 26
2.6 Meassurement of Poverty 27
2.6.1 Estimation of poverty through household expenditure 27
2.6.2 Weighted poverty index 29
CHAPTER THREE 31
METHODOLOGY 31
3.1 Study Area 31
3.2 Sampling Technique and Sample Size Determination 34
3.3 Data Collection 36
3.4 Analytical Technique 36
3.4.1 Descriptive statistics 36
3.4.2 Stochastic frontier analyses 37
3.4.3 Net farm income analysis 40
3.4.4 Estimating poverty line through the expenditure approach 41
3.5 Definitions and Measurement of Variables 42
CHAPTER FOUR 48
RESULTS AND DISCUSSION 48
4.1 Socio-economic Characteristics of Maize Farmers 48
4.1.1 Age of maize farmers 48

4.1.2 Sex of maize farmers 49
4.1.3 Marital status 51
4.1.4 Household size 52
4.1.5 Level of education 53
4.1.6 Farming experience 54
4.1.7 Farm size 55
4.1.8 Extension contact 56
4.1.9 Membership of farmer group 58
4.1.10 Source of farmland 58
4.2 Maize Production Efficiency 59
4.2.1 Maize stochastic frontier production function 60
4.2.1.1 Level of technical efficiencies 64
4.2.1.2 Determinants of technical efficiency 66
4.2.2 Estimation of allocative efficiency 70
4.2.2.1 Farm level allocative efficiency of maize farmers 74
4.2.2.2 Determinants of allocative efficiency in maize production 75
4.2.3 Economic efficiency of maize farmers 78
4.3 Costs and Return Analysis of Maize Production 79
4.4 Poverty Line and Status of Maize Farmers in the Area 81
4.4.1 Poverty line among maize farmers 82
4.4.2 Poverty status of maize farmers in the study area 82
4.5 Challenges of Maize Production in the Study Area 83

CHAPTER FIVE 97

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS 97

5.1 Summary 86

5.2 Conclusion 87

5.3 Recommendations 88

5.4 Contributions to knowledge 89

REFERENCES 90

LIST OF TABLES

Table 2.1: Trend in quantity of seed, area cultivated, yield and production of maize in Nigeria 12

Table 3.1: Population disstribution of the FCT by Area Council 33

Table 3.2: Number of samples selected from each Area Council of the FCT 35

Table 4.1: Distribution of maize farmers by age 49

Table 4.2: Distribution of maize farmers by sex 50

Table 4.3: Distribution of maize farmers by marital status 51

Table 4.4: Distribution of maize farmers by household size 52

Table 4.5: Distribution of maize farmers by level of education 53

Table 4.6: Distribution of maize farmers by farming experience 54

Table 4.7: Distribution of maize farmers by farm size 56

Table 4.8: Distribution of maize farmers by contact with extension agent 57

Table 4.9: Distribution of maize farmers by membership of farmer group 58

Table 4.10: Distribution of maize farmers by source of farm land 59

Table 4.11: Maximum likelihood estimates of stochastic frontier production function ... 61

Table 4.12: Distribution of maize farmers' technical efficiency index 65

Table 4.13: Determinants of technical efficiency in maize production 66

Table 4.14: Maximum likelihood estimates of stochastic fronteir cost function 71

Table 4.15: Distribution of maize farmers' allocative efficiency index 74

Table 4.16: Determinants of allocative efficiency in maize production 76

Table 4.17: Disstribution of farm level economic efficiency of maize farmers 79

Table 4.18: Costs and return analysis in maize production 80

Table 4.19: Household poverty profile among maize farmers 82

Table 4.20: Distribution of maize farmers based on challenges 84

LIST OF FIGURES

Figure 1: Map of the Federal Capital Territory …….32

LIST OF APPENDICES

Appendix 1: Research questionnaire……...……100

Appendix 2: Computer printout of maximum likelihood estimates of technical efficiency……..106

Appendix 3: Computer printout of maximum likelihood estimates of allocative efficiency……..107

ABSTRACT

The study had the main objective of analyzing the production efficiency and poverty status of growth enhancement support scheme of smallholder maize farmers in the Federal Capital Territory (FCT). Structured questionnaire was used to collect data from 200 randomly selected smallholder GES beneficiary maize farmers in the six Area Councils of the FCT. Descriptive statistics, stochastic frontier model, farm budgeting and weighted poverty index were used in analyzing the data. Findings from the study showed that the mean age of maize farmers was 47 years and the mean farm size of 1.5 hectares was cultivated by an average household size of 8 persons. Maximum likelihood estimates of the stochastic frontier function of maize showed that variables such as farming experience, farm size, extension contact and membership of farmer group were found to be the common sources of technical inefficiency among maize farmers. Mean technical efficiency was estimated at 91.4%. Major sources of allocative inefficiency were household size, farming experience, educational level, farm size and membership of farmer-based organization. Mean allocative efficiency score was 84.4% while that of economic efficiency was 78.6%. Net farm income realized by the maize farmers per hectare was ₦104,376 indicating that the every ₦1.00 invested in maize production returned a profit of ₦1.99. Estimated poverty line for maize farmers in the study area was ₦13,194.84 and the mean adult equivalent household expenditure was estimated to be N22,267.41. Poverty incidence was computed to be 30% while the poverty gap index (PGI) was 36%. In conclusion, there was room for maize farmers to increase their production efficiency to attain the frontier optimum. Also, maize production was profitable and could help reduce poverty among farmers. It was recommended that more young people be supported to acquire education at low-cost through such facilities as tuition-free and scholarship opportunities, subsidized inputs, soft loans and access to market information services in order to enhance their production efficiency and eventually reduce poverty among them.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Maize is a major cereal and one of the most important crops in Nigeria. It is one of the most dominant cereal crops in the southern and northern Guinea savannas (Onyibe *et al*., 2006). Maize is a primary diet to many Nigerian families. A beneficiary assessment report by the Kaduna State Fadama Development Office (2007) observes that improving the quality of life in the rural areas and reducing the level of poverty is a major problem. Nigeria is poverty-ridden, and the poverty is multi-dimensional as reflected in the low income per capita. Most of the poor farmers are based in the rural areas, and are usually resource poor. A resource poor farmer is one that farms a modest piece of land which may not belong to him; uses mostly family labour for farm operations; consumes most of what he produces; lacks funds to purchase inputs, uses low level of technology that is based on low risk and traditional practices, resulting in low productivity; lacks collateral and has no access to loans from financial institutions; and his poverty is further expressed in the use of poor and crude tools, smallness of operations and poor output (KADP-SFDO, 2007).

Increasing population puts pressure on available food products as production can hardly keep pace with food demand. Food and Agriculture Organization (FAO) projections in food demand suggest that cereal demand will increase by almost 50% towards 2050 (FAO, 2003). To increase crop production in line with increasing demand for food, three primary factors should be considered and these are; increased cropland and rangeland area (15% contribution in 1961 to 1999); increased yield per unit area (78% contribution); and greater cropping intensity (7% contribution) (FAO, 2006).

Salau (2013) points out that as a result of the different uses into which maize can be put; there has been an increase in its demand over the years. The demand for maize in the country for industrial, human and animal consumption is high and it is estimated at 14.0 million metric tons as against the production level of 7.0 million metric tons (FMARD, 2007). This could be due to farmers' low production efficiency and the fact that the nation's agriculture has always been dominated by the smallholder farmers who represent a substantial proportion of the total farming population and produce over 90% of the total agricultural output in the country (Ajibefun *et al*, 2002).

The poverty status of rural farming households worsens due to a combination of factors such as population growth, low production efficiency and product competitiveness. The significant imbalance between food production and expanding population has resulted in ever-increasing demand for agricultural products. This therefore, underlines the need to increase the production efficiency of smallholder farming households and, eventually reduce or alleviate the incidences of poverty among them on a consistent basis. That is to say, agricultural growth through increasing production efficiency can be a tool for achieving poverty reduction in rural areas both in absolute and relative terms (Ojo and Imoudu, 2000; Diao, 2010; Oladejo and Ladipo, 2012).

This shortfall in output relative to demand had continued till 2012 when the Federal Government of Nigeria came up with the Agricultural Transformation Agenda (ATA) implemented by the Federal Ministry of Agriculture and Rural Development (FMARD). The ATA had the goal of adding 20 million metric tons of food to the domestic food supply and creating 3.5 million jobs by 2015 (FMARD, 2014).

The basic thrust of economics of agricultural production at the micro level is to assist farmers to attain their objectives through efficient farm allocation of resources over a given period of time. Profit maximization could be achieved by maximizing output from a given resource or minimizing the resources required for a given output. Agricultural productivity is synonymous with resource productivity which is the ratio of total output to the resource/inputs being considered (Olayide and Heady, 1997).

1.2 Problem Statement

Agricultural production in Nigeria has always been dominated by the smallholder farmers who represent a substantial proportion of the total farming population and produce over 90% of the total agricultural output in the country. The production process of these smallholder farmers is characterized by small-scale, poor, subsistence and semi-subsistence farmers and informal traders. The farmers cultivate small landholdings, which are often less than one hectare in size and in fragmented plots relying on manual labor and, hence, low resource productivity, low production efficiency and low income, thus, leaving them with low revenue and eventual poor state (Ajibefun *et al.*, 2002; IITA, 2009).

Some farmers obtain seeds from the previous season's harvest or purchase directly in the open market without regard to genetic purity. A key activity in raising crop yields and agricultural output is increasing the availability of high quality seeds and other inputs (Ajeigbe *et al.*, 2009). Food production has failed to keep pace with population demand due to the use of local seed varieties, increasing population, low yield per unit area resulting from low production efficiency and poor cropping intensity (Ojo, 2004; FAO, 2006; Oladejo and Ladipo, 2012).

Further, low capitalisation, price fluctuation, disease and pest, poor storage facilities and inefficiency of resources utilization are the identified problems that have characterized maize production in Nigeria. This production efficiency of smallholder maize farmers has important implication on their poverty status sand the development strategies adopted in many developing countries where the primary sector is still dominant. Therefore an improvement in the understanding of the level of production efficiency and its relationship with farming household poverty reduction 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 (Ajibefun, *et al.*, 2002; Ojo, 2004; Zalkuwi, *et al*., 2010).

With several interventions by successive governments and that of growth enhancement support scheme (GESS) targeted at improving the production capacity and livelihood of the small scale maize farmers in the FCT, no specific study has been conducted to assess the production efficiency and level of poverty reduction among maize farmers in the FCT within the period of implementation of the GES programme. Therefore, this study aims at analyzing the production efficiency and poverty status of the farmers under the GES. Thus, the following research questions were formulated to guide this study:

i. What are the socio-economic factors that influence maize production in the study area?
ii. What are the factors that affect production efficiency of the maize farmers?
iii. Is maize production profitable to farmers under the GES in the study area?
iv. What is the poverty status of maize farmers in the area?

v. What are the major problems associated with maize production in the study area?

1.3 Objectives of the Study

The general objective of the study was to assess maize production efficiency and its impact on poverty reduction among small scale farmers in the Federal Capital Territory (FCT) under the Growth Enhancement Support (GES) Scheme of the Agricultural Transformation Agenda (ATA). The specific objectives were to:

i) Identify and describe the socio-economic characteristics of maize farmers in the study area;

ii) analyze the determinants of production efficiency of the maize farmers;

iii) analyze the profitability of maize production;

iv) determine the poverty status of maize farmers;

v) Identify and discribe the main constraints associated with maize production.

1.4 Justification

According to Actionaid Nigeria (2009 – 2013), the issues of employment and underemployment are major challenges in the country. Majority of the workforce are self-employed in subsistence agriculture and the informal economy or employed casually. Nigeria still has a generalized manifestation of poverty and inequality in the distribution of income. The poor spend more of their income on food. Their commonly used coping strategy is by reducing food consumption, re-selling household assets, pulling children out of school and borrowing with harsh lending policies, all these having long term consequences.

The Living Standards Measurement Study (NBS, 2004) revealed that 35% of Nigerians lived in extreme poverty, and about 54% were poor in relative terms. The national Gini Coefficient was 0.4882, while those for urban and rural areas were 0.5541 and 0.5187, respectively. The trend in population growth also indicates increase in the number of poor people in Nigeria. Statistics indicated that 36.6% of the population was food poor. About 86.5% of rural households participate in agriculture, compared to 14% in the urban areas. About 25% of the core poor households were in agriculture while 21% were in non-agricultural activities. Yet low level of production efficiency has often been reported on the rural smallholder farmers and, this worsens their income level and hence, livelihood.

The demand for maize in the country for industrial, human and animal consumption is high and it was estimated at 14.0 million metric tons as against the production level of 7.0 million metric tons (FMARD, 2007). This shortfall in output relative to demand makes it necessary to study the production efficiency and poverty status of maize farmers.

The result of this study would give insight to the socio-economic characteristics of small scale maize farmers in the Federal Capital Territory (FCT). The outcome of this research could serve as a form of evaluation and feedback to the government, policy makers, development partners and even Non-Governmental Organizations (NGOs) on the performance (success or otherwise) of the implementation of the GES in the study area. Furthermore, findings from this work would complement any available body of knowledge on maize production efficiency, profitability and its contribution to household poverty reduction in the FCT under the GES scheme. It would also provide a

basis for further research. Finally, this study would offer a learning opportunity that could result in policy recommendations aimed at achieving better design, implementation and coordination of subsequent poverty alleviation programmes targeted at boosting the productivity, efficiency and profit level of small scale farmers.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview of Maize Production in the World

The bulk of maize grown worldwide is yellow, and three times as much maize is used for livestock feed as for direct human consumption. In parts of the developing world, demand for maize for livestock is increasing rapidly. Nonetheless, maize remains an important part of the human diet in many developing countries and, where it is grown; white maize tends to assume much greater importance than yellow varieties (FAO, 1997). According to Food and Agriculture Organization (FAO, 2007) estimates, 158 million hectares of maize are harvested worldwide. Africa harvests 29 million hectares, with Nigeria, the largest producer in SSA, harvesting 3%, followed by Tanzania. International Institute of Tropical Agriculture (2004), in an online publication reported that worldwide production of maize is 785 million tons, with the largest producer, the United States, producing 42%. Africa produces 6.5% and the largest African producer is Nigeria with nearly 8 million tons, followed by South Africa. Africa imports 28% of the required maize from countries outside the continent. Most maize production in Africa is rain fed.

Globally, maize takes the 11th place in the ranking of most valuable agricultural commodities. Aggregate output of the crop was estimated at about 873 million tons worth $53.6 billion. Global of ranking of countries that produce maize shows that the United States of America is the leading country in maize production having an estimated 273.8 million tons valued at about $22.3 billion. Nigeria placed 11th having an output of about 9.4 million tons worth about $1.0 billion (FAOSTAT, 2012).

Globally demand and supply of the crop between 2014 and 2015 is estimated at 1,148 million tons. The United States Department of Agriculture (USDA, 2015) listed the major exporting countries of the maize to include the USA (38.8%), Brazil (19.2%), Ukraine (14.4%) and Argentina (10.6%) of the total world export of maize while the major importing countries include Japan (13.4%), Mexico (8.5%), South Korea (8.4%) and Egypt (6.5%).

2.2 Maize Production in Nigeria

Edache (1999) cited in Olarinde (2011), said the first major effort to promote the production of maize in Nigeria was in 1974 when the federal government launched the National Accelerated Food Production Programme (NAFPP) on a pilot basis. The phenomenal growth in maize production which the nation achieved in the past decade is attributed to a number of factors, notably: A restriction on the importation of maize and, lately, wheat, rice and malted barley, which gave rise to high demand for locally produced maize as a result of its use as a substitute for some inputs in the brewery, pharmaceutical and bakery industries; good weather conditions for crop production; and, high demand for Nigerian grains in neighbouring Sahelian countries.

Maize has been in the diet of Nigerian's for centuries. It started as a subsistence crop and has gradually become more important crop. Maize has now risen to a commercial crop on which many agro-based industries depend on as raw materials. The absence of resistance or tolerance in the local maize varieties to the American rust shaped the first approach towards an improvement of the maize crop and introduction of maize materials from all over the world (Iken and Amusa, 2004).

