ANALYSIS OF THE IMPACT OF THE ADOPTION OF EARLY MAIZE TECHNOLOGY ON PRODUCTIVITY AND FOOD SECURITY STATUS OF THE FARMERS IN GWAGWALADA AND KUJE AREA COUNCILS OF FCT, ABUJA

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DECLARATION

I hereby declare that this dissertation titled **"Analysis of the Impact of the Adoption of Early Maize Technology on Productivity and Food Security Status of Farmers in Gwagwalada and Kuje Area Councils of FCT, Abuja"** 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 information has been duly acknowledged in the text and list of references provided.

_____ _____

Dora Aladi AGBONIKA **Date**

CERTIFICATION

This dissertation titled **"Analysis of the Impact of the Adoption of Early Maize Technology on Productivity and Food Security Status of the Farmers in Gwagwalada and Kuje Area Councils of FCT, Abuja"**, by Dora Aladi **AGBONIKA** meets the regulations governing the award of the Degree of Master of science of the Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This work is dedicated to the almighty God who gave the strength, knowledge and life to finish this work. To him alone be the glory.

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ABSTRACT

The study examined the impact of the adoption of early maize technology on productivity and food security status of farmers in Gwagwalada and Kuje area council of FCT Abuja. The study examined the rate of adoption of early maize varieties, determine the economic efficiency of the farmers that adopted early maize varieties in the study area, determine the factors that influence adoption of early maize varieties, determine the impact of adoption of early maize varieties on income and food security of farmers in the study area and identify the problems faced by farmers in the study area. Primary data were used for the study. A multi-stage sampling technique was employed in the selection of respondent for the study. The primary data were obtained using structured questionnaires administered to 269 farmers. Descriptive statistics, adoption index, stochastic frontier model, logit regression model, t-test, food security line were used for the analysis of data. The result showed that DMR-ESR Y CIF2, AC 90 POOL 16DT STR, TZE-W DT STR C4, ACR 95 TZE COMP4 C3, TZE-WDT STR QPM C0 and ACR 90POOL 16 DT STR were the early maize varieties planted in the study area. DMR-ESR Y CIF2 was identified as the variety adopted by a larger proportion (21%). The major drivers of adoption in the study area were found to be farming experience, education, marital status, membership of cooperative societies, household income and extension contact. 11% of the farming household that adopted early maize varieties fall within the highest annual income range of above ₦599,000 with 18% for non adopters. 10% of the adopters are within the lowest income range of less than ₦100,000. The mean annual income of adopters was ₦412,720 and that of non-adopters was ₦276,844 which implies that adopters of early maize varieties realized higher income than the non-adopters of the varieties. 79% of adopters with an average daily per capita household calorie consumption of 3606.30kcal were food secure while 44% of non-adopters were food secured. Adequate policy measures should be put in place to fast track seed multiplication and distribution and on-farm trials through effective extension service delivery so as to intensify and sustain the adoption of early maize varieties.

CHAPTER ONE

INTRODUCTION

1.1 Background to the study

Agriculture in Nigeria is increasingly recognized to be central to sustained growth and improved economic development. Agriculture plays a significant role in food security, poverty alleviation and human development (Amaza and Maurice, 2005). Food security became a catch-phrase in the mid 1990s (Okezie and Okorie, 2009). The concept of food security has evolved, developed, multiplied and diversified since the World Food Conference in the 70s (Maxwell and Smith, 1992; Maxwell, 1996). Its main focus has shifted from global and national to household and individual food security and from food availability to food accessibility. It can be defined as the success of the local livelihood to guarantee access to sufficient food at the household level (Devereaux and Maxwell, 2001).

The failure of early solutions to food insecurity in the 1970s and 1980s was largely attributed to their technological bias, stressing production rather than equitable distribution, access, affordability and utilization of improved varieties of crops. Since then, it has become clear that food security revolves around complex issues that encompass a wide range of interrelated environmental, economic, social and political factors. An approach encompassing improve varieties of seed is required in addressing food security and lack of which pose serious challenge to many regions in their ability to address food security adequately (Vogel and Smith, 2002: Clover, 2003). Individuals have sufficient access to food when they have adequate incomes or other resources to purchase or barter to obtain levels of appropriate foods needed to maintain consumption of an adequate diet/nutrition level (United States Agency for International Development

(USAID), 1992). Food access depends on the ability of households to obtain food from current production, purchases, gathering, or through food transfers from relatives, members of the community, the government or donors. The distribution of food is an important determinant of food security for all household members. Food access is also influenced by the aggregate availability of food in the market, market prices, productive inputs, and credit (USAID, 1992).

Maize is a crop of great economic importance in Nigeria. Maize is a cereal crop grown for food, feed and industrial uses and it is the second most common cereal food crop after rice (Akande, 1994). Maize is widely cultivated throughout the world, and a greater amount of maize is produced each year than any other grain, in Nigeria it is produced largely in the Northern Guinea Savannah. There are several domestic markets for maize all over Nigeria and maize also filters into international markets such as Niger, Chad, Mali, Benin Republic and some other countries in the West African Sub region (Iken and Amusa, 2004). Maize is widely consumed as a stable food by poor rural and urban households: providing carbohydrate, vitamins, and relatively small amount of protein to human beings and livestock as well. Maize will continue to play a large and important role in Nigeria's food production (USAID, 2010). The total land planted to maize in Nigeria is above 2.5 million hectares with an estimated yield of about 1.4 metric tonnes per hectare (Agbonika, 2013). It is recorded that about 1000 metric tonnes of maize is produced in Abuja (GAC, FCT, 2004).

Adoption of maize production technologies has received much attention in recent years because of increase in demand for maize. Several varieties have been introduced that give high yield and resistance to diseases. Oladele (2005) opined that the efficiency of technologies generated and disseminated depend on the effective utilization by farmers.

The steady growth of population has led to an increase in the demand for food and agricultural raw material (Owolabi *et al.*, 2012). According to Selener (1997) adoption of these technologies can bring about low cost of production and high returns which will improve household livelihood and its cultivation in large quantity enhance food security.

Maize technologies are; Extra-early, Early- intermediate and late maturing varieties which were developed with yields up to twice as much as traditional varieties (Iken *et al.*, 2002). Early maturing varieties enabled maize production to expand into new areas, especially to the Sudan savannas where the short rainy season had adversely affected maize cultivation in the past.