In Nigeria, maize production has spread from the forest zone to the savannah regions of the north, mostly through the activities of the Agricultural Development Projects (ADPs). It has also evolved from being a minor delicacy grain crop cultivated on a limited scale around the homestead to a major commercial crop (Valencia and Breth, 1999). Most of the expansion of maize has, until recently, occurred in the dry savannah ecological zone within the states of the north-west. Questions have been raised about: (i) The reasons for the slow pace of maize expansion in other ecological zones such as the southwestern region of Nigeria, that has been known to possess suitable conditions for its production; (ii) whether the fluctuating nature of maize production can be improved upon to sustain a viable expansion programme, more so when the various non-government-funded agricultural improvement schemes have been relaxed or, in some cases, are not functioning anymore; and (iii) whether the current effort by the Nigerian government targeted towards empowering farmers to cultivate the land for national food security and for export will not be derailed by the traditionally known constraints which have so far defied appropriate solutions (Olarinde, 2011). The various efforts by the Nigerian government to improve food security have made it beneficial for farmers to grow such crops as maize on a scale which is larger than that for a small holding (Olarinde, 2011).

Food and Agriculture Organization (FAO, 2014) reported that maize ranks third in terms of volume of output among the crops in Nigeria with about 9.4 million tons of harvest. This output was estimated at $1.0 billion placing the commodity as the seventh most valuable crop in Nigeria. The estimated the output of maize from Nigeria was put at about 10 million tons in 2013, harvested from 5.2 million hectares of land on which an estimated 13,000 tons of maize seed was planted (Table 2.1).

The trend indicates a marginal but steady annual increase in the output of maize with the cultivated area and seed quantity remaining the same between 2012 and 2013. It can therefore, be said that intensification of maize production is progressively being realized with the introduction of improved varieties and other production techniques rather than mere expansion of cultivated land area. Thus for food production to keep pace with population demand, there is a need to invest in more efforts to increase yields, continued expansion of cropland by conversion of natural habitats, or by optimizing food or feed energy efficiency from production to consumption (Mutambara *et al.*, 2013).

Table 2.1: Trend of quantity of seed, area cultivated, yield and production of maize in Nigeria

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013
Seed Qty (Mt)	97625	98600	96125	83764	103732.8	150211.8	130000	130000	130000
Cultivated Area (Ha)	3589000	3905000	3944000	3845000	3350560	4149310	6008470	5200000	5200000
Yield (Mt/Ha)	1.6598	1.8182	1.7049	1.9571	2.1961	1.8502	1.5279	1.8096	2.0000
Production (Mt)	5957000	7100000	6724000	7525000	7358260	7676850	9180270	9410000	10400000

Source: FAOSTAT, 2014

2.2.1 Economic value of maize production

According to Alene *et al.* (2009), maize grows in a wide range of production environment and is thus very important to the poor in production for home consumption. Maize is the most important cereal crop in sub-Saharan Africa (SSA) and an important staple food for more than 1.2 billion people in SSA and Latin America. All parts of the crop can be used for food and non-food products. In industrialized countries, maize is largely used as livestock feed and as a raw material for industrial products (IITA, 2014). The University of Mississipi (2010) reported that the meat industry depends heavily on corn; for this is one of the main feeds used for livestock.

In Nigeria, for example, maize accounts for the largest share (20%) of total food consumption among the rural poor (Alene *et al*., 2009). The National Bureau of Statistics (2007), in a report of consumption pattern in Nigeria said the consumption of white maize unlike guinea corn and millet was generally huge across the country. The sum of N3,796,727 and N586,216 was spent on the consumption of white and yellow maize, respectively, throughout the country. In the FCT, about 14.5 percent of household income is spent on cereals (including maize) and 10.2 percent on flour. It provides producers with greater market opportunities for generating cash incomes. In Ghana, for example, at least half of all maize produced enters the market (Morris *et al*., 1999). Maize accounts for 30−50% of low-income household expenditures in Eastern and Southern Africa. Maize is processed and prepared in various forms depending+ on the country. Ground maize is prepared into porridge in Eastern and Southern Africa, while maize flour is prepared into porridge in West Africa. Ground maize is also fried or baked in many countries. In all parts of Africa, green (fresh) maize is boiled or roasted on its cob and served as a snack. Popcorn is also a popular snack (IITA, 2014).

Report of a recent study conducted in Zambia by Brya *et al*. (2014) to determine the total body reserves (TBRs) of vitamin A with consumption of bio-fortified maize revealed that beta-carotene from maize was efficacious when consumed as staple food and could avoid the potential for hypervitaminosis A.

2.2.2 Problems of maize production in Nigeria

Maize production is faced with a number of challenges which limit both productivity and production by farmers. Shortage of improved varieties and relevant production technologies constitute a problem to maize farmers. The Food and Agriculture Organization and International Maize and Wheat Improvement Centre (CIMMYT) in a 1997 publication observed that expanding white maize output will depend primarily on increases in yields, which in turn will require farmers to adopt new technology. From an environmental point of view, in many countries increases in maize yields on better land are preferable to expanding maize cultivation into more marginal areas. Difference in varietal preferences and circumstances of maize farmers equally pose a challenge. Worldwide however, the greatest constraint to the diffusion of better germplasm to farmers has been the failure of seed industries to evolve to meet the needs of a wide variety of growers.

Incidence of pests and diseases reduce output of maize by farmers. Various species of stem borers rank as the most devastating maize pests in SSA. They can cause 20-40% losses during cultivation and 30-90% losses postharvest and during storage. Other pests in SSA include ear borers, armyworms, cutworms, grain moths, beetles, weevils, grain borers, rootworms, and white grubs. The parasitic Striga weed is another maize pest. In

fact, weed-related yield losses ranging from 65 to 92% have been recorded in the Nigerian savanna. Maize diseases in Sub-Saharan Africa (SSA) include downy mildew, rust, leaf blight, stalk and ear rots, leaf spot, and maize streak virus (MSV). Maize does not tolerate drought well and the grain can rot during storage in tropical climates. A lack of sunshine and nitrogen can reduce the production potential of the crop (International Institute of Tropical Agriculture, 2004). Tambo and Abdoulaye (2012), also observed that despite the potential for further yield increases, maize production faces numerous problems including poor soil fertility, striga, diseases, drought, low and erratic rainfall, and long dry season.

2.3 Growth Enhancement Support Scheme (GESS)

The Growth Enhancement Support (GES) Scheme is a component of the Agricultural Transformation Agenda (ATA). The Federal Ministry of Agriculture & Rural Development (FMARD, 2012), said the GES Scheme represents a policy and pragmatic shift within the existing Fertilizer Market Stabilization Programme and it puts the resource constrained farmer at its centre through the provision of incentives to encourage the critical actors in the fertilizer value chain to work together to improve productivity, household food security and income of the farmer. The goals of the GES are outlined as follows:

i. Target 5 million farmers each year (for 4 years) that will receive in mobile phones directly totaling 20 million at the end of 4 years;

ii. To provide support directly to farmers to enable them procure agricultural inputs at affordable prices, at the right time and place;

iii. To increase the productivity of farmers across the length and breadth of the country through increased use of fertilizers (i.e. 50kg/ha from 13kg/ha);

iv. Change the role of government from direct procurement and distribution of fertilizer to a facilitator of procurement, regulator of fertilizer quality and catalyst of active private sector participation in fertilizer value chain.

Ayoola (2012) and FMARD (2012), said the GES Scheme has a component involving "electronic wallet or voucher system" to which only farmers whose biostatistics have been captured in a validated database are expected to have access to subsidized agricultural inputs. The Scheme was designed to break the inefficient fertilizer support delivery to farmers, eliminate political/spurious farmers, fertilizer vendors/traffickers and ensure that the country's huge investments in the sub-sector reach the target beneficiaries. The federal and state government will subsidize 50 percent of the price of the supplied inputs by 25 percent each, while farmers pay the remaining 50 percent. Government believes that this will lead to increased yield and guarantee food security by raising farm production to 50kg/ha by 2015. In a 2012 GESS report prepared by the Federal Capital Territory Administration (FCTA) Agricultural Secretariat, about 140,126 farmers had been registered as at 2013 while 92,808 of them were served as against 37,128 farmers served in 2012; that is an increase of 150 percent over 2012 (FCTA, 2012 and FMARD, 2013).

2.4 Agricultural Productivity, Efficiency and Poverty Reduction

Lovell (1993), Harold *et al*. (2007) and Jim Riley (2012), describe productivity of a production unit as a measure of the ratio of its output to its input. That is, it is a measure of economic progress. However, productivity varies with differences in production technology, production process and differences in the environment in which production occurs. It helps in measuring such problems as: allocation of resources,

distribution of income, efficiency or productivity measurements and the relationship between stocks and flows. Efficiency measurement involves a comparison of actual performance with optimal performance located on the relevant frontier. Since the true frontier is unknown, an empirical approximation is needed. The approximation is frequently dubbed a "best practice" frontier (Harold *et al.*, 2007). According to Investopedia online publication, production efficiency is the ability of production unit to produce a good using the fewest resources possible. Efficient production is achieved when a product is created at its lowest average total cost. It measures whether the production unit is producing as much as possible without wasting precious resources. Taphee and Jongur (2014), Korir *et al*. (2013) and Shehu *et al*. (2007) observed that farm size, quantity and variety of seeds, family labour and contact with Extension Officers are critical determinants of productivity and efficiency. Further, socio-economic, demographic, institutional and environmental factors also affect farmer's efficiency. These include farmer's age, sex, marital status, household size, educational attainment, access to credit, off-farm income, membership of farmer organization and so on ((Kumbhakar and Bhatteacharya, 1992). Thus, increase in production and productivity is a direct consequence of efficiency of input combination given the available technology (Ogundari and Ojo, 2005).

The Oxford Advanced Learner's Dictionary (2010) defined poverty as the state of having very little money or not having enough money for basic needs. The New International Webster's Comprehensive Dictionary of the English Language (2004) defined poverty as the condition that relates to the absence or scarcity of requisite substance or element. The report of Summit on Food Security in Africa (2009) said poverty was defined in Nigeria's National Policy on Poverty Alleviation as

"multidimensional and dynamic process of socio-economic deprivation which leads to individual's lack of access to basic necessities of life such as food, shelter, potable water, energy sources and information". Akintola and Yusuf (2001) cited in Arogundade *et al*. (2011), Olorunsanya *et al*. (2011), and NBS (2011), defined poverty as a social condition characterized by inadequate access to basic human needs (food and non – food) to the sustenance of socially acceptable minimum standard of living in a given society. Some of these basic determinants of well being include adequate food, clothing, shelter, potable water, health care, education, sanitation facilities, access to information and employment opportunities. The Food and Agriculture Organization (FAO, 1996) said that poverty is a major cause of food insecurity and sustainable progress in poverty eradication is critical to improve access to food. The determinants of poverty include per capita income of household, household size, age of household members, gender of household members, educational attainment of household members, marital status, working or business experience, child dependency ratio and availability of credit (Akinleye, 2006 and Olorunsanya *et al*., 2011).

Agricultural productivity and efficiency have strong implication on poverty reduction, especially among smallholder farmers. Most of the interventions targeted at poverty reduction indirectly target improvement in production efficiency. This association is supported by Jayne, et al., (2010) thus, "History suggests the necessity of productivity increases in smallholder agriculture. Except for a handful of city-states, there are virtually no examples of mass poverty reduction since 1700 that did not start with sharp rises in employment and self-employment income due to higher productivity in small family farms". Increased production efficiency targets reducing costs and increasing revenue, and hence, farm income, which is a proxy for the determination of poverty

status. This may be part of the reasons Farell (1957) cautions that it is necessary to measure the extent to which a farm firm uses the various factors of production in the best proportions to get the largest possible output, in view of their prices. Since cost efficiency is an aspect of production efficiency, as reflected in economic efficiency, increasing agricultural production efficiency has effect on the farmer's revenue, and net farm income, which is a primary source of sustenance to most rural households and a proxy for determining poverty status (Bravo-Ortega and Lederman, 2005; Diao, 2010; Rovere, *et al*., 2014).

Agricultural transformation is characterized by significant improvement in productivity arising from efficient use of productive resources (land, labour, high quality fertilizers, improved seeds and agro-chemicals) stimulates increase in incomes for poor farmers and then the demand for other goods and services by the poor farmers. This eventually reduces both rural and urban poverty through a combination of factors. Reduction in poverty arising from increased production efficiency and income, induces rural smallholder farmers to resort to less of the coping strategies such as reduced number of meals per day, poor nutrition (low quality meals), sale of assets, withdrawal of children from school, and so on (Mellor, 1999; Thirtle, 2001; Diao, 2010; Schneider and Gugerty, 2011; Rovere, *et al*, 2014).

In an effort to increase the productivity and efficiency of rural farmers, and by extension, their incomes, government at different times have embarked on a number of poverty reduction programmes. Ahmed (2011), reports that the most pragmatic past approaches taken at alleviating poverty as well as create employment opportunities in Nigeria included the establishment of some programmes and schemes which have

helped in alleviating or reducing poverty. The Agricultural Transformation Agenda introduced in 2011 is also aimed at reducing poverty through empowerment of rural farmers to embrace agriculture as a business.

Agriculture contributes to poverty reduction because increased efficiency in production may lead to increased output, reduced costs and increased revenue, greater supply of food-stuffs and lower food prices to the benefit of both rural and urban poor, thereby providing employment to the poor, who have also generally low skills and education (Grewal and Ahmed, 2011; Oyakhilome and Zibah, 2014). It is therefore, hoped that the growth enhancement support scheme (GESS) will go a long a way in increasing the production efficiency of rural farmers and in turn their income, thereby improving their poverty status.

2.4.1 Technical efficiency

A firm is considered more technical efficient than another, if given the same quantities of measurable inputs, it consistently produces a large output. Technical efficiency is the physical ratio of product output to the factor input (an engineering concept); the greater the ratio, the greater the magnitude of technical efficiency. By implication, difference in technical efficiency exists between firms. The production function pre-supposes technical efficiency, whereby maximum output is obtained from a given level of input combination. Therefore, it is a factor-product relationship. An important assumption here is that firms operate on the outer bound production function, that is, on their efficiency frontier. When firms fail to operate on the outer bound production function, they are said to be technically inefficient. For such firms, Heady (1960) suggests three ways of improvement in technical efficiency to include: improvement in production

techniques, improvement in production technology and improvement in both production technique and technology.