1.2 Problem Statement

Maize continues to play a large and important role in Nigeria's food production (USAID, 2010). More than 60 percent of the Nigeria's production of maize is consumed by the industrial sector for production of flour, animal feeds, biscuits, beverages, malt drink, beer, cornflakes, starch, syrup, and dextrose (Iken and Amusa, 2004). The ban on importation of cereals by the Federal Government of Nigeria since 1986 has greatly expanded these latter uses and thus overall demand for maize (Idrisa *et al*., 2006). The versatile uses of maize create great demand for maize. Kamara *et al.* (2006) estimated 80% of the maize crop suffers periodic yield reduction due to drought stress. Drought at flowering and grain filling period may cause losses of 40-90% (Grant *et al,* 1989; Nesmith and Ritchie, 1992; Menkir and Akintunde, 2001). Maize productivity has been hindered by low adoption of improved seeds, poor seed quality, little or no use of fertilizers, low investment in research funding, and poor extension services (Ebojei *et*

al., 2012). The drastic decline in agricultural production became worrisome, as this led to the worsening of economic fortune in terms of declining growth, increase unemployment, galloping inflation, poor food supply etc. that characterise the Nigeria economy (Kwaghe, 2006). Increased food yield makes food available to the farmer's household and the nation at large; this can be achieved through adoption of improve technologies (Ojo, 2004), the human right to food that is basic is directly linked to the right to life as food is essential to be able to live. The demand for maize as a result of various domestic uses shows that a domestic demand of 3.5 million metric tonnes outstrips production of about 1000 metric tonnes (Akinola *et al.*, 2007). Food insecurity remain a fundamental challenge in Gwagwalada and Kuje Area Council that is faced with the problem of increasing population and consequently inadequate supply of food to households as prices of food increase as a result of high demand (Ibrahim *et al*., 2009). The population of the study area is fast increasing as a result of movement of people from the Boko haram affected area of the Northern Nigeria, search for job in the Abuja environ, and several government parastatals located in the area but food production is not fast increasing (Patricia, 2011). It is therefore desirable to estimate the impact of adoption of early maturing maize. Achieving food security has three dimensions. First, it is necessary to ensure a safe and nutritionally adequate food supply both at the national level and at the household level. Second, it is necessary to have a reasonable degree of stability in the supply of food both from one year to the other and during the year. Third, and most critical, is the need to ensure that each household has physical, social and economic access to enough food to meet its needs. This means that each household must have the knowledge and the ability to produce the food that it needs on a sustainable basis. This can be achieved through technology adoption (Agbonika, 2013).

There is therefore, need for adoption of improved maize production technology to increase production capacity and yield. Consequently there is need to increase output per hectare through the use of modern technologies to raise the productivity of maize in the study area. Closing this gap and increasing food production will require intensive agriculture based on use of modern technologies such as improved seeds and fertilizer. It is therefore, on this note that this study attempted to address the following research questions:

i. What is the rate of adoption of the early maturing maize by farmers in the study area?

ii. What is the economic efficiency of maize farmers that adopted early maize technology in the study area?

iii. What are the factors influencing the adoption of early maize production by farmers?

iv. What is the impact of adoption of early maize technology on the income and food security level of farmers in the study area?

v. What are the problems faced by farmers in maize production?

1.3 Objectives of the Study

The broad objective of the study was to determine impact of the adoption of early maturing maize technology on productivity and food security status of farmers in Gwagwalada and Kuje Area Councils of Federal Capital Territory, Abuja. The specific objectives were to:

i. examine the rate of adoption of early maize technology.

ii. determine the economic efficiency of the farmers that adopted early maize varieties in the study area.

iii. determine the factors that influence the adoption of early maize variety in the study area.

iv. determine the impact of adoption of early maize varieties on income and food security of farmers in the study area.

v. identify the problems faced by maize farmers in the study area.

1.4 Hypotheses of the Study

The hypotheses tested in this study include:

i. Early maize variety adopters are economically inefficient.

ii. Adoption of early maize variety has no significant impact on the income of the maize farming households.

iii. Adoption of early maize variety has no significant impact on food security level of the maize farming households.

1.5 Justification of the Study

Maize is an important food and feed crop in Nigeria and remains an important crop for rural food security. The production of the crop must be increased in order to ensure food and income through the development of improved maize varieties and technologies. Maize is a staple food of great socioeconomic importance in developing countries. It is hoped that adoption of improved varieties of maize planted in large quantity will bring about food security. The study will provide both researchers and extension workers with relevant information on factors influencing adoption of the technology package, and

other individual decisions. Information gathered from this work will guide policy makers on how to direct government towards effective food production in the nation with specific reference to adoption of improved maize varieties. The study will also to a greater extent, provide required data on the current adoption status of the variety involved in the study area as well as help extend fast growing literatures in adoption of innovation studies.

CHAPTER TWO

LITERATURE REVIEW

2.1 Origin and History of Maize

Maize is the domesticated variant of teosinte, the two crop has dissimilar appearance, maize having a single tall stalk with multiple leaves and teosinte being a short, bushy plant (Bello *et al.*, 2012). It is a direct domestication of a Mexican annual teosinte. It has been derived from hybridization between small domesticated maize (a slightly changed form of wild maize) and a teosinte of section *luxuriantes,* either Z. *luxurian* or Z.*diploperennis.* After it underwent two or more domestication it has evolve from a hybridization Z. *diploperennis* by tripsacum dactyloides. Maize was first cultivated in what is now the United States at several sites in new Mexico and Arizona about 2100BC (Roney, 2009). In 1992, research by the USDA Forest Service suggested that the rise in maize cultivation 500 to 1000 years ago in what is now the southeastern United States corresponded with a decline of freshwater mussels, which are sensitive to environmental changes (Evan *et al.,* 2005). Maize began to spread widely and rapidly. As it was introduced to new cultures, new uses were developed and new varieties selected to better serve in those preparations. Maize was the staple food, or a major staple of most pre-Columbian North American, Mesoamerican, south American and Caribbean cultures. The Mesoamerican civilization was strengthened upon the field crop of maize, through harvesting it, its religious and spiritual importance and how it imparted their diet. It formed the Mesoamerican people's identity.

2.2 Theoretical / Emperical Framework

In agriculture adoption is very vital and over time technology adoption have moved through phases; initially attempts were made by policy makers to explain the use and

diffusion of new agricultural technologies; trying to explain the impact of technology adoption on commodity production, on poverty and malnutrition, on farm size and input use, on genetic diversity, and on variety of social issues (Doss, 2004).