The stochastic frontier model was developed to account for noise in estimation of technical efficiency. Harold (2007), Latruffe (2010) and Gideon *et al*. (2014) said it was simultaneously proposed by Aigner *et al*. (1977) and by Meeusen and van den Broeck (1977). It assumes a double random error by adding to the deterministic model an additional random error. The stochastic production function is defined by:

$Y_i = f(\chi_i, \beta) + \varepsilon_i$ for $i = 1,2,3, \ldots, n$ ……..……..…….. (1)

$\varepsilon_i = v_i - u_i$……..……..…….. (2)

Where Y_i is the observed output quantity of the *i*-th farm; f is the production function; χ_i is the vector of the input quantities used by the firm; β is a vector of parameters to be estimated. ε_i is an error term made up of two components: v_i is assumed to account for random effects on production associated with factors such as measurement errors and other factors which the farmer does not have control over; and u_i is a non-negative random error term associated with farm-specific factors, which lead to the *i-th* farm not attaining maximum efficiency in production (i.e. u_i accounting for inefficiency). Thus, u_i measures the technical inefficiency effects that fall within the control of the decision making unit. The stochastic frontier model specifies technical efficiency of an individual farm as the ratio of the observed output to the corresponding frontier output conditioned on the level of inputs used by the farm. Technical inefficiency, therefore, is the amount by which the level of production for the farm is less than the frontier output. The technical efficiency (TE_i) of the *i-th* farm is then given by:

$TE = Y_i/Y_i^* = \{f(\chi_i ; \beta) .\exp(v_i - u_i)\}/\{f(\chi_i ; \beta) . \exp(v_i)\} = \exp(-u_i)$.....…….… (3)

Where Y_i or $f(\chi_i ; \beta)$ .exp($v_i - u_i$) is the observed output and Y_i^* *or* $f(\chi_i ; \beta)$. exp(v_i) is the unobserved (frontier) output. According to Battese and Coelli (1995), cited in Olarnde (2011) and Gideon *et al* (2014), and Huang and Liu (1994), the error term v_i is assumed to be identically independent and normally distributed with zero mean and constant (unknown) variance, N(0, σ_v^2). The error term u_i is also assumed to be distributed as a truncation of the normal distribution with mean u_i and variance N(u_i,σ_u^2)*;* such that the inefficiency error term can be explained by exogenous variables specified as:

$u_i = \delta_0 + \Sigma\delta_i Zi$ (for i = 1, 2, …., n) ……..…….. (4)

The inefficiency effects are estimated through a truncated normal distribution, which is a non-neutral frontier model (Huang and Liu, 1994). Therefore the model in Equation (4) can be explicitly written as:

$u_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \ldots\ldots\ldots\ldots + \delta_n Z_n$ …… …….(5)

where u_i represents the technical inefficiency effects and $\delta_i$is the vector of unknown parameters to be estimated. The Z_1 is the vector of variables that determine technical inefficiency among the maize farmers. The *Zs* include Z_1 (age in years); Z_2 (level of education); Z_3 (farming experience in years); Z_4 (total farm size in hectares); Z_5 (household size); Z_6 (access to credit, dummy); up to the *n-th* variable.

The maximum likelihood estimates of the stochastic frontier model provide the estimates of β and the gamma (γ), where the gamma explains the variation of the observed total output from the frontier output. Gamma is specified as:

$\gamma = \sigma_u^2/\sigma^2$..... (6)

Where γ lies between zero and one ($0 \leq \gamma \leq 1$); σ_u^2 is the variance of the error term associated with inefficiency and σ^2 is the overall variation in the model specified as the sum of the variance associated with the inefficiency (σ_u^2) and that associated with random noise factors (σ_v^2).

Thus, $\sigma^2 = \sigma_u^2 + \sigma_v^2$ ……..…… (7)

The closer the value of γ is to one (1), the more the deviation of the observed output from the deterministic output which is as a result of inefficiency factors. If however, the value of γ is closer to zero (0), then deviations are largely due to random factors and if it lies between zero (0) and one (1), then the deviations are as a result of both inefficiency and random factors.

2.4.2 Allocative efficiency

Price or allocative efficiency traditionally rests on an index of marginal product or opportunity cost. If among all inputs, the ratios of marginal products to opportunity costs are equal to one (unity), a firm is said to be price efficient. That is, if it equates the value of the marginal product of each variable input to its price (allocative efficiency occurs at a point where the marginal value product is equal to the marginal factor cost). Thus, allocative efficiency is concerned with choosing optimal sets of inputs (behavioural concept). A price efficient firm is a profit maximizer, therefore, a firm which fails to maximize profit is price inefficient.

Measurement of price or allocative efficiency of farm firms has often been achieved by many researchers including Ali and Samad (2013) and Girei *et al.* (2013) using the stochastic frontier cost function analysis. The model is similar to that of stochastic production frontier production function and has been used by many researchers. The cost frontier as used by Ogundari *et al*. (2006) can be derived analytically as:

$C = y(P, Y_i: \gamma) + (v_i + u_i)$ ……(8)

Where C is the total production cost, P is a vector variable of input prices, y is a suitable functional form, Y_i is the value of output in Kg, and γ is the parameter to be

estimated. Zalkuwi *et al.* (2010) said in his study of economic efficiency of maize production that the cost efficiency of an individual farm is defined in terms of the ratio of the observed cost (C^b) to the corresponding minimum cost (C^{min}) given the available technology. That is,

Cost Efficiency (C_{EE}) = $(C^b)/(C^{min})$ = exp (Ui) ……..……..……..(9)

Where:

C^b = the observed cost represents the actual total production cost

C^{min} = minimum cost and represents the frontier total production cost or least cost total production level.

C_{EE} = exp (Ui) ……..…….... (10)

C_{EE} takes the values of 1 or higher with 1definig cost efficient farm.

According to Girei *et al.* (2013), the empirical stochastic frontier cost function for crop farmers is given by:

$\text{LogC} = \beta_0 + \beta_1 \text{Log}P_1 + \beta_2 \text{Log}P_2 + \ldots + \beta_n \text{Log}P_n + \beta_i \text{Log}Y_i + (v_i + u_i)$ …….....(11)

Where:

C =Total production cost (naira)

P_1 - P_n = Cost of inputs (naira)

Y = Volume of output (kg)

β_i = Parameter to be estimated

The decision rule is that inputs with negative coefficients are over-utilized while the ones with positive coefficients are under-utilized. It is assumed that the technical inefficiency effects are independently distributed and U_i arises by truncation (at zero) of the normal distribution with mean, μ_{is} and variance δ^2, where μ_i is as defined for the stochastic frontier production function.

2.4.3 **Economic efficiency**

Economic efficiency is the product of both technical and allocative efficiencies whose policy implications permeate both the micro and the macro-economic level. Therefore, the achievement of either technical or allocative efficiency is a necessary but not sufficient condition to ensure economic efficiency (Ellis, 1988). The simultaneous achievement of both efficiencies however, provides the sufficient condition for economic efficiency. Thus, economic efficiency refers to the choice of the best combination (of inputs) for a particular level of output, which is determined by both input and output prices. Farrell (1957) described economic efficiency as the "overall efficiency", indicating that such a firm is perfectly efficient both technically and in terms of prices, producing each unit of output at the least cost possible. Of course, an economically efficient smallholder farmer would be expected to make relatively more income and enjoy better living standard. Economic (Scale) efficiency gives insights into whether the firm operates at an optimal or sub-optimal size. Firms that are scale efficient operate under constant returns to scale (CRS) and have a scale elasticity of one, while scale inefficient firms could exploit scale economies or diseconomies (Latruffe, 2010).

The economic efficiency of a farm firm is the product of its technical efficiency (TE) and allocative efficiency (AE). In classical economic theory it is equal to AE itself as TE is presupposed to be one. The conversion of various cost components in into prices of each input enables the direct estimation of the economic efficiency of a production (Singh *et al*., 2007). The economic efficiency index gives a measure of the overall

efficiency level or performance of the farm business as it affects cost and technical effectiveness.

2.5 Profitability Analysis

The farm business is usually assessed to ascertain the returns in relation to the amount of resources invested. Profitability of a farm business considers the relationship of the net farm profit to resources (farm land, labour and management skills) invested in the farm business (Johnson, *et al.* 1998).

Odii (1998) outlined three approaches to economic assessment a farm business to include enterprise (partial) analysis, gross margin analysis and whole farm (net farm income) analysis. In addition to the methods listed methods, White (2006) said the application of financial ratios (liquidity, solvency, repayment ability, profitability and efficiency) give better idea of the performance of a farm business. Miller, *et* al (2003) emphasized the rational for preferring net farm operating income for computing these ratios is that the net farm income from operations is more likely to predict future income than net farm income, which includes revenues that are unusual in nature or infrequent in occurrence. Two methods of measuring the net farm income were identified as the "valuation method" and the "transactions method". The choice of method is very much related to the type of record system used on a farm. The valuation method is most often associated with situations where relatively simple tax records are kept on the farm. The transactions method measures net farm income based on complete and accurate recording of farm business transactions. With this method net farm income (or loss) is the difference between farm revenues and farm expenses as recorded in the farm accounts. The net farm income analysis from the transactions

method will be employed in measuring the costs and return of maize farmers in the FCT. Some authors (Johnson, *et al.* 1998, Odii 1998, Miller, *et* al. 2003 and White 2006) agreed that the methods of measuring farm profitability depend on properly kept records of financial dealings (cash flow statement, income statement and balance sheet).

Net farm income analysis considers the level of profit in terms of its adequacy in relation to the level of capital invested and the standard of living it can support. The factors that will affect the level or profit include product and input prices, yield rates and rate of turnover (Johnson, *et* al., 1998; Odii, 1998; White, 2006). Therefore, net farm income analysis aims at evaluating the returns (profit) to the farmer after the cost of fixed assets used in the production process has been offset. Thus,

$NFI = TVP - TC$ …….……...……. (12)

Where *NFI* is the net farm income, *TR* is total revenue (total value of output) and *TC* is total cost of production. The *TFC* is derived by depreciating the fixed assets used in production.

2.6 Measurement of Poverty

The measurement and analysis of poverty are necessary to: (a) know what the situation is, (b) understand the factors determining this situation, (c) help design interventions best adapted to the situation, and (d) assess the effectiveness of current policies and to determine whether the situation is changing (IFPRI, 2010).

2.6.1 Estimation of the poverty line through household expenditure

Olowa (2012) defined poverty line as the monetary cost to a given person, at a given place and time, of a reference level of welfare. People who do not attain that level of welfare are deemed poor; and those who do are not. In a poverty line, people are counted as poor when their measured standard of living falls below a minimum acceptable threshold (NBS, 2004). A distinction is sometimes made between "absolute poverty line" and "relative poverty line", whereby the former has fixed "real value" over time and space, while a relative poverty line rises with average expenditure. Arguably, for the purposes of informing anti-poverty policies, a poverty line should always be absolute in the space of welfare. Such a poverty line guarantees that the poverty comparisons made are consistent in the sense that two individuals with the same level of welfare are treated the same way (Olowa, 2012).

The World Bank (2002) puts the poverty line at $1 per person per day for extreme poverty and $2 per person per day as general poverty line value. However, NBS (2011) in a review of the 2009/2010 absolute poverty rates across Nigeria, on dollar-per-day basis; said the poverty line is set at US$2 or less and $1.25 per day for the extreme poor. The poverty line value is estimated from the mean per capita (mean adult equivalent) household expenditure of the sampled farmers. Two-thirds of the mean adult equivalent household expenditure of the sampled farmers is used as the poverty line value for the study. This technique has been used by some research institutes and individual researchers (Omonona 2001, FOS 2004, Kwaghe 2006, Amaza *et al*. 2007, Olorunsanya *et al*. 2011, and NBS 2011). The poverty line model is specified as follows:

$$P = \frac{2}{3}(MAHE) \quad \text{..... (13)}$$

Where:

P = Poverty Line Value

MAHE = Mean Adult equivalent Household Expenditure

Adult equivalent = $1+0.7(N_{adults} - 1) + 0.5N_{children}$ ..... (14)

2.6.2 Weighted poverty index

The International Food Policy Research Institute (2010) describes incidence of poverty (headcount index) as the share of the population whose income or consumption is below the poverty line; that is, the share of the population that cannot afford to buy a basic basket of goods. The depth of poverty (poverty gap) provides information regarding how far households are from the poverty line. This measure captures the mean aggregate income or consumption shortfall relative to the poverty line across the whole population. The poverty severity (squared poverty gap)takes into account not only the distance separating the poor from the poverty line (the poverty gap), but also the inequality among the poor; that is, a higher weight is placed on those households further away from the poverty line. The NBS (2011) emphasizes that the measure incorporates the extent to which a poor person's expenditure level falls below the poverty line. This makes it possible to distinguish, for example, between States that have high poverty incidence but shallow poverty gap from those with lower poverty incidence but deeper poverty gap.

International Institute of Tropical Agriculture (IITA, 2009), Olorunsanya *et al.* (2011), Akinleye (2006), Olowa (2012) and Igbalajobi *et al*. (2013) applied the Foster *et al*. (1984) weighted poverty measures in poverty status analysis in their various researches. An advantage of the *P*-alpha measures in the Foster, Greer and Thorbecke (FGT)

poverty index is that it is decomposable among different poverty groups. The FGT poverty index model is represented as follows:

$$P_{\alpha_i} = \frac{1}{n}\sum_{i=1}^{q}\left[\frac{Z - Y_i}{Z}\right]^{\alpha} \quad \text{.....(15)}$$

Where:

α = the FGT index and takes values 0, 1 or 2, indicating poverty headcount, depth and severity, respectively.

n = total number of households

q = number of households below the poverty line

Z = estimated poverty line

Y_i = expenditure of the *i-th* household

When α = 0:

$P_0 = \frac{q}{n}$ = H (i.e Poverty Headcount ratio) .....(16)

CHAPTER THREE

METHODOLOGY

3.1 Study Area

The Federal Capital Territory (FCT) Abuja (Fig 3.1) was created by an edict in 1976 by the government of General Murtala Mohammed. The FCT lies between latitudes $8^{o}2'$ and $9^{o}25'$ north of the Equator and longitudes $26^{o}45'$ and 30^{o} east of the Greenwich Meridian. It occupies an estimated land area of 8000 square kilometers, with the Federal Capital City (FCC) occupying 250 square kilometers. Figure 3.1 shows the map of the Federal Capital Territory (FCT) Abuja. It is located in the North Central Region of Nigeria and bounded in the north by Kaduna State, on the west by Niger State, on the east and south by Nasarawa and Kogi States, respectively (FCTA FEEDS, 2008). The FCT has six (6) Area Councils, namely Abaji, Abuja Municipal, Bwari, Gwagwalada, Kuje and Kwali. Bwari and Kuje Area Councils were carved out on 1st October, 1996 for administrative convenience (FCT ADP, 2006).The forest reserve occupies about 270 square kilometers and national resources such as rivers, hills and so on occupy about 60 square kilometers.

The FCT has two main seasons, rainy (April to October) and dry (November to March). Average annual temperature varies between $20^{o}C$ ($68^{o}F$) and $33^{o}C$ ($91.5^{o}F$) with a relative humidity, in the dry season, of between 20 and 30 per cent. Average annual rainfall range is in the order of 1,100mm to 1,600mm, with an annual average of 82 rainy days. This favours the production of grain crop, including maize. The total number of farming families in all these six Area of the FCT Councils is about 165,156 (FCT-ADP, 2006; NPFS, 2012).



Source: FEEDS, 2008

Fig.3.1: Map of the FCT showing the six Area Councils

According to the 2006 Census, the population of people living in the FCT is estimated at 1,406,239 comprising of 733,172 males and 673,067 females, with a population density of 181 persons per square kilometer. At the estimated growth rate of 9.28%, the population of the FCT is projected to rise to 1,536,738 persons by 2015. About 59% of these depend on farming activities for their livelihood (NPC, 2010). Population distribution of the FCT among the Area Councils is presented in Table 3.1.

Table 3.1 Population distribution of the FCT by Area Council

S/N	Area Council	Population (2006 Census)	2015 Population* (Projected)	Land Area (Km^2)
1	Abaji	58,642	63,868	1,015.927
2	Abuja Municipal	776,298	848,338	1,813.333
3	Bwari	229,274	250,551	938.744
4	Gwagwalada	158,618	173,338	1,069.589
5	Kuje	97,233	106,256	1,682.061
6	Kwali	86,174	94,171	1,234.199
	Abuja	1,406,239	1,536,738	7,753.853

Source: National Population Census, 2010; * Projected

Among majority of the communities in the FCT are farmers that cultivate variety of crops (yam, cassava, soya bean, rice, melon, maize, millet, guinea corn, groundnut, beans, sesame and others such as vegetables and fruits) with emphasis on guinea corn, yam and maize. These crops are usually cultivated in mixed patterns in small holdings (FCT-MDG, 2010; Mutumbara, *et al*., 2013). On average 1.2ha of maize were cultivated per household and, 61.4% of farmers who grew maize used a local variety of maize while 38.6% used improved varieties. The seed rate was on average 16.8 kg/ha. The study area for this work comprises all the Area Councils of the FCT.

3.2 Sampling Technique and Sample Size

The total number of samples selected from the population of farmers for data collection in the study area was determined using the IFAD base sample-size calculation approach (IFAD, 2015). It is stated as follows:

$$n = \frac{pt^2(1-p)}{m^2} \quad \text{..... (17)}$$

Where:

n = required sample size

t = confidence level at 95% (standard value of 1.96)

p = estimated prevalence of maize farmers in the study area (at 84.5%)

m = margin of error at 5% (standard value of 0.05).

This amounted to about 200 samples. In all, therefore, a total of 200 GES beneficiary maize farmers were randomly selected from the six Area Councils of the FCT for data collection. A multi-stage random sampling technique was adopted in choosing respondents. The first stage was a purposive selection of all the six (6) Area Councils of the FCT because they were all covered by the GES Scheme (Ayoola, 2012). These 200 GES maize farmers were selected following the probability proportional to size (PPS) approach. Thus, the number of samples selected from each Area Council was proportionate to the number of GES beneficiaries in the Area Council. The National Programme for Food Security (NPFS) applied this approach in the conduct of Annual Agricultural Production survey (NPFS, 2012). The approach is described as follows:

$$n_i = \frac{Y_i}{N}(n) \quad \text{..... (18)}$$

{for i = 1, 2, …, 6; representing the six Area Councils}

where:

n_i = number of samples required from *i-th* Area Council

n = total number of samples to be drawn from the entire study area

Y_i = population of maize farmers in *i-th* Area Council

N = total population of GES beneficiary maize farmers in the study area

Therefore, the number of sample of maize farmers selected for data collection from each of the Area Councils is detailed in Table 3.2. The second stage involved the random selection of four (4) wards from each of the Area Councils because the wards are considered to be largely homogeneous. Finally, the determined number of samples for each Area Council were drawn from these wards following a simple random approach too because the maize farmers were considered homogeneous and representative of their localities. The listing or frame of maize farmers and GES beneficiaries were compiled by the FCT Agricultural Secretariat in collaboration with the FCT Agricultural Development Programme (ADP).

Table 3.2: Number of sample selected from each Area Council of the FCT

Area Council	**Number of Farm Families**	**Population of maize Farmers**	**Number of GES Beneficiaries (2014)**	**Number of Samples Selected**
Abaji	13,974	69,870	13,639	24
AMAC	15,267	76,335	23,651	43
Bwari	30,086	150,430	14,856	27
Gwagwalada	41,064	205,320	23,625	43
Kuje	31,176	155,880	15,647	28
Kwali	33,589	167,945	19,224	35
Total	**165,156**	**825,780**	**110,642**	**200**

Source: FCT ADP (2006) and FCTA (2008)

3.3 Data Collection

Primary data was collected from the sampled maize farmers by interview method using well-structured questionnaires. The questionnaires were administered by trained enumerators selected from the FCT Agricultural Development Programme following the pattern of an interview. Data was collected on such variables as farmers' socio-economic characteristics (age, sex, marital status, level of education, household size, farming experience, source of capital, contact with extension agent), the inputs used (seed, fertilizer, agrochemicals, land, lime, labour), the output of the production activity (the quantity of maize harvested in kilograms) as well as expenditure of maize farmers on food and non-food items and problems militating against maize production in the area.

3.4 Analytical Technique

A number of techniques were applied to analyze the data collected on this study. These include the use of descriptive statistics (to resolve objectives *i and v*), stochastic frontier function analysis (objective *ii*), net farm income analysis (objective *iii*), poverty line estimation (by mean household expenditure approach) and the Foster, Greer and Thorbecke (FGT) weighted poverty index measure (objective *iv*).

3.4.1 Descriptive statistics

Frequency tables, means and percentages were used to analyze and present the socio-economic characteristics of the respondent maize farmers and problems associated with maize production in the study area (objectives i and v).

3.4.2 Stochastic frontier analysis

The stochastic frontier model is a parametric approach to the estimation of technical efficiency of a production firm using econometric modeling of production frontier. The stochastic frontier model is usually applied within the framework of suitable production and cost functions (Coelli, 1995; FAO, 2003). The frontier model assumes that production units produce according to common technology, and reach the frontier when they produce the maximum possible set of outputs. It is therefore, possible to have outputs under the frontier or on the frontier but outputs cannot be above the frontier (i.e. best possible output) for an efficient firm. The frontier model permits the decomposition of the error in both output and stochastic element into noise and inefficiency effects (Ali and Samad, 2013; Danso-Abbeam, *et al*., 2014). A disadvantage of the stochastic frontier model is that the estimation of multiple output technique is somehow complicated because it will require stochastic output multiple distance functions, thereby creating problems for outputs that take zero values (FAO, 2003; Mastromarco, 2008).

This study therefore, used the stochastic frontier model to establish the influence of variables (inputs and socio-economic factors) on the production efficiency of maize farmers (objective *ii*). Such factors include seed, fertilizer, labour, farm size, farmer's age, gender, household size, agro-chemicals, farming experience, level of education, membership of organization, contact with extension agents, access to credit, and so on. In effect, stochastic frontier function was used to estimate the technical and allocative efficiency in maize production (objective ii). The maximum-likelihood estimates of β_i and δ_i coefficients were estimated simultaneously using the computer program, FRONTIER 4.1, in which the variance parameters are expressed in terms of

$\sigma^2 = \sigma_v^2 + \sigma_u^2$, and $\gamma = \sigma_u^2/ \sigma^2$ (Coelli, 1994). The stochastic production frontier model is specified as follows:

$\ln Y_i = \beta_o + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + e$ ……………………… (19)

Where:

Y_i = Output of maize in kilograms

X_1 = Quantity of maize seeds in kilograms

X_2= Quantity of fertilizers in kilograms

X_3= Labour used in man-days

X_4 = Farm size in hectares

X_5 = Agro-chemicals in litres

B_i = Parameters to be estimated

Ln = Natural logarithms

e = Composite error term defined as $v_i - u_i$

The technical efficiency model is specified as:

$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6$…….………………………………...... (20)

Where:

U_i = Technical efficiency of the maize farmers

Z_1 = Age of farmers in years

Z_2 = Household size in numbers

Z_3 = Farming experience in years

Z_4 = Level of education (1 = No formal education, 2 = primary, 3 = secondary;, 4 = Tertiary)

Z_5 = Farm size in hectares

Z_6 = Extension contact (dummy) {contact = 1; no contact = 0}

Z_6 = Gender (dummy) {male = 1; female = 2}

Z_7 = Membership of farmer-based organization (dummy) {member = 1; non-member 0)

δ_i = Parameters to be estimated

Similarly, the stochastic frontier cost function for the maize farmers is given by:

$\ln C = \beta_0 + \beta_1 \ln P_1 + \beta_2 \ln P_2 + \beta_3 \ln P_3 + \beta_4 \ln P_4 + \beta_5 \ln P_5 + \beta_6 \ln Y_i + (v_i + u_i)$……....(21)

Where:

C =Total production cost

P_1 = Cost of land

P_2 = Cost of maize seed

P_3 = Cost of inorganic fertilizer

P_4= Cost of agro-chemicals

P_5 = Cost of labour

Y_i = Output of maize (Kg)

Ln = Natural logarithm

β_i = Parameters to be estimated (i = 1, 2, ….., 6)

$(v_i + u_i)$ = Composite error term

If the coefficient of an input is positive, then the resource is under-utilized but if negative, it is over-utilized. The stochastic frontier cost function was used in analyzing the allocative (cost) efficiency of maize farmers in their production process. Many researcher including Girei *et al.* (2013) have used the stochastic frontier cost function in analyzing crop farmers' allocative efficiency.

The economic efficiency of in maize production is the basis for the estimation of technical and allocative efficiencies. They are intended to provide indices for estimating the economic efficiency of maize farmers in the study. In effect, farm

specific economic efficiency of the maize farmers was obtained by taking a product of their technical and allocative efficiency scores already obtained from the Stochastic Frontier analysis. Alias, *et al.* (1996) and Girei, *et al.* (2013), used this same approach in estimating farm level economic efficiency. Therefore, the farm level and overall (mean) economic efficiency in maize production were realized using the function:

$EE_j = TE_j . AE_j$ ……..……..…….(22)

Where:

EE_j = Economic Efficiency of *j-th* farm

TE_j = Technical Efficiency of *j-th* farm

AE_j = Allocativ Efficiency of *j-th* farm

3.4.3 Net farm income analysis

Net farm income analysis was used to determine the profitability of maize production in the study area, that is, it was applied to address objective (*iii*).The net farm income is the profit the farmer gets after all production costs have been offset. Net farm income (NFI) is obtained by deducting the total cost (TC) incurred in acquiring production inputs (fixed- land, machete, hoe, wheel barrow, sprayer; and variable- seed, fertilizer, labour, agro-chemical) from the total revenue (TR) realized from the sale of maize output produced from the farm (i.e. total quantity of output multiplied by unit price of output). The model is specified as follows:

NFI = TR-TC.....(20)

Where:

NFI = Net Farm Income

TR = Total Revenue

TC = Total Cost (Total Variable Cost + Total Fixed Cost)

The fixed inputs (land, machete, hoe and wheel barrow) would not normally be used up in one farming or cropping season. They were depreciated using the straight line method as shown below:

$$D = \frac{P - S}{N} \quad \text{..... (21)}$$

Where:

D = Annual depreciation

P = Purchased value

S = Salvage value

N = Useful life span of asset

3.4.4 Estimating poverty line through the expenditure approach

This approach was utilized to determine the poverty line for the sampled farmers in the study area (objective *iv*). It was calculated from the household expenditure of the sampled maize farmers. Two-thirds of the mean per adult equivalent of the household expenditure of the sampled maize farmers will be used as the poverty line value for the study. The model is specified as:

$$P = \frac{2}{3}MAHEI \quad \text{..... (22)}$$

Where:

P = Poverty Line Value

MAHE = Mean Adult equivalent Household Expenditure

Adult equivalent = $1+0.7(N_{adults} - 1) + 0.5N_{children}$

Then the FGT poverty index measure was employed to isolate the sampled maize farmers into various poverty groups, thereby satisfying objective (i*v).* It is specified as follows:

$$P_{\alpha_1} = \frac{1}{n}\sum_{i=1}^{q}\left[\frac{Z - Y_i}{Z}\right]^{\alpha} \quad \text{.....(23)}$$

Where:

α = the FGT index and takes values 0, 1, 2.

n = total number of households

q = number of households below the poverty line

Z = poverty line

Y_i = expenditure of the household in which the *i-th* individual lives.

3.5 Definitions and Measurement of Variables

Variables are the indicators on which information are collected for study. The indicators are useful in explaining the study in that data collected from the sampled maize farmers centred on them. Measurements and estimations are based on these indicators. The variables used in the study include output of maize, maize seed, fertilizers, labour, farm size, agro-chemical, age of farmer, household size, farming experience, level of education, contact with extension agent, membership of farmer group and cost of inputs. It is therefore, important these variables as well as how they are measured are explained.

i. Output of maize

This is the quantity of maize harvested at the end of the production or farming season. It is measured in kilogrammes. The output of the farmer is important as it determines the volume of returns to the investment of resources, given favourable market price. It is believed that the output of maize famers depend on a number of factors which include productive inputs such as size of farmland, availability and affordability of improved high-yielding maize seeds, quantity and quality of fertilizer used, quantity

and quality of agro-chemicals used, availability and affordability of labour, natural and other socio-economic factors.

ii. **Maize seed**

This is the quantity of maize seeds used by the farmers as planting materials at the beginning of the production season or cycle. Quantity of maize seed is also measured in kilogrammes. The seed quality and seed rate determine to a good extent, the plant density and population during growth. This will eventually affect maize output. Improved maize seed with high-yielding quality is expected to give higher output of maize and vice versa, all things being equal.

iii. **Fertilizers**

Quantity of fertilizer used by farmers is measured in kilogrammes. The amount (rate), type (straight or compound) and quality of the active ingredients in the fertilizers applied to maize crop by farmers have great influence on the yield and consequently, output of maize. If recommended rate of fertilizer is applied, greater yield is expected by the maize farmer. The quantity and price of this input has direct effect also, on the total cost of production that the famer incurs in his production activity.

iv. **Labour**

Labour used in executing the various farm operations is measured in man-days. The maize farmer needs labour for virtually all the work associated with maize production. Labour requirement is usually high for operations such as bush clearing, land preparation, drilling, fertilizer and chemical applications, weeding, harvesting, and so on. Farmers could satisfy their labour needs by hiring or using family labour, where

available. Availability and cost of labour usually has strong influence on the output of maize. If maize farmers are able to source labour at affordable price, sufficient man-power would be employed for the needed operations in the farm, thus leading to better output, if other factors remain constant.

v. **Farm size**

The size of farmland (holding) managed by a farmer sometimes gives a pointer to the size of output to be expected. Farmland is measured in hectares. Larger farm size avails the farmer some economies of scale in his production activities. However, too large or small a farm will be uneconomical to a farmer. In any case, it would be rewarding for a farmer to operate an optimum farm size to enable him maximize the use of resources and, hence, profit. Nonetheless, larger farm size is expected to return more output than smaller farm holdings, ceteris paribus.

vi. **Agro-chemicals**

This is measured in litres. Different types and formulations of agro-chemicals are applied to either boost the disease-resistant ability of the maize plant or control weeds and pests. When used as recommended and in optimum combination with other relevant inputs, agro-chemical is expected to increase the farmer's chances of getting better yield. The quantity and cost of agro-chemical is expected to contribute directly to the overall cost of production.

vii. **Age of farmer**

Age is measured in years. It is believed that age influences reasoning and, even managerial ability. Therefore, the age of a farmer will affect the quality of labour and mental work he puts in operating the farm business. This also determines his capacity to coordinate the entire production process by taking good and timely decisions. Older farmer (who is still in his active form) is expected to plan better and obtain higher output than a teenage farmer who might lack the insight to handle the vagaries associated with farming business.

viii. **Household size**

Household size is measured in absolute number. The number of individuals living under the farmers control is expected to affect his production activities directly or indirectly. The more, the number of persons in a farmer's household, the more the likelihood of having family labour and, eventually larger farm size which might result in larger output, all things being equal. It has been argued that some men marry many wives in a quest to have more children who will supply labour for the farm business of the family. Household size is expected to have direct relationship with the farmer's level of expenditure, savings and consumption of output from his farm.

ix. **Farming experience**

Farming experience is measured in years. The more the number of years over which a farmer has been on the production of a crop or livestock, the more knowledgeable he is expected to be, compared to a farmer who is just new in the business. More years of farming experience implies that a farmer is able to adjust quickly to changes in production practices as well as reach timely decisions to adopt any new technology or

otherwise. Farmers with more years of farming experience would be expected to have better yield and output than beginners.

x. **Educational status**

Educational status refers to the highest level of formal education attained by a farmer. Educational status is measured in years. The level of education of a farmer determines the volume of knowledge he has acquired. Farmers with more years of education are expected to do better in managing their production activities for higher outputs and returns. Such farmers can easily access credits, try and adopt new technologies as well as take advantage of new opportunities open to them.

xi. Contact with extension agents

Contact with extension agents is measured as a dummy and it takes either of the two values (Yes = 1 or No = 2). Farmer's contact with extension agents could change his perception on existing practices and innovations. Farmers with frequent extension contact would be expected to follow improved production practices (by way of adoption of innovations) than those who do not have extension contact. This frequent contact with extension agents is expected to have direct effect on the farmer's output of maize.

xii. Membership of farmer group:

This is also a dummy which takes either 1 or 2 depending on whether a farmer belongs to a group or not. Farmer-based organizations expose their members to some form of training, field days and agric shows. These are opportunities to showcase skills, compete and learn about better ways of doing a farm business. Farmer groups also

facilitate access to credit and inputs for their members at reduced costs. This would have direct influence on the output and profit of member farmers.

xiii. Cost of inputs:

Cost of inputs refers to the amount of money paid to procure or acquire the resources applied to the production process. It is measured in naira (₦). All the resources used in production activities are bought at specified amounts of money (naira). The farmer incurs cost in acquiring these productive resources. The cost and quantities of inputs used is expected to influence the total production cost of outputs. Furthermore, the cost of inputs is useful in determining the farmers allocative efficiency, and hence, economic efficiency.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Socio-economic Characteristics of Maize Farmers

Socio-economic characteristics of maize farmers refer to a combination of social, economic and demographic variables or features and how directly or indirectly influence his maize production activities. They are usually not direct inputs but go a long way in influencing the production efficiency of the maize farmers (Olayiwola, 2013; IITA, 2008). Such variables include age of maize farmer, gender, marital status, household size, level of educational, farming experience, contact with extension agent and membership of organization.