In defining adoption the first thing is to consider whether adoption is a discrete state with binary variables that is, a farmer is either or not an "adopter" or whether adoption is a continuous measure (Ochi and Malumfashi, 2005). Many studies use different approaches to adoption (Philip et al., 2000; Imoh and Essien, 2005). A farmer maybe said to be an adopter if he were using the technology that has been recycled for several generations from hybrid ancestors, adoption can also be identifies when a farmer uses new certified technology (Ouma, 2002). Studies of agricultural technology adoption are used widely in four areas of agricultural policy (Doss, 2004; Evenson and Gollin, 2003). These are: assessing the impact of agricultural research, evaluating the distributional impacts of new technology, priority setting for research, and Identifying and reducing constraints to adoption. Literature on adoption is currently moving in three dimentions (Doss, 2004). These include; innovative econometrics and modeling methodologies to understand adoption decisions, micro level studies based on local data collection intended to shed light on adoption decisions in particular context for policy purposes and examination of the process of learning and social networks in adoption decisions. Most available literature focus on new methodologies to deal with issues of endogeneity and simultaneity of decisions (Ransom, 2003). Adoption of improved agricultural techniques remains a big challenge to development of agriculture and this has to be addressed to increase productivity and improve standard of living of farmer's household.

2.3 Importance of Maize Crop in National Development

Maize is an important food and feed crop in Nigeria and remains an important crop for rural food security (Kudi *et al.*, 2011). The production of the crop must be increased in order to ensure food and income security through the development of improved maize varieties and technologies. Maize or corn is a cereal crop that is grown widely throughout the world in a range of agro ecological environments. More maize is produced annually than any other grain. About 50 species exist and consist of different colors, textures and grain shapes and sizes. White, yellow and red are the most common types. The white and yellow varieties are preferred by most people depending on the region. Maize was introduced into Africa in the 1500s and has since become one of Africa's dominant food crops.

Like many other regions, it is consumed as a vegetable although it is a grain crop. The grains are rich in vitamins A, C and E, carbohydrates, and essential minerals, and contain 9% protein. They are also rich in dietary fiber and calories which are a good source of energy. It is an important source of carbohydrate, protein, iron, vitamin B, and minerals. Green maize (fresh on the cob) is eaten parched, baked, roasted or boiled; playing an important role in filling the hunger gap after the dry season and serving as a staple diet for 200 million people (Directorate Agricultural Information Services in cooperation with ARC-Grain Crop Institute, 2003). Maize is a staple food of great socioeconomic importance in developing countries and it has a wide range of uses these include; baking, brewing industries and livestock feed. In developed countries, maize is consumed as second-cycle produce in the form of meat, eggs and dairy products. The importance of maize cannot be overemphasized, with Nigeria producing 43% of maize grown in West Africa. Maize is the most important staple food in Nigeria. It accounts

for about 43% of calorie intake (Nweke *et al.,* 1983; NARP, 1994). Maize has consumption quantity of 53.20 g/capital/day (FAOSTAT, 2007). 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. Maize accounts for 30-50% of low-income household expenditures in Eastern and Southern Africa. A heavy reliance on maize in the diet, however, can lead to malnutrition and vitamin deficiency diseases such as night blindness and kwashiorkor. The released maize varieties, which were approved by the Nigeria National Variety Release Committee, include 13 open-pollinated varieties of extra-early-, early-, intermediate-, and late-maturity with resistance to the parasitic weed *Striga hermonthica* and stem borers, tolerance to drought, and with good adaptation to sub-optimal soil nitrogen. Four hybrids with drought-tolerance have also been released.

Abebe (2010) reported that the release of these varieties will hasten the adoption of improved maize cultivars by farmers in Nigeria, consequently increasing yields, raising farm incomes, and improving food security. Nigeria is predominantly rural in character with about 80% of the population directly and indirectly dependent on agriculture. Land is much diversified reflecting various ecological conditions. The production of food and fibre to satisfy the ever-increasing population globally is critical to the socio-economic well-being of our societies. Unless agricultural produce are surplus and relatively cheap in both the urban and rural settlements, the life chances of human population are significantly reduced.

In the developed or advanced nations of the World such as the United States of America and Japan, the productivity of their agricultural sector has been consistently high for several decades (Camboni and Napier, 1993). As a major source of their economic buoyancy, those countries have over the years placed high values and emphasis on their agriculture by making substantial budgetary provision for the sector, particularly in the area of research and extension activities. Consequently, studies on adoption-diffusion of innovations aimed at improving farm productivity have been conducted which have largely translated into their present self-sufficiency in food production and food reserve.

2.4 The Usefulness of Maize Crop

2.4.1 Consumption uses of maize

Maize can be used for varieties of things for human uses and animal feed. Maize as cornmeal constitutes a staple food in many region of the world. Introduced into Africa by the Portuguese in the 16th century, maize has become Africa's most important staple food crop (FAO 2008). Maize can be made into a thick porridge in many cultures: *Tuwo*, *Oje'akpa* among the Hausa's and Igala's in Nigeria, *Polenta* of Italy, the *angu* of brazil, *mealis* pap in south Africa. It is used as replacement for wheat flour to make cornbread and other baked products. Maize is a major source of starch; it is also a major source of cooking oil (corn oil) and of maize gluten. The starch can be hydrolyzed and enzymatically treated to produce syrups, particularly high fructose corn syrup which can be used as sweetener and when fermented and distilled produces grain alcohol. Maize is grown to feed for livestock as forage. Maize is also used as fish bait, called dough balls which is popular in Europe for coarse fishing. The stigma from female maize flowers called corn silk are sold as herbal supplements. There are over 500 uses of maize (Lance and Garren, 2002). Maize is a component of canned, baby food, hominy, mush, puddings, tamales and many more human foods. Some industrial

uses of corn include filler for plastic, packing materials, insulating materials, adhesives, chemicals, explosives, paint, paste, abrasives, dyes, insecticides, pharmaceuticals, organic acids, solvents, rayon, antifreeze, soaps, and many more. Maize is also used as the major study plant for many academic disciplines such as genetics, physiology, soil fertility and biochemistry. It is doubtful that any other plant has been studied as extensively as has the maize plant.