4.1.1 Age of maize farmers

Age is a measure of the number of years a farmer has lived on earth, counting from the day he or she was born. Age is believed to influence a farmer's reasoning, and even managerial capacity. Age influences the amount of labour and coordination the maize farmer will deploy in his production process. This is because smallholder farmers use basically manual labour for almost all operations (Idiong, 2007). Thus, age affects the physical ability of the maize farmer to handle such tools as machete and hoes in executing his tasks. The age distribution of the maize farmers sampled in the study is presented in Table 4.1.

Table 4.1: Distribution of maize farmers by age (years)

Age	Frequency	Percentage
23 – 32	4	2.0
33 – 42	25	12.5
43 – 52	88	44.0
53 – 62	60	30.0
63 – 72	20	10.0
73 – 82	3	1.5
Total	**200**	**100.0**
Mean Age	47	
Minimum Age	23	
Maximum Age	75	

Results from field study shows that the mean age of maize farmers was 47 years, with 56% of them belonging to the age bracket of (30 – 49) years. This implies that more than half of the sampled maize farmers were still in their active age to carry out physical and mental work needed for increased production efficiency. The total output and overall efficiency in maize production in the area will be driven by this group because they have the requisite endurance needed to withstand stress arising from the tedium on the farm.

Danso-Abbeam *et al*. (2015) and Fakoya and Daramola (2005) observed that those who belong to this age bracket are relatively economic active adult population that are innovative, have the ability to work very hard and can cope with challenges that may emanate from farming activities to increase maize production efficiency.

4.1.2 Gender of maize farmers

Gender refers to the sex of maize farmers in the study. Gender describes whether a respondent is in the category of a male or female farmer. Gender is a sensitive socio-

economic factor that plays an important role in farming activities. Sometimes it is important to understand the involvement of both male and female individuals in production activities with a view to striking a balance and carry everyone along during intervention programmes. The proportion of male and female farmers involved in production activity will affect the total output and by extension, the production efficiency. Male and female farmers have their strengths and weaknesses relative to farming operations. Table 4.2 presents the distribution of maize farmers in the study by gender.

Table 4.2: Distribution of maize farmers by sex

Gender	**Frequency**	**Percentage**
Male	152	76.0
Female	48	24.0
Total	**200**	**100.0**

Amongst the 200 maize farmers surveyed, 76% were male while 24% were female farmers. The low representation of female in the study could be attributed to the prevailing culture in some of the localities where women were not allowed direct access to and ownership of productive assets. Thus, most women worked for their husbands. Similarly men appear more adventurous than women; hence, they tend to cope with the challenging nature of the farm business. The implication of this finding is that the supply of maize in the area would be largely influenced by male farmers. Amusa *et al*. (2011) had a similar result but cited Eboh and Ogbazi (1990) and Fakoya and Aderti (2006) as saying that, "this finding is not an indication that women were less involved in production because they are often perceived as subordinate to male authority in male headed households. This finding, to some extent, affirms the claim by IFPRI (2008), that, "In Nigeria, women are often marginalized in their access to

economic, political and social resources compared to men, rendering them more relatively poorer than their male counterparts.

4.1.3 Marital Status

Marriage is the legal relationship characterized by the union of male and female individuals who are believed to have attained maturity and take responsibilities for their actions and live together as partners. Marriage is a social status as it confers on individuals some degree of responsibility and respect in the society. Marital status influences the decisions taken by a maize farmer as well as the way he or she goes about the farming business. Married individuals tend to be more focused in the production activities because they believe that sustenance of the family depend on the returns from their production activities. Marriage also increases the chances that a maize farmer would have more persons in his or her household to contribute to farm labour. Marital status of the sampled maize farmers in the study is as shown in Table 4.3.

Table 4.3 Distribution of maize farmers by marital status

Marital Status	**Frequency**	**Percentage**
Single	2	1.0
Married	194	97.0
Divorced	1	0.5
Widowed	3	1.5
Total	**200**	**100.0**

The table above shows that most of the maize farmers (97%) were married. Only 0.5% of the maize farmers were divorced, 1.0% were single and yet to marry and 1.5% were widowed. This by implication shows that most of the maize farmers have some

responsibilities to cater for at home. The family members would have to feed from their output and other needs may have to be met from the revenue realized from produce. It is also possible to derive a larger household size to support farm labour.

4.1.4 Household size

Household size is the number of individuals living under a maize farmer's control and may depend on him or her for support. It is made up of the farmer, his or her spouse, children, relation and any other dependant who lives in the same house with the farmer. The household size of a farmer determines the availability of family labour for various operations. Table 4.4 displays of the household size of maize farmers in the study.

Table 4.4: Distribution of maize farmers by household size

Household Size	**Frequency**	**Percentage**
1 – 5	65	32.5
6 – 10	86	43
11 – 15	42	21
16 – 20	4	2
21 - 25	2	1
26 – 30	1	0.5
Total	**200**	**100**
Mean	8	

The table on household size shows that 43% of the GES beneficiary maize farmers had household size range of (6 - 10) persons. However, an average 8 of persons lived in a maize farmer's household in the study area. This implies that maize farmers in the area could readily use family labour in discharging some of the tasks thereby reducing cost that would have been incurred in hiring labour. It also places on the maize farmer, the burden of having to feed an average of 8 individuals as well solve other needs of theirs

from his maize output. This finding is consistent with the finding by Olorunsanya *et al*. (2011) who reported more than 62% of the surveyed households having sizes ranging between 6 and 10 persons with an average of 9 persons per household in the rural area and 6 persons in the urban area.

4.1.5 Educational Status

Educational status refers to the highest level of education attained by a maize farmer. Maize farmers could acquire formal education beginning from primary to secondary and up to the tertiary level. The level of education of a farmer gives an indication on the volume knowledge such a farmer might have acquired. The distribution of maize farmers in the study area by educational attainment is presented in table 4.5.

Table 4.5: Distribution of maize farmers by level of education

Level of Education	**Frequency**	**Percentage**
No formal education	74	37
Primary	43	21.5
Secondary	44	22
Tertiary	39	19.5
Total	**200**	**100**

Findings from the study reveal that 37% of the maize farmers had no formal education. Among those that had formal education, 21.5% attained primary level, 22% stopped at secondary level while 19.5% attained tertiary level. Although 37% of the maize farmers did not have formal education, that is, they never enrolled in any school (primary, secondary or tertiary) for study, they would have acquired ample knowledge about maize production from other sources such as farm-based association, friends, farming experience, public enlightenment programmes and so on, especially considering the

metropolitan nature of the study area. This result suggests that maize farmers in the study could take good decisions pertaining to the farm business. Fakayode *et al*. (2006), obtained a similar result and said, such a situation where greater proportion of the respondents were literate could have positive impact on the productivity of farmers in the area as most of them could possibly read or write.

4.1.6 Farming experience

Farming experience is the number of years over which a farmer has been on the production of crop or livestock. It is measured in years. It is believed that the more the number of years a farmer has been on a farm business, the more his level of experience and expertise, all things being equal. Therefore, the importance of experience in the management of any enterprise cannot be over-emphasized. The distribution of maize farmers in the study by years of experience is summarized in Table 4.6.

Table 4.6: Distribution of maize farmers by farming experience

Farming Experience	**Frequency**	**Percentage**
1 – 5	35	17.5
6 – 10	54	27
11 –15	33	16.5
16 -20	40	20
21- 25	38	19
Total	**200**	**100**
Mean	12	

The results in table 4.6 indicate that 27% of the maize farmers farming experience of between 6 and 10 years and 20% had experience spanning between 16 and 20 years. Farmers who had experience of between 21 and 25 years constituted 19% of the respondents. Average experience of maize farmers in the area was 12 years for both

groups. This implies that the maize farmers are relatively old and experienced in maize production. Therefore, they are in a position to apply knowledge of the past in taking informed decisions that would increase production efficiency. The mean experience level of the farmers also point to the fact that they would have come to terms with some technologies and might not waste time in trying new ones (if available). The mean level of experience of the farmers equally suggests that chances of production failure due to poor management or inexperience would be minimal. The mean farming experience of 12 years is more than the average of 8 years of maize production experience reported by Fakayode *et al*. (2006) in an economic assessment of fadama maize production in Kwara State.

4.1.7 Farm size

Farm size is the total amount of land holding cultivated by a farmer during a production period. It is the total size of land area from which a farmer realized his output during a production season. Farm size is measured in hectares. Larger farm size is argued to avail the farmer some economies of scale in his production activities. However, too large or small a farm would be uneconomical to the maize farmer. Operating an optimal farm size enables the farmer to maximize the use of resources and possible attain higher level of production efficiency and make more profit. Table 4.7 is the farm size distribution of maize farmers in the study.

Table 4.7: Distribution of maize farmers by farm size (hectares)

Farm Size	Frequency	Percentage
0.1 - 1.0	66	33
1.1 - 2.0	88	44
2.1 - 3.0	33	16.5
3.1 - 4.0	9	4.5
4.1 - 5.0	2	1
5.1 - 6.0	2	1
Total	**200**	**100**
Mean Farm Size	1.5	
Minimum Farm Size	0.1	
Maximum Farm Size	6	

The table above indicates that 33% of the GES beneficiary maize farmers cultivated between 0.1 and 1.0 hectare and 44% cultivated between 1.1 and 2.0 hectares of land. Average farm size of 1.5 hectares was obtained from the study. This farm size could be uneconomical for a farmer who is actually targeting to break even. It also underscores the fact that maize farmers in the study are actually smallholder farmers. The implication of the small size of their farm holdings is that outputs would be relatively low due to under inefficient use of inputs. Considering the mean household size of the maize farmers, it is likely that labour and other inputs might be under-utilized. The average farm size obtained in this study agrees with the results reported by Fadare and Akerele (2014) and Olarinde (2011) where majority of maize farmers cultivated between 0.5 and 2.0 hectares of land.

4.1.8 Contact with Extension Agent

Contact with extension agent relates to individual meeting between the farmer and an extension worker or an interactive meeting between a group of farmers and an

extension worker in which the extension worker educates the farmers on recommended practices such as new technologies, planting techniques, fertilizer application methods, timing of operations and so on. This study sought to know if the maize farmers in the area interacted with an extension agent in the last 2 years or not. It is measured as a dummy variable that takes two values (contact = 1; no contact = 2). Contact with extension worker has the possibility of enhancing farmer's knowledge of recommended practices and new technologies and, eventually increasing his or her farm output and production efficiency. Table 4.8 shows that 78.5% of the sampled maize farmers had contact with extension agents in the last 2 years while 21.5% did not.

Table 4.8 Contact with extension agent (percentage saying yes)

Variable	**Frequency**	**Percentage**
Extension Contact	157	78.5

This implies that majority of the respondents were in a position to carry out better management practices due to their interactions with extension agents. Such farmers could also serve as contact farmers for the extension workers and would be of great assistance in promoting the diffusion new ideas. It is worthy to note that farmers' awareness of the GES intervention was not regarded or taken as an outcome of extension contact between because it did not offer a teaching-learning platform between the maize farmers and extension agents. Higher proportion (87.4%) of maize farmers who accessed extension services was reported by Fadare and Akerele (2014) in a study of factors influencing adoption decisions of maize farmers in Nigeria.

4.1.9 Membership of Farmer-based Organization

Membership of farmer-based organization entails that a farmers is registered with one or more groups of farmers. Such groups include cooperatives, maize farmers association, and so on. This variable is also measured as a dummy which takes the values of either 1 or 2 depending on whether a farmer belongs to a group or not. Groups facilitate access to inputs and credit for their members. They also help in exposing their members to some form of training, field days and agricultural shows. Farmers use these opportunities to showcase their skills as well as learn from one another's experiences. Table 4.9 reveals that 62.5% of the maize farmers belonged to a group.

Table 4.9: Distribution of maize farmers by membership of farmer-based group

Variable	Frequency	Percentage
Membership of Farmer Group	125	62.5

This means more than half of the sampled farmers were in touch with other people so they could quickly access or share information about prevailing practices or even ideas in the society. Thus, their output and efficiency level could be relatively better than those who did not belong to any group. Idion (2007) said the combination of supports that farmers receive from their involvement in group activities has the effect of increasing their production efficiency.

4.1.10 Source of farmland

Source of farmland refers to how the maize farmers obtain the land on which they carry out maize production. Farmers could get farmland by inheritance, purchase, rent or lease. Soured of farmland may influence the farm size a farmer cultivates and

eventually his output and return. The distribution of maize farmers in the study area by source of farmland is presented in Table 4.10.

Table 4.10: Distribution of maize farmers by source of farm land

Source	Frequency	Percentage
Inheritance	138	69.0
Purchase	14	7.0
Rent	35	17.5
Lease	13	6.5
Total	**200**	**100.0**

About 69% (i.e. majority) of the maize farmers inherited their farmland while those who rented their farmland constituted 17.5% of the sampled farmers. Land purchase and lease seem to be unpopular in the area as only 7% and 6.5% of the farmers got their farmland through these sources. The preponderance of land inheritance could be disincentive to expansion of scale of production because most farmers who desire to do so might not readily farmland to buy. This is so because in some cultures, inherited lands are often not easily disposed except on a consensus.

4.2 Maize Production Efficiency

Maize production efficiency relates to the capacity of maize farmers to produce an economically optimum output of maize from a mix of available inputs (land, seed, fertilizers, agro-chemicals and labour). In this context, maize production efficiency entails technical, allocative and economic efficiencies. Therefore, maize production efficiency examines the relationship between the farmers observed output of maize and the best possible (frontier) output obtainable from a given combination of inputs at the lowest possible cost (Latruffe, 2010; Girei *et al.,* 2013; Danso-Abbeam *et al*., 2014).

The production efficiency of maize farmers in this study was estimated using the stochastic frontier production model.

4.2.1 Maize stochastic frontier production function

The stochastic frontier model is a parametric approach to the estimation of production efficiency of a production firm using econometric modeling of production frontier. The stochastic frontier model is usually applied within the framework of suitable production and cost functions (Coelli, 1995; FAO, 2003). The frontier model permits the decomposition of the error in both output and stochastic element into noise and inefficiency effects (Ali and Samad, 2013; Danso-Abbeam *et al*., 2014). Input variables (seed, fertilizer, labour, farm size and agro-chemical) that could affect the output of maize were fitted to a frontier model using the Cobb Douglas (Double Log) functional form. Results from the estimation of stochastic frontier production of maize in the study area are presented in Table 4.11.

Table 4.11: Maximum likelihood estimates of the stochastic frontier production function in maize production

Variable	Coefficient	Std Error	T-value
Constant	6.0557	0.2804	21.5939***
Seed	0.1837	0.06128	2.9978***
Fertilizer	0.0143	0.0362	0.3945
Labour	0.1812	0.0645	2.8074***
Farm Size	0.2584	0.0891	2.8996***
Agro-chemical	0.1362	0.0575	0.2370**
Sigma-sq	0.3705	0.0343	10.7936***
Gamma	0.4600	0.0130	3.6012***
LLF	-184.558		
RTS	0.7738		

*** Significant at p < 0.01; **Significant at p < 0.05; * Significant at p < 0.1,

The estimated sigma-squared of 0.37 was significantly different from zero at p<0.01 and indicates a "good fit" and the appropriateness of the specified distributional assumption of the composite error term rather than the average response specification. Gamma which is a measure of the level of inefficiency in the variance parameter, that is, the difference between the frontier output and the observed output had a value of 0.46 and was equally significant at p<0.01. This implies that about 46% of the variation in maize output was due to maize farmers' inefficiency in the use of inputs and other factors within their control; while the remaining 54% of the difference between actual and frontier outputs could be attributed to random factors outside the influence of the maize farmers such as inclement weather condition, outbreak of pests and diseases and data collection and measurement errors.

The coefficient of the constant was 6.0557 and was significant at p<0.01. The coefficients obtained for the inputs show that maize output responded positively to changes in the amount of seed, fertilizer, labour, farm size and agro-chemical.

The coefficient of maize seed (0.1837) was positive and significant at $p<0.01$. This implies that a unit change in the quantity of maize seed will lead to a change in the output of maize by 0.1837 unit. Based on this result, maize farmers in the area could increase their maize output and possibly profitability by increasing the quantity of maize seeds planted per unit area. This should however, be done following recommended seed rate to avoid wasteful use of inputs and its attendant low productivity and diseconomy. This finding, relating to maize seed conforms to the result published by Sanusi *et al*. (2015) where the coefficient of maize seed was found to be positive and significant at 5%. Similarly, Ibrahim *et al*. (2014) in a survey of technical efficiency in maize production and its determinants across agro-ecological zones in Northern Nigeria, found that the coefficient of maize seed was a significant (at $p<0.01$) determinant of maize output.

The coefficient of labour (0.1812) was also positive and significant ($p<0.01$) in influencing maize output. Thus, a unit change in the quantity of labour employed by a maize farmer will alter maize output by the value of the coefficient. It implies that maize farmers in the study have the opportunity of increasing the output by engaging more units of labour. Most of the labour requirements by smallholder farmers are supplied by members of the household. It is, therefore, very likely that maize farmers would be inefficient in the use of labour since it is not paid for. This result is consistent with the one obtained by Mtumbara *et al.* (2013) in a study of the production and productivity of maize subjected to modern and traditional methods of weed control options in the Federal Capital Territory, Nigeria where labour was found to have significant positive effect on the output of maize at $p<0.05$.

The coefficient of farm size (0.2584) was positive and significant both groups at $p<0.01$. Hence, adjustments in the size of farmland allocated to maize production have direct effect on the corresponding outputs of maize by both groups. This result suggests that maize farmers could expand their maize output and even their scale of profit by cultivating more land rather than the current size of holdings. This may increase their output and income through making additional profit. Of course, the mean farm size of 1.5 hectares obtained in this study may not be an economical farm size. Thus, to be able to offset production costs and break even, an economically optimum farm size has to be cultivated. This result is in line with the finding of Ogunniyi and Ajao (2011) from a similar study in Oyo State of Nigeria in which farm size was found to have direct significant effect on the output of maize at $p<0.01$ level of probability.

Agro-chemical has positive coefficient (0.1362) and was significant ($p<0.05$) in determining maize output. Therefore, increasing the volume of agro-chemical use by maize farmers in the area by 1% will potentially increase the output of maize by margins equivalent to the 0.1362. This result points to the fact that weed and pest control cannot be over looked. Manual weed control could be tedious and expensive; therefore, maize farmers need to invest more in the purchase and application of agro-chemicals and spraying gangs in order to increase crop protection against weeds and pests and consequently increase output. This is contrary to the finding of a related study conducted in Niger State by Salau (2013) where he reported that the effect of agro-chemical on maize output in was negative and not statistically different from zero.

The use of fertilizer does not have significant effect on maize output by both GES beneficiaries and non-beneficiaries even though it has positive coefficient of elasticity, and relates directly with maize output. It is probable that the GES intervention has made the maize farmers apply more of the input than their farm sizes would have required for optimum production. Ogunniyi and Ajao (2011) opined that findings of this sort could imply that many farmers purchased and used more fertilizers beyond the optimal level, given the relative input/output prices and thus negatively affecting efficiency. Thus, changes in the quantity of fertilizer applied by maize farmers in the study area will not bring about any significant change in the output of maize. The insignificant effect of fertilizer on maize output in this study contradicts the result reported by Mutumbara *et al*. (2013) who studied the production and productivity of maize subjected to modern and traditional methods of weed control option in the Federal Capital Territory, Nigeria and found that the use fertilizer had significant positive influence on maize output.

Considering the combined elasticity of the inputs, the return to scale (RTS) was 0.7738. This suggests that maize farmers are producing at decreasing returns to scale. Therefore, any further increase in the quantity of inputs will yield less than proportionate output.

4.2.1.1 Level of technical efficiencies

The technical efficiency refers to the ability of a production firm to avoid waste, either by producing as much output as technology and input usage allow or by using as little input as required by technology to generate a determined output level. Thus the analysis of technical efficiency can have an output augmenting orientation or an input

conserving orientation (Harold *et al*., 2007). Individual maize farmers in this study have varying levels of technical efficiency as shown in Table 4.12.

Table 4.12: Distribution of maize farmers' technical efficiency index

Efficiency Class	**Frequency**	**Percentage (%)**
41 – 50	1	0.5
51 – 60	3	1.5
61 – 70	9	4.5
71 – 80	23	11.5
81 – 90	32	16
91 – 100	132	66
Total	**200**	**100**
Mean efficiency	91.4	
Minimum efficiency	46.6	
Maximum efficiency	100	

The predicted levels of farm efficiency range from 46.6% to 100% while the mean technical efficiency was estimated at 91.4%. The implication of this finding is that an average maize farmer in the area is producing below the technically efficient optimum. Thus, there is room for improvement in their technical efficiency level by 8.6% to attain the optimum technical efficiency level. This could be made possible by the adoption of new technologies, improved production practices and more efficient combination of production inputs. These findings are closely related to the results published by Oyewo *et al*. (2009) who estimated the mean technical efficiency of maize farmers in Ogbomoso Local Government Area of Oyo State at 84.3%.

4.2.1.2 Determinants of technical efficiency

Determinants of technical efficiency are the variables contribute to maize farmer's efficiency or otherwise. In other words, determinants of technical efficiency are the sources of variations in the observed efficiency level of the maize farmer. The variables in the inefficiency model are determinants of technical inefficiency, implying that a positively signed variable increases technical inefficiency and reduces technical efficiency while a negatively signed variable reduces technical inefficiency thereby increasing technical efficiency level. Sources of variations in technical efficiency estimates are presented in Table 4.13.

Table 4.13: Determinants of technical inefficiency in maize production

Variable	Coefficient	Std Error	T-value
Constant	0.0206	0.1009	0.2044
Age	-0.0014	0.0009	-1.5163
Household-Size	0.0501	0.0085	5.8902***
Farming Experience	-0.0132	0.0079	-1.6686*
Educational Level	0.0198	0.0077	2.5807**
Farm Size	-0.0248	0.0249	-0.9956
Extension Contact	-0.318	0.0993	-3.2020***
Group Membership	-0.1559	0.0651	-2.3943**

*** Significant at p<0.01, **Significant at p<0.05, * Significant at p<0.1

The constant of specified model is positive but not significant in influencing maize production efficiency. This indicates that the constant term relates directly with technical inefficiency and inversely with technical efficiency but at an insignificant level. Farming experience, extension contact and membership of farmer group are all negative and significant in influencing maize farmers' technical efficiency. Age and

farm size also have negatively signed coefficients but are not significant. However, household size and level of education are positively signed and significant determinants of technical efficiency.

Farming experience has a negative coefficient of 0.0132 and is significant at $p<0.1$ level of probability. This is in line with *apriori* expectation. The negatively signed coefficient indicates that farming experience is an increasing function of technical efficiency. Therefore, increasing a farmer's level of experience in maize production will have the effect of increasing production efficiency. By this result, maize farmers who have been engaged in maize production for many years are likely to be more technically efficient than those who are newly engaged in maize production. This is because over time, they have acquired better understanding of the technicalities of input combination as well as access technology and information that could yield better efficiency level when applied. This result conforms to the finding by Ebong *et al*. (2009) in a study of the determinants of technical efficiency of urban farming in Uyo of Akwa-Ibom State which reported that farmers who have more years of farming experience have higher technical efficiency level than those that have fewer years of experience.

The coefficient of contact with extension service provider (0.318) was negative and significantly different from zero at $p<0.01$. Therefore, increasing the frequency of contact between maize farmers and extension service providers will significantly increase technical efficiency of maize farmers. This is true because contact with extension agents expose farmers to new technologies as well as improved management practices which when adopted, improve their production efficiency. Earlier studies

conducted by Danso-Abbeam *et al*. (2015) and Ebong *et al*. (2009) documented similar findings where contact with extension service providers was a significant variable influencing technical efficiency of farmers.

Coefficient of membership of a farmer-based-group (0.1559) was negative and significant at $p<0.05$ level of probability. Thus, farmers who belong to farmer groups are more technically efficient than those who do not belong to farmer-based-groups. This result buttresses the fact that groups usually assist their members by organizing trainings on the technicalities of production as well as facilitating access to credit and other inputs at reduced prices for them. It would therefore, be of benefit to encouraged maize farmers to register with farmer-based groups. This finding is consistent with the finding by Danso-Abbeam *et al*. (2015) and Idiong (2007) who remarked that membership of in farmer-based organization/cooperatives affords the farmers the opportunity of sharing information on modern production practices by interacting with other farmers. It could also be that members of farmer groups receive free or cheap inputs and support services from many donors and NGOs.

The coefficient of age of maize farmers is positive (0.0014) but not significant in influencing maize production efficiency. This indicates that the age of maize farmers relates inversely with technical inefficiency and directly with technical efficiency but not at a significant level. Increasing the age of maize farmers will not significantly increase technical efficiency in maize production. This result may be due to the fact that at any age, once a farmer has a firm understanding of the optimum input mix, he could produce at a higher efficiency level. This also underscores the need for younger people to be engaged in maize farming. This finding contradicts that reported by

Olarinde (2011) from a study of technical efficiency differentials among maize farmers in Nigeria in which the coefficient level. He therefore, concluded that older farmers were less technically efficient. He such a finding could be associated with the interaction between age and farming experience.

Farm size also has a negative coefficient (0.0248) but it is not significant in determining technical efficiency of maize farmers. This implies that maize farmers who have larger farm sizes are more technically efficient in maize production. However, increasing size of land cultivated by maize farmers does not significantly increase their level of technical efficiency. This result suggests that maize farmers in the study are not maximizing output from the land they are currently cultivating and so it would be un-economical to expand their land holdings.

Household size is found to have a positively signed coefficient (0.0501) and significant at $p<0.01$ level of probability. Thus, increasing the size household of maize farmers will significantly reduce their technical efficiency. This may be due to under utilization of family labour in maize production process because it is available and relatively cheaper compared to hired labour. It could also be that because of the burden that larger household size places on the famer, resources that should have been invested in maize production process could be diverted to other pressing needs of household members. This result is in line with the finding reported by Ebong *et al*. (2009) in which household size was also positively signed at $p<0.01$ significant level.

The coefficient of level of education is also positively signed (0.0198) and statistically significant at $p<0.05$. This result indicates that maize farmers that attain higher levels of

education are technically inefficient. This finding is contrary to apriori expectation that level of education has direct effect on farmers' production efficiency. It is possible that maize farmers with higher level of education have other engagements that make it difficult for them to be physically present to coordinate the activities of the farm. They may delegate the production process to their spouses or their eldest child and in some cases, hired car-taker who may not have the desired level of technical competence to manage the affairs of the farm. Salau (2013) also observed that level of education had negative but not significant effect on maize farmers technical efficiency in a recent study conducted in Niger State.

4.2.2 Estimation of allocative efficiency (Stochastic frontier cost function)

Coelli *et al*. (2002) and Ogundari *et al.* (2006) as cited in Girei *et al*. (2013) described allocative efficiency as relating to the degree to which a farmer utilizes inputs in optimal proportions, given the observed input prices. Thus, allocative efficiency occurs at the point where the marginal value of product (i.e. unit price of output) equals the marginal factor cost (i.e. cost of producing an additional unit of output). Allocative efficiency is sometimes called "social efficiency" (Pettinger, 2012). The stochastic frontier cost function is used to determine the how the cost of each productive input relates to the total cost of production. It is also able to isolate the sources of variations in cost efficiency between the frontier cost and observed production cost. Many researchers have used the model in estimating the cost efficiency of farmers. Zalkuwi *et al*. (2010) applied the stochastic frontier model in analyzing the efficiency of maize production in Ganye LGA of Adamawa State and Girei *et al.* 92013) use it in estimating the resource use efficiency of Fadama II farmers in Adamawa State.

Result of the maximum likelihood estimates of the stochastic frontier cost function of maize farmers are presented in Table 4.14. The input variables which include cost of farmland, cost of maize seed, cost of fertilizer, cost of agro-chemicals, cost of labour and value of output, were fitted to the stochastic frontier model using the Cobb-Douglas (Double Log) functional form.

Table 4.14: Maximum likelihood estimates of stochastic frontier cost function

Variable	**Coefficient**	**Std Error**	**T-value**
Constant	2.1436	0.1951	10.9868***
Cost of farm land	0.001	0.0024	0.4114
Cost of seed	0.0888	0.0118	7.2244***
Cost of fertilizer	0.0671	0.0118	5.6905***
Cost of agro-chemicals	0.0182	0.0061	2.9733***
Cost of labour	0.6547	0.0139	47.0403***
Value of output	0.0468	0.0161	2.8989***
Sigma squared(σ^2)	2.1954	0.3637	6.0370***
Gamma (γ)	0.9988	0.0006	1670
LR test	305.78		

*** Significant at p>0.01,

The sigma-squared of 2.195 was significant at $p<0.01$ indicating a 'good fit' and appropriateness of the assumptions about the composite error term. The gamma measures the level of cost inefficiency in the variance parameter, that is, the difference between the frontier production cost and the observed production cost. Thus, the gamma value of 0.999 was significant at $p<0.01$. The implication is that about 99.9% of the variation in maize production cost is due to maize farmers' cost inefficiency in the pricing of inputs. Positive coefficient implies that resource was under-utilized while a negative coefficient connotes over-utilization of input. The constant is positive (2.1436) and significant at $p<0.01$.

The coefficients of cost of seed, fertilizer, agro-chemicals and labour are all positive, as expected, and significant at $p<0.01$. That is to say, the cost of each of these inputs contributes directly to the total cost of production of maize output. Therefore, increasing the cost of any of the inputs will directly increase the total production cost and vice versa. The coefficient of cost of farmland is 0.001 and it is significant ($p<0.01$). This indicates that maize farmers in the study under-utilize their farm land. However, the effect of the under-utilization of farm land does not add significantly to increasing the total production cost. The insignificant contribution of cost of farm land to total production cost could be attributed to the fact that most of the maize farmers in the study inherited their farm land.

The coefficient of cost of seed is also positive (0.0888) and significant at $p<0.01$. The implication is that cost of maize seed significantly determines the total cost of maize production. A 1% increase in the cost of maize seed will increase the total cost of production by 0.0888. The positive coefficient of this resource implies that it under-utilized by the maize farmers. The under-utilization of maize seed could be because the farmers do not follow recommended planting procedures (spacing and seed rate). It is common to see some smallholder maize farmers place as many as 7 seeds in a single hole thereby limiting the land area that a given quantity of maize seed would have planted. This actually increases the cost of seed and eventually the total cost of production. This finding conforms to the result published by Zalkuwi *et al.* (2010) in a study of the analysis of efficiency of maize production in Ganye LGA of Adamawa State in which the coefficient of cost of maize seed was also found to be positive and significant ($p<0.01$) in influencing the total cost of production.

Cost of fertilizer has a positive coefficient of 0.0671 and is significant ($p<0.01$) in determining the total cost of maize production. The positive coefficient implies that 1% increase in the cost of fertilizer will increase the total cost by 0.067%.The positively signed coefficient indicates that maize farmers the study under-utilized the input, and so, were allocative inefficient. This follows from the fact that the smallholder farmers cultivate only small farm sizes (mean farm size of 1.5 hectares in the study) and would apply virtually all inputs at their disposal on the fixed land area under cultivation. Girei *et al.* (2013) applied the stochastic model in the study of resource use efficiency of fadama II crop farmers in the Adamawa State and found that the coefficient of cost of fertilizer was also positive but not statistically different from zero in influencing the total cost of food crop production.