2.4.2 Medicinal uses

A crop which is highly edible and nutritious as maize, also has some medicinal uses among the local people. It is used to cure many diseases, which it had over the years proved to be very effective. These include:

i. Water filtered through charcoal obtained from maize stalk can be used as a treatment to cure gonorrhea (Abdurrahman, 1997).

ii. An infusion obtained from stigma of maize inflorescence can be used for treatment of diseases of the urinary tract or passage (Abdurrahman, 1997).

iii. Water (i.e. '*omi-eko*' or '*omikan*' or '*omidun*') obtained during the preparation of pap is used to soak bark or root of some plants (e.g. '*dokita igbo*'). This is used to treat fever and malaria. Water obtained from the cold-pap is more effective than that from the hot-pap.

iv. Cold-pap or '*eko-tutu*' is used more often in traditional medicines. It is mixed with some preparations (usually granulated, black particles) to cure some

spiritual problems. It may be prescribed to provide protection against enemies, bad occurrences or to foster posterities.

v. Holes are created or made in some maize grains to make rosary. This is put on the hand (wrist) of a child to prevent him or her from becoming slim.

vi. Whole dried maize fruit and dried yam with some charms are planted or buried together. This preparation is done to unite or bind couple together with effect that either of them cannot remarry to another person. It means that they will remain husband and wife forever.

2.5 Maize production

Maize is widely cultivated throughout the world, and a greater weight of maize is produced each year than any other grain. The United States produces 40% of the world's harvest; other top producing countries include China, Brazil, Mexico, Indonesia, India, France and Argentina. Worldwide production was 817 million tonnes in 2009-more than rice (678 million tonnes) or wheat (682 million tonnes). In 2009, over 159 million hectares (390 million acres) of maize were planted worldwide, with a yield of over 5 tonnes/hectare (80 bu/acre). Production can be significantly higher in certain regions of the world; 2009 forecasts for production in Iowa were 11614 kg/ha (185 bu/acre). Is conflicting evidence to support the hypothesis that maize yield potential has increased over the past few decades. This suggests that changes in yield potential are associated with leaf angle, lodging resistance, tolerance of high plant density, disease/pest tolerance, and other agronomic traits rather than increase of yield potential per individual plant.

Table 2.1: Fifteen largest corn producing countries – 2011 est.
(Marketing year- thousands of hectares, ton per hectare, and thousands of metric tons)

Rank	Country	Area harvested	Yield	Production	Exports	Total domestic consumption
1	United states	33,986	9.2	313,918	41,912	279,540
2	China	33,400	5.8	192,780	200	188,000
3	Brazil	15,200	4.5	69,000	12,000	54,000
4	EU-27	8,745	7.4	64,636	2,700	67,000
5	Ukraine	3,544	6.4	22,838	14,000	8,800
6	India	8,600	2.5	21,300	2,400	18,800
7	Argentina	3,600	5.8	21,000	13,000	7,700
8	Mexico	6,000	3.2	19,000	10	29,700
9	South Africa	3,200	3.6	11,500	1,500	10,700
10	Canada	1,200	8.9	10,700	400	10,800
11	Nigeria	5,150	1.8	9,250	100	9,250
12	Indonesia	3,080	2.8	8,700	25	10,000
13	Philippines	2,585	2.8	7,139	-	7,300
14	Russia	1,550	4.3	6,680	2,000	4,700
15	Serbia	1,260	5.0	6,300	1,700	4,800
	World	168,403	5.2	872,983	96,407	865,679
	Top 15 as % of World	78%	NM	90%	95%	82%

Source: USDA, 2012

2.6 Adoption of Improved Varieties in Nigeria

The way out of low Productivity of maize is the adoption of improved seeds with other packages that go with the technology. It has been found from demonstration conducted by IITA, National Rice/Maize Centre and Sasakawa Global SG 2000 among others that yield levels of more than 3 ton/ha are achievable with the use of improved seeds, pesticides and adequate fertilizer application. Adoption process can be described as the mental process an individual passes from first hearing about an innovation to final adoption. Rogers (1995) identified five characteristics of agricultural innovations, which are important in adoption studies. These include relative advantage, compatibility, complexity, trialability and observability. Production and use of improved seed depends on availability of the improved, high yielding and well adapted varieties (muhammed *et al.,* 2002). This is important since quality seed is one of the primary requirement for

establishing food security to farmers and the nation at large (FAO, 1999). A systematic collection and evaluation of locally available maize germplasm was initiated in 1953. Staton (1954) grew all the collected germplasm at Moor Plantation, Ibadan and suggested a maize type distribution on the basis of bran characteristics only. Van Eijnathen (1965) included colour of grain, teaselling time, number of kernel rows per ear and plant height to group the cultivated varieties into four distinct classes as follows:

(1) Western floury types – White grain – often showing some flintiness in the endosperm, relatively early maturing, of medium height with ears having up to 16 kernel rows.

(2) Eastern floury types – White floury grains – larger in size than Western floury types. Red and blue grains commonly available; medium to late maturity, medium height; less than 16 kernel rows.

(3) Southern flint – predominantly yellow flinty types; with medium to late maturity, plants are usually tall (over 2m) about 12 kernel rows.

(4) Northern flints – Predominately yellow flint types, white types often round, medium maturity and medium height about 16 kernel rows.

Adoption of early maturing varieties would enable maize production expand into new areas, especially to the Sudan savannas where the short rainy season adversely affect cultivation in the past. Availability and adoption of these varieties is a strategy for adapting maize to the gradual shortening rainy season, so that maize could tolerate or/and escape drought stress that occurs during the grain filling stage in the late season.

Adoption of these varieties in Nigeria would contribute significantly to food security and lead to improved incomes and livelihoods for farmers in Nigeria. Adoption and promotion of the varieties is also a promising strategy to appreciably increase maize production and productivity and to revolutionize agriculture in West and Central Africa.

2.7 Factors Affecting Adoption of Agricultural Technologies

There are constraints to adoption of improved varieties in rural farming communities (Nweke *et al.*, 2002). These constraints are access to information, access to credit, illiteracy and cultural and numerous socio-economic factors. In some instances, farmers reject some of the modern technology due to their cultural background and inhibiting due to religious beliefs (Teklewold *et al.*, 2002). Ebojie *et al.*(2012) in their study on socio-economic factors influencing the adoption of Hybrid Maize in Giwa Local Government Area of Kaduna state, Nigeria pointed out that age ($P<0.013$), income ($p<0.034$), education ($p<0.001$) and extension visits ($P<0.017$) were the significant factors that influenced farmers adoption of Hybrid Maize in the study area.

No doubt, the importance of farmers' adoption of new agricultural technology has long been of interest to researchers. Researchers across the globe have identified several parameters believed to be influencing farmers' decision to adopt a technology or not. Lawal *et al.* (2004) examined the adoption and assessment of improved maize varieties by farmers in Institute-of-Agricultural-Research-&Training-adopted villages in Southwest Nigeria. The findings showed that adoption of improved maize seed was 56.7 percent. Empirical evidence reveals that age, household size, education and varietal attributes were the most important factors that influenced the adoption of improved maize seed. Saka *et al.* (2005) analyzed the factors influencing adoption of improved

rice seeds in south western Nigeria. The study showed that farm size, frequency of extension contact and the yield rating of the improved rice varieties are the significant factors influencing farmers to adopt the improved rice varieties. According to Odoemenem and Obinne (2010), intensity of extension contact, amount and use of credit, cooperative membership, all of which are institutional in nature, were found to be most important factors influencing the adoption of improved cereal crop production technologies in their paper on assessing the factors influencing the utilization of improved cereal crop production technologies by small scale farmers in Nigeria. Studies have also shown that people of different socio-economic class tend to have different channel of communication through which innovations can be diffused, low level farmers are likely to start much earlier than upper level farmers in the adoption of recommended farm practices (Aiyedun, 2003).

2.8 Importance of Technology Adoption in Agriculture as it relates to Food Security

Agricultural productivity in Nigeria, as any other country, requires a continuous inflow of innovations on how farm operations could be more effectively and efficiently carried out. This requires the interaction of the research scientists, extentionist and farmers. Adoption is a mental process which an individual passes through from hearing about innovation to final adoption (Rogers, 1962, Saka *et al*., 2005). Our current trajectory with food is not sustainable. In order to have enough food there is need to improve productivity via technology adoption of improved varieties of crops. The world's population will climb to over 9 billion in the coming years, with nearly all of the growth occurring in less developed parts of the world where agricultural productivity is relatively low, such as Sub-Saharan Africa and Asia (Idachaba, 2006). This population boom will be accompanied by increased strains on our food supply and resources,

causing increased pressure on already delicate political and ecological systems, as well as threats to global food security.

According to FAO, to feed our ballooning population, global food production must increase by an estimated 70 percent, and almost double in developing countries. Moreover, we will need to address both under nutrition and over nutrition, which contribute to poor health outcomes and impose significant costs on our society. As a result, the need has never been greater for innovative solutions that will lead to significant improvements in our food and nutritional security, including greater investment in science and technology. For years, scientific and technological advancements have benefited farmers in the industrialized world by driving agriculture production. Several studies reveal that adoption of agricultural innovation has increased yield and income output, for instance, the release of TZB and TZPB that combine high yield with resistance to lowland rust and blight developed at IITA, spearheaded the first maize revolution in Nigeria in the 1980's (Smith *et al.,* 1996). The release of these varieties combined with the availability of subsidized fertilizer as well as improved infrastructure and extension services, contributed to the phenomenal increase in maize production in the country. Production figures from FAO (FAOSTAT, 2011) show that the area planted to maize in Nigeria has increased from 438,000 ha in 1981 to 3,335,860 ha in 2009 with associated increase in production from 720,000 tons to 7,338,840 tons during the same period. Grain yield was also increased from 1.6 t/ha in 1981 to 2.0. t/ha in 2009. Agricultural technology has played a central role in overcoming food security challenges in the past.

The 20th Century marked a time of significant public investments in scientific research that contributed to historical increases in food production, Coined the *Green Revolution*,

Norman Borlaug's discoveries contributed to historical increases in food production during a time of widespread hunger and malnutrition. For example, the adoption of high-yielding varieties of rice and wheat, the expansion of irrigation infrastructure, and the use of other inputs more than doubled cereal production in Asia between 1970 and 1995 (FAO,2010). As yields increased, farmers quickly adopted these technologies, resulting in increased profitably and incomes. By 1995, real per capita income nearly doubled in Asia and poverty declined from nearly three out of every five to less than one in three (FAO, 2010). Adoption of improved varieties will tackle the world's growing population food demands problem. From improved seeds, to modern crop protection solutions, to mobile technology for farmers in the fields, to making foods fresher, safer, and healthier along the food chain, the agricultural and food system of the future can be more productive, more sustainable, more efficient, and more interconnected. Greater investment in and broader adoption of science and technology can enable the world to meet the growing demand for food as the population increases by (a) improving the livelihoods of farmers and their families by producing more and higher quality crops for a growing population; (b) enhancing the nutritional value and safety of food to improve the health and wellbeing of people around the world; and (c) contributing to agriculture sustainability through reduced resource use.

2.9 Overview of Food Security in Nigeria

Food security is defined in its most basic form as access by all people at all times to the food needed for a healthy life. Achieving food security has three dimensions. First, it is necessary to ensure a safe and nutritionally adequate food supply both at the national level and at the household level. Second, it is necessary to have a reasonable degree of stability in the supply of food both from one year to the other and during the year.

Third, and most critical, is the need to ensure that each household has physical, social and economic access to enough food to meet its needs. This means that each household must have the knowledge and the ability to produce or procure the food that it needs on a sustainable basis. In this context, properly balanced diets that supply all necessary nutrients and energy without leading to overconsumption or waste should be encouraged. It is also important to encourage the proper distribution of food within the household, among all its members. Shortage of food as a result of no increase in output production can be due to sticking to old traditional practice and not embracing new technology, this problem leads to food insecurity (Agbonika, 2013).

Food security is defined as "access by all people at all times to enough food for an active and healthy life (FAO, 1996). Food security therefore, exists when all the people at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and preference for an active and healthy lifestyles (National Special Programme for food Security, 2005). Food security is a critical factor for economic growth and development of a nation, improved food security is important for global reduction of hunger and poverty and for economic development (Agbonika and Aiyedun, 2012). It has therefore invoked a global concern that calls for the need to evolve strategies that are workable and sustainable for minimizing or possibly eliminating the obstacle against full realization of universal food security (Omonona and Agosi, 2007).

Greater attention has been paid to food and nutrition issues at the levels of national government especially in the less developed countries as well as by the international community. This is in recognition of the importance of adequate food and nutrition in the development process and in supporting world peace and stability (Ojo, 2004). In

recent times, the global focus has been on food security and poverty alleviation. This is in response to increasing food insecurity and poverty in the world. The incidence of food insecurity and poverty are particularly devastating in the developing countries as a lot of resources are been channeled towards programmes aimed at eradicating food insecurity and poverty by various international organizations and government of developing nations (Babatunde *et al*., 2007).