Cost of agro-chemicals is positive (0.0182) and significant ($p<0.01$) in determining the total cost of maize production. Thus, a unit increase in the cost of agro-chemicals will increase the total cost of maize production by 0.0182 units. The input is also under-utilized by maize farmers. In a bid to effectively put weeds and pests under control, some farmers apply agro-chemicals indiscriminately without recourse to the economic implication.

Cost of labour is positive (0.6547) and significantly ($p<0.01$) contribute to the total cost of maize production of the farmers. The significant influence of labour cost on the overall production cost may be linked to the short supply of hired labour which makes acquisition of the input relatively expensive. This is evident in the costs and return analysis conducted for maize farmers in this study which shows that labour accounts for about 60% of the total production cost. The positive coefficient of the input implies

that the resource was under-utilized by the maize farmers in the study. This could be made possible by the availability of cheap family labour for households with large number of members. An average of 8 persons lived in the household of each maize farmer in the study. It is possible that this household size is maintained to supply farm labour at little or no cost. The tendency is that when a resource is available and cheap, it would be used wastefully (under-utilized, in this case).

4.2.2.1 Farm level allocative efficiency of maize farmers

Farell (1957) as cited in Zalkuwi *et al*. (2010) described allocative efficiency is the ability of the firm to choose optimal input level for a given factor prices. The allocative efficiency scores give indication or measure of the rate at which individual maize farmers allocate resources in optimal proportion. Table 4.15 shows that none of the maize farmers is 100% allocative efficient, implying that all the maize farmers are producing below the maximum possible cost efficiency frontier.

Table 4.15: Distribution of maize farmers' allocative efficiency index

Efficiency Class	Frequency	%
1 - 10	1	0.5
11 – 20	0	0.0
21- 30	1	0.5
31 – 40	2	1.0
41 – 50	4	2.0
51 - 60	4	2.0
61 - 70	8	4.0
71 - 80	24	12.0
81 - 90	76	38.0
91 – 100	80	40.0
Total	**200**	**100**
Mean Efficiency	84.4	
Minimum efficiency	1.0	
Maximum efficiency	98	

Mean allocative efficiency score is 84.4%. This indicates that maize farmers in the study have an adjustment margin of about 15.6% to make in their choice of input mix with respect to prices, to enable them attain the maximum frontier cost efficiency level. About 90% of the maize farmers have allocative efficiency scores of 70% or more. Girei *et al.* (2013), in a study of the resource use efficiency of fadama II crop farmers in Adamawa State, also observed that all respondents in the study scored less than 100% in resource use efficiency with a mean of 76%.

4.2.2.2 Determinants of allocative efficiency in maize production

Determinants of allocative efficiency are socio-economic variables which directly or indirectly affects the maize farmer in his production activities. Generally, these variables are within the control of the maize farmers. The variables of interest in this include age of maize farmer, household size, farming experience, educational level, farm size, contact with extension service and membership of farmer-based organization.

Coefficients that have positive sign increase cost inefficiency thereby reducing allocative efficiency or maize farmers while the ones with negative coefficients reduce cost inefficiency and increase cost efficiency of maize farmers. Result obtained from the maximum likelihood estimates of the frontier cost function of maize farmers in the study as presented in Table 4.16 shows that age, farming experience and level of education are negatively signed while household size, farm size, contact with extension service and membership of farmer group are positively signed. All the variables are significant except age and contact with extension agent. That means, the constant term in the inefficiency model relates directly with cost efficiency.

Table 4.16 Determinants of allocative efficiency in maize production

Variable	Coefficient	Std Error	T-value
Constant	-11.5137	1.8333	-6.2802***
Age	-0.0157	0.0228	-0.6884
Household-Size	0.1562	0.0310	5.0467***
Farming Experience	-0.2934	0.0831	-3.5291***
Educational Level	-5.968×10^{-6}	2.259×10^{-6}	-2.6418***
Farm Size	0.3097	0.0858	3.6116***
Extension Contact	0.4498	0.5543	0.8115
Group Membership	1.5461	0.2265	6.8248***

The constant is negative and significant at $p<0.01$ level of probability.

The coefficient of farming experience is negative (0.2934) and significant at $p<0.01$ as expected. This implies that farmers who have spent more years in maize production are more cost efficient than those who are just new in the practice. It is believed that with many years of exposure to the management of the farm firm, a farmer devises strategies (such as buying insurance policy, partnering with other farms, timing of sale of output and buying of inputs, early planting, and so on) to avoid or overcome certain risks associated with the farming business. This eventually saves the farmer the cost he would have incurred if he had not gotten the experience.

Educational level also has a negative coefficient ($0.5.968 \times 10^{-6}$) and is significant ($p<0.01$) in influencing the allocative efficiency of maize farmers. Thus, the higher the level of educational attainment of a maize farmer, the more allocative efficient he would be. This conforms to priori expectation. Education of all sorts imparts knowledge to individuals. The knowledge acquired from undergoing education gives an individual the capacity to reason and make informed decisions about issues relating to

the farm business. This might be the reason level of education is positively relating with allocative efficiency of maize farmers.

Household size has a positive coefficient (0.1562) and is significant ($p<0.01$) in determining the cost efficiency of maize farmers. Due its direct relationship with cost inefficiency, increasing the size of a maize farmer's household has the implication of increasing his or her cost inefficiency. Therefore, farming households with fewer number of members are more cost efficient than those with larger family sizes. This result underscores the fact that it is expensive to maintain larger families.

The coefficient of farm size is positive (0.3097) and significant ($p<0.01$) in determining maize farmer's allocative efficiency. The positive coefficient implies that farmers who manage smaller farm sizes are more allocative efficient. That is to say, increasing the land holding of maize farmers directly reduces their cost efficiency. This follows from the fact that the input has been found to be under-utilized by maize farmers in the study. If all available resources are well managed within the same available land space on which they are currently producing, chances are that there could be improvement in their allocative efficiency.

Membership of farmer-based group has a positive coefficient (1.5461) and it is significant ($p<0.01$) in determining the allocative efficiency of maize farmers. The positive coefficient implies that farmers who belong to many groups are less allocative efficient than those who belong to fewer or no group at all. This could be because once a particular number of group membership is exceeded, registration with more organizations becomes diseconomy to the farmer as this competes with both available time and other resources like money. This is particularly true because the farmer has to put in time attending group meetings and programmes, spend money to register and even pay other levies that could be required. This invariably makes him allocative inefficient in managing the affairs of the farm.

Although age is not significant, its negative coefficient of 0.0157 indicates that increasing the age of maize farmers will not significantly increase their cost efficiency. Older farmers in the study would therefore, be more cost efficient than younger farmers.

Similarly, contact with extension agents has a positive coefficient (1.5461) but does not exercise significant influence in reducing the farmer's allocative efficiency. This could be because of the exposure of farmers to education and membership of organization. These are alternate sources of knowledge from where the farmer makes up for the role of extension services.

4.2.3 Economic efficiency of maize farmers

Economic efficiency is an overall performance measure of a farm and is equal to the product of Technical Efficiency and Allocative efficiency, i.e EE = TE x AE. The simultaneous achievement of both efficient conditions occurs when price relationship are employed to denote maximum profits for the firm or when the choice indicators are employed to denote the maximization of other economic objectives according to Heady (1952) as cited in Girei *et al*. (2013). Economic efficiency of the farmers is obtained as the product of maize farmers' technical and allocative efficiency scores. Table 4.17 presents the individual farm level economic efficiency of the maize farmers in the study area. The distribution of the economic efficiency scores indicates that mean economic efficiency of the maize farmers is 78.6% with a maximum score of 98%. This means that the maize farmers are producing below the maximum possible economic efficiency frontier.

Table 4.17: Distribution of farm level economic efficiency of maize farmers

Efficiency Class	Frequency	Percentage (%)
1 – 10	1	0.5
11 – 20	2	1.0
21 – 30	3	1.5
31 – 40	5	2.5
41 – 50	7	3.5
51 - 60	13	6.5
61 - 70	19	9.5
71 - 80	27	13.5
81 - 90	53	26.5
91 - 100	70	35.0
Total	**200**	**100**
Mean Efficiency	78.6	
Minimum efficiency	4.7	
Maximum efficiency	98.0	

The maize farmers can therefore, increase their economic efficiency by 21.4% to attain the frontier economic efficiency if they are able to adjust their choices of inputs mix in the best proportion with respect to their prices. These results are higher than the mean and maximum economic efficiency scores of 54% and 87% reported by Girei *et al.* (2013) for Fadama II crop producers in Adamawa State. About 75% of the maize farmers attained economic efficiency of 70% or more.

4.3 Costs and Return Analysis of Maize Production

Costs and return analysis is a tool for assessing the profitability of a farm business. The technique involves objective valuation of all the costs incurred during the production process and all the revenue realized from the production process. In this study, the net farm income (NFI) analysis was applied. In any production process, costs are incurred

in producing output and return is earned from the sale of such output (Tsoho and Salau, 2012). Table 4.18 presents the summary of average costs and return (per hectare) to maize farmers in the study area expressed in ₦/ha. The exchange rate was ₦200 per dollar as at the time of this survey.

Table 4.18: Costs and return analysis (per hectare) of maize farm

Item	Unit	Quantity	Unit price (₦)	Value/ha	% of Total Cost
Output	Kg	1780.0	88	**156,756.0**	
A. Total Revenue	**(₦)**			**156,756.0**	
B. Variable Cost					
Land rent	₦	2.5	550	1,391.4	2.7
Seed	Kg	47.9	25	1,196.9	2.3
Fertilizer	Kg	110.2	80	8,817.0	16.8
Chemical	Ltr	3.2	1,150	3,623.1	6.9
Hired Labour	Md	47.0	700	32,761.3	**62.5**
Fuel	₦			573.1	1.1
Transport	₦			311.8	0.6
Other expenses	₦			2,255.6	4.3
Total Variable Cost	₦			**50,930.1**	**97.2**
C. Fixed cost					
Depreciation on:					
Wheel barrow	₦			500.6	1.0
Sprayer	₦			22.0	0.0
Cutlass	₦			415.0	0.8
Hoe	₦			511.9	1.0
Total Fixed Cost	₦			**1,449.5**	**2.8**
D. Total Cost (B + C)	₦			**52,379.7**	**100.0**
Net Farm Income (A – D)	₦			**104,376.3**	199.3
Return per ₦ invested				1.99	

Average variable cost per hectare of maize production in the area is ₦50,930.13, representing 97.2% average total production cost for the maize farmers. Labour cost

(₦32,761.28) accounts for 62.5% of the total cost of production. The fixed cost of ₦1,449.5 per hectare was derived from the provision made for capital consumption (depreciation) estimated through the straight line method. The fixed cost per hectare of maize farm represents only about 2.8% of the total production cost per hectare. Net farm income (NFI) per hectare is ₦104,376.34 with a return on capital investment (ROI) of 1.99 obtained from the ratio of the Net Farm Income (NFI) to the total cost of production. This implies that every ₦1.00 investment in maize production in the area will return ₦1.99 (i.e. a profit of ₦1.99 per naira invested). Summarily, from the results of the costs and return analysis, maize production in the study area is both viable and profitable considering net farm income realized per hectare. The result on costs and returns of maize production is in line with findings reported by Fakayode *et al*. (2011) when they conducted an economic assessment of fadama maize production in Kwara State of Nigeria and documented a net farm income (NFI) of ₦113,946.80 per hectare of maize farm with a rate of return (RoR) of 152%.

4.4 Poverty Line and Status of Maize Farmers in the Area

Poverty is defined based on availability of certain needs such as food, clothing, shelter, sanitation facilities, pipe-borne water, education, good healthcare and access to information (NBS, 2010). However poverty is determined in terms of income and expenditure of individuals. A poverty line is an estimated amount of money (representing income or expenditure) which can be used as benchmark for classifying individuals or households as being rich or poor. Usually, those whose incomes or expenditure fall below the set amount are said to be poor. This section presents the poverty line and poverty indices estimated for maize farmers in the study area.

4.4.1 Poverty line among maize farmers

The poverty line of maize farmers in the study area is estimated as two-thirds of the computed mean adult equivalent household expenditure (MAHE). Result of the computed poverty profile and indices of maize farmers in the study area as summarized in Table 4.19 shows that the mean adult equivalent household expenditure is ₦22,267.41. With the poverty line (*Z*) set at ₦13,194.81, about 70% of the maize farmers lived above poverty line (non-poor). The poverty line value computed from this study translates to a daily expenditure of ₦377.38, which is a little higher than the poverty line value of $1 per day set by the World Bank.

Table 4.19: Household poverty profile among maize farmers

Indicator	**Value**
Non-poor	(70.0)
Moderate-poor	(21.5)
Core-poor	(8.0)
FGT poverty indices	
Poverty incidence	0.30
Poverty gap index	0.36
Poverty depth	0.11
Poverty severity	0.04
Mean Per Capita Expenditure	22,267.41

Poverty line (2/3) = ₦13,194.84; Figures in parenthesis are percentages

4.4.2 Poverty status of maize farmers in the study area

Maize farmers in the study are isolated into various poverty groups using the FGT weighted poverty index measure. Table 4.19 shows that estimated poverty incidence (P_0) is 0.30. This implies that 30% of the respondent maize farmers live below the

poverty line. The poverty gap index or depth (P_1) which is a product of the poverty incidence and poverty gap ratio is computed to be 0.36, suggesting that 36% of the current household expenditure of the maize farmers is required to bring them up to the poverty line. Then poverty severity (P_2) which is a product of the poverty incidence and the square of the poverty gap is calculated to be 0.04. The proportion of maize farmers estimated to be non-poor (that is 70%) points to the fact that the profit they realize from maize production is useful in supporting the household consumption expenditure. Based on the indices above, subsequent intervention aimed at generating additional income of about of about 36% of the current income level of the poor maize farmers will lift them up to the estimated poverty line.

4.5 Challenges of Maize Production in the Study Area

Farmers are confronted with a number of problems in the production process. Some of the problems encountered by maize farmers are presented in Table 4.20. Going by the ranking of farmers' responses to the potential problems facing maize production, issue of shortage and high cost of fertilizer ranked first. About 78% of the sampled maize farmers said high cost and shortage of fertilizer constitute the greatest challenge. This could also be seen from the costs and return analysis where cost of fertilizer constituted close to 16.8% of the farmers' total cost of production per hectare of maize farm. This is even in the regime of the Growth Enhancement Support (GES) Scheme which is believed to have greatly reduced the difficulty experienced by farmers in the areas of fertilizer quality, shortage and cost.

Table 4.20: Distribution of maize farmers based on challenges (percentage)

Challenges	***Beneficiaries**	**Rank**
Incidence of pests and diseases	73.0	2
Environmental problems	53.5	5
Shortage and high cost of improved seeds	27.0	8
Shortage and high cost of fertilizer	78.0	1
Shortage and high cost of labour	54.5	4
Lack of processing equipment	34.5	7
Lack of storage infrastructure	40.0	6
Difficulty in accessing credit	70.0	3
Difficulty in acquiring farm land	20.0	9

* Multiple responses were allowed

Incidence of pests and diseases was next in the ranking of problems after fertilizer. Majority (73%) of the respondent farmers underscored this problem. Maize streak and striga had been identified as the worst in this category, causing the farmers to lose much of their yield on the field.

Difficulty in accessing credit coupled with its high cost affects maize production in a negative sense. This problem was reported by 70% of the entire respondents in the study. Credit is necessary for the acquisition of the relevant inputs needed by maize farmers during the production season.

Shortage and high cost of labour ranked fourth on the list of problems and was responded to by 54.5% of the sampled farmers. This is contrary to a priori expectation that the problem of labour ranks first in the farmers' list. The downward position of labour in this study might be attributed to the fact that some of the farmers have large

family sizes (mean of 8 persons) which provided cheap source of labour for working their smallholdings.