Among the development problems facing Nigeria, food insecurity ranks topmost. The level of food insecurity has continued to rise steadily since the 1980s. It rose from about 18% in 1986 to about 41% in 2004 (Sanusi *et al*., 2006). The national per capital growth in the production of major food items in Nigeria has not been sufficient to satisfy the demand for an increasing population, as result of these there is a big gap between national supply and demand for food. Several reports have been published that shows a consistent increase in the production of staple food in the country especially between 1999 and 2005, but there is still an observable gap between food demand and food supply (Sanusi *et al*., 2006). Maziya-Dixton *et al*. (2004) reported that over 40% of households across all agro-ecological zones in Nigeria face the problem of severe food insecurity. Food insecurity therefore remains a fundamental challenge in Nigeria (Hall, 2004). The concept of the food problem is complex and goes beyond the simplistic idea of a country's inability to feed its population (Ojo, 2004). Idachaba (2006) also reported that many households and individuals in Nigeria merely eat for Survival. The fight against food insecurity therefore demands an integrated set of actions (F.A.O, 2000). Furthermore, urban areas such as those in Gwagwalada Area Council are faced with the problem of increasing population and consequently inadequate supply of food items. Due to the increasing prices of consumer items especially food, the quantity and quality

of food intake among households has continued to decrease and a large proportion of households earning is being spent on food.

The right to an adequate standard of living, including food, is recognized in the Universal Declaration of Human Rights. Food security should be a fundamental objective of development policy as well as a measure of its success. Household food insecurity affects a wide cross-section of the population in both rural and urban areas. The food-insecure socio-economic groups may include: farmers, many of them women, with limited access to natural resources and inputs; landless labourers; rural artisans; temporary workers; homeless people; the elderly; refugees and displaced persons; immigrants; indigenous people; small scale fishermen and forest dwellers; pastoralists; female-headed households; unemployed or underemployed people; isolated rural communities; and the urban poor. Increasing the productivity and incomes of these diverse groups requires adopting multiple policy instruments and striking a balance between short-term and long-term benefits.

In addition to physical access, insufficient income exacerbated by the high cost of housing, utilities, health care, and other necessities can leave very little money left in a household budget for food, especially in Abuja the nation's capital, even if it is reasonably priced. Physical access to and the affordability of food are the primary contributing factors to food insecurity in most cities across the nation. There are multiple barriers to obtaining a healthy diet in Nigeria's food system. The most commonly cited factors are cost and convenience. On a limited income, the cost of food can greatly influenced decisions about what and where to eat. Studies conducted over the course of the last two years have shown that there is need for food production to be increased (Aiyedun, 2003).

CHAPTER THREE

METHODOLOGY

3.1 Description of Study Area

This study areas are Gwagwalada and Kuje Area Councils of Federal Capital Territory, Abuja. Abuja is located between latitudes $9^0$25′and $9^0$21′ north of the Equator and Longitudes $6^0$45′ and $7^0$39′ east of the Greenwich meridian. Abuja shares boundary with Kaduna State to the north, Niger State to the west, Nassarawa and Kogi States to the east and south respectively. It covers an area of 8,000 square kilometres with a population of about 1,405, 201 people (National Population Commission- 2006). Abuja comprises of six (6) constitutionally recognised area councils namely: Abaji, Bwari, Gwagwalada, Kuje, Kwali and Abuja Municipal.

Gwagwalada Area Council has an area of 1,043 km² and a population of 157,770 at the 2006 census. Gwagwalada area council lies between latitude 07^0.57'N and longitude 07^0.7'E. Kuje area council comprises of 162 communities widely spread within a land mass of about 1,800 square kilometer and a population of over 420,000 at the 2006 census. The vegetation of these area councils combines the best features of the Southern tropical rain forest and Guinea savanna of the North (Aiyedun, 2003). This reflects the full transitional nature of the Area as between the Southern forest and Northern grassland which have the woods and shrubs respectively. The soil is reddish with isolated hills filled by plains and well drained sandy clay loams which supports farming of the major crops such as sorghum, millet, maize, melon, yam, soybean, benniseed, cassava and rice cultivation (Abuja ADP, 2004). Gwagwalada and Kuje area council has been known for agricultural activities over the years, informed of the areas agro-climatic conditions and rural characteristics with about 85% of the population who are

mostly indigenes engaged in farming activities which includes the cultivation of cereals, tuber/root crops and legumes it make the council areas suitable for this study.

3.2 Sampling Procedure and Sample Size

The study was conducted in Gwagwalada and Kuje Area Council of Federal Capital Territory, Abuja. Gwagwalada area council consists of ten wards namely: Central, quarters, ibuwa, paiko, gwako, dobi, ikwa, zuba, kutunku and tugan mage. Kuje area council consist of fifteen districts/wards namely; Kwaku, Kuje, Rubochi, Gwargwada, Kujekwa, Gaube, Tukpeki, Yenche, Dibe, Agwai, Barayi, Kebi, Huni, Ukuya, and Gudunkarya. A multi-stage sampling technique was used to select the maize farming household for this study. In the first stage two Area Councils were purposively selected which are Gwagwalada area council and Kuje Area Council. In the second stage two wards from Gwagwalada Area council and three wards from Kuje Area Council were selected purposively based on their high intensity in maize farming activities. These wards includes; Paiko, dobi, Rubochi, Gwargwada and Gudunkarya. Thirdly ten villages were selected, two from each ward based on their high level of maize production due to richness of the soil making it suitable for agricultural activities. Lastly, simple random sampling was employed in selecting 10% of the sample frame (2690) to give a sample size of 269.

Table 3.1: Distribution of sample size for the study

L.G.A	Wards	Villages	Sample Frame	Sample Size
Gwagwalada	Paiko	Kaidaganua	200	20
		Dashi	360	36
	Dobi	Kwalita	280	28
		Sauna	280	28
Kuje	Rubochi	Kogo	300	30
		Panda	230	23
	Gwargwada	gayina	300	30
		Tokolo	220	22
	Gudunkarya	Kwambara	280	28
		Angwa-maje	240	24
	Total		**2690**	**269**

Source: ADP (Gwagwalada)

3.3 Method of Data Collection

Primary data were used in this study and the data were obtained through the use of well-structured questionnaire administered to household heads using enumerators. The data collected during field survey were on the socio-economic characteristics such as age, gender, household size, farm size, farming experience, income, access to credit, number of extension contacts, level of education of household heads and income. Data on maize varieties adopted were also collected and in order to determine the food security level, data on farmers' food consumption and expenditure were collected.

3.4 Analytical Tools

Descriptive and inferential statistics were employed in the analysis of data.

3.4.1 Descriptive statistics

This includes frequency count and percentages and was used to achieve objective (v)

3.4.2 Adoption index

This was used to achieve objective (i) of the study. It is based on expressing the number of farmers adopting early maize variety technology as a percentage of the total number of farmers under study (Floyd *et al.*, 1999). It is expressed as:

$$\beta_v = \frac{\sum_{i=1}^{n} \beta_{vi}}{\sum_{i=1}^{n} \beta} \times 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where:

β_v = Adoption rate for early maize variety v

β_{vi} = Adoption of early maize variety v by ith farmers

β = Number of maize farmers (269)

i = 1, 2, ...n

$\sum$ = Summation

3.4.3 Stochastic frontier model

The stochastic frontier production function was used to achieve objective (ii) of the study and is expressed as:

$$Y = X_{it}\beta + e_{it} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\

X_2 = Quantity of seeds (Kg)

X_3 = Quantity of labour (man-days)

X_4 = Quantity of fertilizer (Kg)

X_5 = Quantity of agrochemicals (herbicides and insecticides used) (liters)

β_0 = Intercept

$\beta_1 - \beta_5$ = Coefficients for the associated independent variables

v_{it} = One sided component which captures deviation from frontier as a result of inefficiency of the farmers.

u_{it} = effect of random shocks outside the farmers control

The individual farmer's level of technical efficiency (TE_i) is then calculated as:

$$TE_i = \exp(-E[u_i/\epsilon_i])\ i, \ldots\ldots\ldots n \ldots\ldots\ldots\

P_4 = Cost of agrochemicals (₦)

P_5 = Cost of farm size (₦)

P_6 = Cost of implements used (₦)

b_0 = intercept

b_i = vector of cost parameter to be estimated

β = vector of output parameter to be estimated

v= random variability in the cost of production that cannot be influenced by the farmer.

u= the deviation from the cost frontier attributed to cost inefficiency.

Economic efficiency

The product of allocative and technical efficiencies provides a measure of economic efficiency measure, that is;

$EE = TE \times AE$..... (8)

Where: EE=Economic efficiency, TE=Technical efficiency and AE=Allocative efficiency. All the efficiency measures are bounded by zero and one. The estimates for all the parameters of the stochastic frontier production and cost functions were obtained using the programme FRONTIER 4.1.

3.4.4 Logit regression model

Logit regression model was used to achieve objective (iii) of this study. The probability of maize farmer adopting early maize variety is determined by an underlying response variable that captures the true economic status of a farmer. The underlying response variable y* in the case of binary choice is defined by logit regression relation:

$y^* = \Sigma x_i \beta_j + \mu$

Where:

$\beta_j = \beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7, \beta_8, \beta_{9,} \beta_{10}$

$X_i = X_{i1}, X_{i2}, X_{i3}, X_{i4}, X_{i5}, X_{i6}, X_{i7}, X_{i8}, X_{i9,} , X_{i10}$

μ = stochastic term

The relevant logistic expressions are given as:

$$Prob(y* = 1) = 1 - F * (\Sigma X_i \beta_j) = \frac{e^{\Sigma X_i \beta_j}}{1 + e^{\Sigma X_i \beta_j}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (9)$$

$$Prob(y* = 0) = F * (\Sigma X_i \beta_j) = \frac{e^{\Sigma xi \beta j}}{1 + e^{\Sigma xi \beta j}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (10)$$

Where:

F = The cumulative distribution function for $\mu_{i,\ldots}$

The explicit logit model is expressed as:

$$Y = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots + \beta_{10} X_{10} + u \ldots\ldots\ldots (11)$$

Where:

Y = adoption (1= adoption of early maize variety, 0 = non-adoption of early maize variety)

X_1 = Age of household head (years)

X_2 = Marital status (Married= 1, single = 0)

X_3 = Farming experience (years)

X_4 = Education (years of formal schooling)

X_5 = Household size (number)

X_6 = Farm size (hectares)

X_7 = Access to credit (Naira)

X_8 = Membership of cooperative (years)

X_9 = Household income (Naira)

X_{10} = Extension contact (Number of contacts)

$\beta_1 - \beta_{10}$= The coefficients for the respective variables in the logit function

μ = error terms

3.4.5 T-Test

This was used to handle part of objective (iv). It is based on comparison of the means of adopters and non-adopters of improve maize crop. It was also used to test hypotheses ii and iii of the study. The t-statistic is expressed as follows:

$$T = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \ldots\ldots\ldots\ldots\ldots (12)$$

Where T = calculated T value

$\overline{X_1}$ = Mean income of the farmers that adopt early maize variety.

$\overline{X_2}$ = Mean income of the farmers that did not adopt early maize variety.

S_1= Standard deviation of the income of farmers that adopt maize early variety.

S_2 = Standard deviation of the income of farmers that did not adopt early maize variety.

n_1= Sample size of the farmers that adopt maize early variety.

n_2 = Sample size of the farmers that did not adopt early maize variety.

3.4.6 Food security line

This was used to achieve part of objective (iv). This was used to classify farmers household into either food secure or food insecure depending on which side of the line

they fall. The food security line is the recommended daily per capita calorie intake of 2260 kilo calorie (FAO, 1996). A farmer whose daily per capita calorie intake is up to 2260 kilo calorie intake was regarded as food secure and those whose daily per capita calorie intake is below 2260 kilo calorie were regarded as food insecure.

The food security line is given as:

$$Z = {}^{Yi}/_{R} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (13)$$

Where:

Z_i = food security status of ith farmers.