Environmental problem was reported by about 53% of the farmers in the study. This is not unexpected given the wave of climate change that has struck the world in recent years. Environmental problems here are the ones related to amount and timing of rainfall, dry spell, flooding and wind storm. They are more or less natural and quite outside the control of maize farmers, hence, could cause maize farmers a lot of damage and financial loss.

Lack of storage infrastructure was reported by 40% of the respondent farmers. It featured as the sixth problem in the ranking order. Most of the farmers surveyed said they stored their produce in jute bags. This is not air-tight, and so, it cannot keep away pests and disease-causing organisms. The smallholder farmers cannot readily acquire metal silos or storage bins for their produce. Therefore, they lose sizable amount of their produce to poor storage.

Other problems which were listed by the farmers include shortage and high cost of improved maize seed, lack of processing equipment and difficulty in acquiring farm land. Each of these problems were however, considered by less than 30% of the sampled farmers. In high or low measure, all these problems directly or indirectly limit the production capacity and efficiency potentials of maize farmers in the area.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

The study focused on estimating the production efficiency and poverty profile of smallholder maize farmers in the Federal Capital Territory under the Growth Enhancement Support (GES) Scheme. Structured questionnaires were used to collect data from 200 GES beneficiary smallholder maize farmers in the FCT selected by a random process. Descriptive statistics, stochastic production frontier, farm budgeting and weighted poverty index were used in analyzing the data.

Findings from the study showed that the mean age of maize farmers was 47 years. About 76% and 24% of the respondents represented male and female of whom 97% were married. About 63% and 37% of the respondents acquired formal and no-formal education. Mean household size was 8 persons while each farmer had a mean farming experience of 12 years with an average farm size of 1.5 hectares.

Maximum likelihood estimates of the stochastic frontier production of maize showed that quantities of maize seed, labour, farm size and agro-chemical have direct and significant effect on maize output in the area (at $p<0.01$). Maize farmers in the study area were technically inefficient for all the resources. Variables such as farmer's age, farming experience, farm size, extension contact and membership of farmer group were found to be the common sources of technical inefficiency among maize farmers. Total cost of maize production was directly and significantly influenced by cost of seeds, cost of fertilizer, cost of agro-chemicals, cost of hired labour and value of output. Maize farmers in the study were allocative inefficient having a mean score of 84.4%. Sources

of allocative inefficiency in maize production include household size, farming experience, education level, farm size and membership of farmer-based organization. Mean economic efficiency of the maize farmers was 78.6%.

About ₦52,379 was required to cultivate a hectare of maize and realize an average net farm income of maize farm ₦104,376 per hectare. Variable costs constituted about 97% of the total cost while hired labour constitutes about 62.5% of the total cost of cultivating a hectare of land. Return per naira invested in maize production was 1.99.

Estimated poverty line for maize farmers in the study area was ₦13,194.84, yielding a poverty incidence of 30% and a poverty gap index of 36%. Mean adult equivalent household expenditure (MAHE) was ₦22,267.41and 59% for GES beneficiaries and non-beneficiaries.

Shortage and high cost of fertilizer, improved seeds, storage facility and credit were the critical problems encountered by maize farmers in the study area.

5.2 Conclusion

Efficiency in maize production was directly influenced by the farmer's choice of inputs combination (maize seed, labour, farm size and agro-chemical) as well as some socio-economic factors; hence, their production efficiency fell below the frontier optimum. Therefore, there is room for them to increase their production efficiency. However, given the profitable nature of maize production in the area, many poor households would be lifted out of poverty if they are supported to go into maize production.

Recommendations

In view of the findings from this study, the following recommendations are necessary:

i) There is the need to stimulate extension work in the direction of educating maize farmers on the technicality of input combinations that will yield optimum output at minimum cost. Application of fertilizers and agrochemicals need to be executed following recommended prescription, it would reduce production cost if farmers are trained in this act.

ii) Based on the significant influence of education on the production efficiency of maize farmers, there is need for maize farmers to embrace education. This will enhance their managerial ability and eventually improve on the operational efficiency rating.

iii) Maize farmers need to adjust their household sizes to their scale of production. This is necessary because the cost of managing the household sometimes compete unfavourably with the cost efficiency of the farm business.

iv) There is need for farmers to mobilize and join farmer-based groups to enable them share knowledge and experiences on production practices as well as access useful information and other benefits derivable from such groups. This would enhance their production efficiency and profitability thereby reducing poverty among them.

v) There is the need to scale up women involvement in maize production through a deliberate effort to facilitate access to and ownership of productive assets by them. This could equally help in poverty reduction.

vi) Based on the profitable nature of maize production in the area, there is the need for more support in the areas of subsidized inputs, low interest soft credit and market information. This would help increase the farmers' production efficiency and profit margin thereby, reducing household poverty.

5.3 Contributions to knowledge

Result from the study reveals that maize farmers who benefited from GES inputs support are 78.6% production efficient, still below the maximum possible efficiency level. Every ₦1.00 invested in maize production in the area yields a return of ₦1.99.

About 30% of the maize farmers in the study area lived below the estimated poverty line of ₦13,194.84. Mean adult equivalent household expenditure of maize farmers in the study area is ₦22,267.41.

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APPENDIX 1: QUESTIONNAIRE

A. IDENTIFIERS

1. Name of Community/Village .....

   Form No:_____

2. Area Council of residence .....

3. Phone number of respondent.....

4. Date …….....

5. GPS Coordinates: Latitude:…… Longitude……

A. SOCIO-ECONOMIC CHARACTERISTICS OF RESPONDENT

6. What is your age: ..... (Please, be exact)

7. Sex: Male { 1 } Female { 2 } (Please tick as applicable)

8. Marital status: Single { 1 } Married { 2 } Divorced { 3 } Widowed { 4 }

9. What is your household size? ……

10. How many of your household members fall in the following categories?

Category	Number of male	Number of female
Children (less than 18yrs)		
Adults (18yrs or more)		

11. What is your highest educational level? (please tick only one option)
    No formal education [1] Primary [2] Secondary [3] Tertiary [4]

12. Is farming your major occupation? Yes { 1 } No { 2 }

13. Do you do any other job apart from crop farming? Yes { 1 } No { 2 }

14. If yes, what job is that? .....

15. How much do you earn from this job on monthly basis? .....

16. For how many years have you been involved in maize production? (Tick only one option)

1 - 5 years { } 6 – 10yrs { } 11 – 15yrs { } 16 – 20yrs { } 20 - 25 { }

17. Do you belong to any farmer group/association/cooperative? Yes {1} No {2}

C. PRODUCTION DETAILS

18. What support did you receive under GES? Maize seed { }

Quantity (Kg) ……. Fertilizer { } Quantity (Bags) …….

19. Do you think GES maize seed is better than the other maize varieties you had before? Yes { 1} No { 2 }

20. If yes, what are your reasons? (Tick the applicable options)

(a) High yielding quality (b) Early maturing ability (c) High resistant to diseases/pests (d) Tolerant to drought (e) Has better market value (f) Stores better for longer period (g) Preferred more by consumers (h) others (specify) .....

21. Is maize your major crop? Yes { 1 } No { 2 }

22. How do grow your maize? Sole crop { 1 } Mixed { 2 }

23. If mixed, mention the other crop(s) in mixture ……..

24. Why do you stick to maize production? (Tick applicable ones)

(a) To be self-employed (b) To supplement household income (c) To provide food for the family (d) My parents are into it (e) People say it is highly profitable (f) It is my profession (g) Retired from work but not tired of doing something productive (h) Others (specify) .....

25. How much money did you spend during the last production cycle/season? N.....

26. How did you source the money used for your production activities? (Tick applicable ones) (a) Personal savings (b) Loan from bank (c) Loan from money lenders (d) Loan from Cooperatives (e) Grants from friends and relations

27. How many plots of land do you have for maize production (in number)? ……..

28. What is the total size of all your maize farms (in hectares)? …….....ha.

29. How did you get the farmland? (Tick as applicable)

(a) Inherited it (b) Bought it (c) Rented it (d) Leased it

30. If rented or leased, what is the annual rent? N…….

31. Did you have contact with Extension Service Providers? Yes { 1 } No { 2 }

32. How many times (cycles) do you produce maize in a year? …….

33. Did you buy any fertilizers from the market? Yes { 1} No {2}

34. If yes, how many bags did you buy and at what price per bag? ……bags; N……./bag

35. Did you use agrochemicals? Yes {1} No {2}

36. If yes, what quantity (kg or ltrs) did you use for the season and at what price per kg/ltr? …….. ltrs; N……./ltr

37. What was your total output of maize last season (in kg)? …… kg

D. PRODUCTION EXPENDITURE AND REVENUE DETAILS

38. Please, indicate in the table below, your expenditure on fixed assets.
Expenditure (Fixed Costs)

S/N	Items	Purchase Price (Original Cost (N))	Estimated life span (No of Years)
I	Land (purchased)		
Ii	Wheel barrow		
Iii	Knapsack spraying machine		
Iv	Cutlass(es)		
V	Hoe(s)		

39. Please, indicate, in the table below, how much you spent on your maize production activities during the last season.

Expenditure Details (Variable costs)

S/N	ITEM NAME	UNIT	UNIT COST (NAIRA)	QUANTITY	TOTAL COST (NAIRA)
A	Land rent	Hectare			
B	Maize Seed	Kg			
C	Land preparation	Man-hour			
D	FERTILIZER – Inorganic	Kg			
E	FERTILIZER - Organic	Kg			
G	Agro-Chemicals (Solid)	Kg			
H	Agro-Chemicals (Liquid)	Ltrs			
I	Hired Labour :	Mandays			
I	Planting	Mandays			
Ii	Weed control	Mandays			
iii	Harvesting	Mandays			
Iv	Threshing	Mandays/hours			
	Total of Hired Labour				
J	Family Labour:	No			
I	No. of Adults who worked (for the season)	No			
Ii	No. of Children who worked (for the season)*	No			
iii	No. of days worked (for the season)	No			
	Total of Family Labour				
L	Transport/carriage	Bags/Pickup loads			
M	Other Expenses (Miscellaneous)				
	Total				

*Note: The Man-day of a child's labour here is assumed equal to half of that of an adult

40. Please, indicate in the table below, how much you realized from your harvest last production season (Be as realistic as possible).

S/N	**Item name**	**Unit (tick as applicable)**	**Unit price (naira)**	**Quantity**	**Total value (naira)**
A	Sales (grain)	Kg/bag			
B	Consumption by family members	Kg/bag			
C	Gift to relations and friends	Kg/bag			
	Total				

E. HOUSEHOLD INCOME AND EXPENDITURE

41. Please, indicate the amount you and your family spend on these items for household consumption

ITEMS	AMOUNT/MONTH (Naira)
Food (rice, beans, yam, meat, fish, groundnut oil, palm oil, sugar, salt, maggi, beverages, bread etc)	
Drinks (beer, palm wine, soft drinks, etc)	
Water (for washing, bathing, cooking and drinking)	
Clothing (wears)	
House Rent	
School fees (annual amount)	
Health Services	
Ceremonies (weddings, funerals, birthday etc)	
Foot wears/Shoes (leather and plastic)	
Kerosene/Cooking Gas	
Toothpaste	
Detergents, washing and bathing soaps, body creams	
Petrol for generator	
Electricity (public power supply)	
Petrol for vehicle/motor cycle	

Transport (by commercial means)	
Repairs of vehicle/motor cycle/bicycle	
Waste management (If applicable)	
Remittances/Gifts/Donations	

42. Please, indicate the amount of money you and your family members received from each of the sources listed in the table below to augment your income for the month.

Source of financial support	**Amount/month (naira)**
Monetary grant from family members and relations	
Monetary grant from friends	
Mutual support groups	
Charitable organizations (NGOs)	
From rents	
Other miscellaneous receipts (specify)	

F. CHALLENGES TO MAIZE PRODUCTION

43. Which of these constitute challenges to maize production in your locality? (Tick the applicable ones)

S/N	**Possible Constraints**	**Tick (if applicable)**
A	Incidence of pests and diseases (streak, striga, etc)	
B	Environmental problems (poor soil fertility, drought, etc)	
C	Poor quality seeds (shortage and high cost of improved varieties)	
D	Shortage and high cost of fertilizers	
E	Shortage and high cost of labour	
F	Lack of processing machines	
G	Lack of storage facilities (infrastructure)	
H	Difficulty in accessing credit facilities (issue of collateral)	
I	Difficulty in acquiring farm land	

APPENDIX 2: Computer Output of Maize Stochastic Production Function

Output from the program FRONTIER (Version 4.1c)

Tech. Eff. Effects Frontier (see B&C 1993)
The model is a production function
The dependent variable is logged

the final mle estimates are :

	coefficient	standard-error	t-ratio
beta 0	0.60557246E+01	0.28043730E+00	0.21593863E+02***
beta 1	0.18370112E+00	0.61277900E-01	0.29978364E+01***
beta 2	0.14280777E-01	0.36197481E-01	0.39452407E+00
beta 3	0.18120033E+00	0.64544012E-01	0.28073917E+01***
beta 4	0.25844060E+00	0.89128926E-01	0.28996266E+01***
beta 5	0.13616502E+00	0.57454712E-01	0.23699539E+01**
delta 0	0.20614332E-01	0.10086005E+00	0.20438551E+00
delta 1	-0.13970767E-02	0.92134714E-03	-0.15163412E+01
delta 2	0.50048882E-01	0.84969377E-02	0.58902259E+01***
delta 3	-0.13249158E-01	0.79401569E-02	-0.16686267E+01*
delta 4	0.19782158E-01	0.76655182E-02	0.25806681E+01**
delta 5	-0.24819687E-01	0.24929322E-01	-0.99560216E+00
delta 6	-0.31802478E+00	0.99321917E-01	-0.32019598E+01***
delta 7	-0.15589011E+00	0.65109506E-01	-0.23942757E+01**
sigma-squared	0.37052523E+00	0.34328172E-01	0.10793620E+02***
gamma	0.46008144E+00	0.12903501E-02	0.36012043E+01***

log likelihood function = -0.18455856E+03

LR test of the one-sided error = 0.15259472E+02
with number of restrictions = 9
[note that this statistic has a mixed chi-square distribution]

number of iterations = 40

(maximum number of iterations set at : 100)

number of cross-sections = 200

number of time periods = 1

total number of observations = 200

APPENDIX 3: Computer output of stochastic frontier cost function

the final mle estimates are :

	coefficient	standard-error	t-ratio
beta 0	0.21435709E+01	0.19510420E+00	0.10986800E+02
beta 1	0.98167337E-03	0.23859238E-02	0.41144373E+00
beta 2	0.88846264E-01	0.12298155E-01	0.72243571E+01
beta 3	0.67057751E-01	0.11784248E-01	0.56904565E+01
beta 4	0.18229329E-01	0.61309099E-02	0.29733480E+01
beta 5	0.65474286E+00	0.13918776E-01	0.47040262E+02
beta 6	0.46769835E-01	0.16133694E-01	0.28988919E+01
delta 0	-0.11513683E+02	0.18333256E+01	-0.62802173E+01
delta 1	-0.15713119E-01	0.22822423E-01	-0.68849479E+00
delta 2	0.15625549E+00	0.30961728E-01	0.50467303E+01
delta 3	-0.29339023E+00	0.83134493E-01	-0.35291035E+01
delta 4	-0.59685299E-05	0.22593066E-05	-0.26417530E+01
delta 5	0.30972450E+00	0.85757646E-01	0.36116255E+01
delta 6	0.44980188E+00	0.55428505E+00	0.81149921E+00
delta 7	0.15460640E+01	0.22653657E+00	0.68247878E+01
sigma-squared	0.21953800E+01	0.36365328E+00	0.60370142E+01
gamma	0.99880489E+00	0.59663020E-03	0.16740770E+04

log likelihood function = 0.64752314E+02

LR test of the one-sided error = 0.30578515E+03
with number of restrictions = 9
[note that this statistic has a mixed chi-square distribution]

number of iterations = 50

(maximum number of iterations set at : 100)

number of cross-sections = 200

number of time periods = 1

total number of observations = 200

thus there are: 0 obsns not in the panel