Y_i = daily per capita calorie intake of ith farmers

R = recommended per capita daily calorie intake (2260 kilo calorie)

Z_i = 1 for Y_i greater than or equal to R

Z_i = 0 for Y_i less than R

Additionally, the shortfall/surplus index and the headcount ratio of food security were calculated for the sampled farmers' household based on the food security line. The shortfall index (P) measures the extent to which poor farmers household are food insecure while the headcount ratio (H) measures the percentage of the population of farmers household that are food insecure/secure.

$$\text{Shortfall Index (P)} = \frac{1}{M}\left(\sum_{i=j}^{M} G_i\right) = \frac{1}{M}\left(\sum_{i=j}^{M} \frac{Y_i - R}{R}\right) \ldots\ldots\ldots\ldots\ldots\ldots (14)$$

$$\text{Head Count Ratio (H)} = \frac{M}{N} \ldots\ldots\ldots\ldots\ldots\ldots (15)$$

Where:

M = The number of food insecure households

G_i = Per capita calorie intake deficiency for ith household

N = Number of households in the sample

3.5 Operational Definitions and Measurement of Variables

a. **Age**: This is the farmer's years showing how old he is. The ability to learn fast and decide on certain key issues and act favourably to certain information depends on the age of the individual. Young people do understand faster than old people but older people have better ways of perception and think deeply before acting. To know the age of the respondent, the actual years the individual has lived as given by him/her. A priori expectation is that age will be a significant factor in early maturing maize adoption.

b. **Education:** This refers to the acquisition of knowledge through formal means. Educational attainment of a household head is considered to be a qualitative variable. Individual's level of education was measured by the number of years a respondent had spent in formal education. The expected impact on adoption, income and food security is positive.

c. **Household size:** The size of a family is an important factor in traditional agriculture because it influences to a large extent the supply of labour for immediate farm employment (Akinyemi, 1998). This will be based on the number of people in a household. A priori expectation is positive.

d. **Farm size:** This is the size of land owned and cultivated by the farmer. It will be given as estimated total area of land in hectares owned and cultivated by a respondent. A priori expectation is positive.

e. **Farming experience:** This refers to the number of years that a respondent has actively involved in farming operation. This will be measured in years the

respondent reported. This is expected to positively influence adoption of early maize.

f. **Output (kg):** This is the product harvested and is measured in kg**.**

g. **Access to Credit:** This refers to access to credit from both formal and informal sources. It was measured as the amount of credit obtained. The farmers' access to credit is expected to enhance their timely acquisition of production inputs that would enhance productivity. This is expected to have a positive influence on adoption.

h. **Labour**: This is the involvement of the family and other people outside the household in production process. A priori expectation is positive.

i. **Income**: This was measured in naira. The amount a farmer realizes in farming maize yearly. It is expected to positively affect adoption.

j. **Membership of association:** In this study, it was measured by the number of years the respondent claimed to belong as at the time the study was conducted. A priori expectation is positive.

k. **Extension contact:** This is the number of contact between extension officials and the farmers. Visitation of extension agent gives the detail of how well informed farmers can be on certain technology. This will be measured on the number of contacts and visits a respondent reported to have had with the extension agents. A priori expectation is positive.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Rate of Adoption of Early Maturing Maize in the Study Area

The estimated adoption rate of the early maize variety cultivated by farming households in the study area is shown in table 4.1. The result showed that a larger proportion of farming households adopted DMR-ESR Y CIF2 with an adoption rate of 21% which implies that 21% of the farmers of early maize varieties in the study area adopted DMR-ESR Y CIF2. TZE COMP 3 DT C3 had an adoption rate of 10% implying that 10% of the respondents adopted TZE COMP 3 DT C3. Adoption rate of TZE-W DT STR C4 was estimated to be 11% which implies that 11% of the respondents adopted TZE-W DT STR C4. AC 90 POOL 16 DT STR had an adoption rate of 17% implying that 17% of the farmers of early maize varieties in the study area adopted AC 90 POOL 16 DT STR and TZE- WDT STR QPM C0 had the lowest adoption rate of 7% indicating that TZE- WDT STR QPM C0 was only adopted by 7% of the respondents in the study area. The proportion of farmers using a technology is a social indicator of farmers' interest in the technology (Ndjuenga *et al.*, 2008) and therefore, the high adoption rate of DMR-ESR Y CIF2 is an indication of farmers' interest on it relative to other early maize varieties in the study area.

These six early varieties (DMR-ESR Y CIF2, AC 90 POOL 16 DT STR, TZE-W DT STR C4, ACR 95TZE COMP4 C3, TZE- WDT STR QPM C0 and ACR 95TZE COMP4 C3) contain certain attributes of drought escape and could adapt better to late season moisture stress than late maturing counterparts especially in the erratic rainfall pattern of the SGS agro-ecology (Shi *et al*., 2008; Wang *et al.*, 2011). They fit into the hunger gap in the savanna zones that normally occurs before the years crops mature.

They are also used for early and late planting when the rains are delayed and fit very well into intercropping systems because they are less competitive with the component crops (Ibikunle *et al.*, 2009).

Table 4.1: Rate of adoption of early maize varieties in the study area

Technology	Maize Farmers (n = 269)	
	Adopters	Adoption Rate (%)
DMR-ESR Y CIF2	56	21
TZE COMP 3 DT C3	28	10
TZE-W DT STR C4	30	11
AC 90 POOL 16 DT STR	45	17
TZE- WDT STR QPM C0	20	7
ACR 95TZE COMP4 C3	33	12

4.2 Efficiency in Early Maturing Maize Production

4.2.1 Technical efficiency of the farmers

Table 4.2 shows the estimates of the parameters for the stochastic frontier production function and the variance parameters of the model. The variance parameter of Sigma (δ^2) was 1.548 for the farmers and statistically significant at 1%, this indicates a good fit and correctness of the distributional form assumed for the composite error term. The gamma (γ) which is the proportion of deviation from frontier that is due to inefficiency estimate was 0.953 and was statistically significant at 1%; it shows the amount of variation resulting from the technical inefficiency of early maize farmers. This means that more than 95% of the variation in the farmer's outputs respectively is due to differences in technical efficiency.

Farm size: The estimated coefficient for farm size (0.566) for the farmers was positive and statistically significant at 1%. This implies that a 1% increase in farm size will

ceteris paribus lead to an increase of 0.566% in maize output. This increase is inelastic because a 1% increase in the input lead to a less than 1% increase in the output.

Seed: The estimated coefficient for seed was positive and statistically significant at 1% for the farmers. This implies that an increase in seed will increase lead to an increase in the output of maize. The significance of seed quantity is due to the fact that seed determines to a large extent the output obtained. If correct seed rates and quality seeds are not used, output will be low even if other inputs are in abundance.

Labour: The coefficient of labour is 0.004; it is positive but not significant. This implies that increasing labour will increase production but not significantly. This is contrary to the findings of Adeoye *et al*. (2011) who reported coefficient of labour (0.10) positive and statistically significant at 1% level of probability among watermelon farmers in Oyo state of Nigeria.

Fertilizer: The production elasticity of output with respect to quantity of fertilizer was 0.638, positive and statistically significant at 1% for the maize farmers. This implies that an increase in fertilizer use will increase output for the farmers. Fertilizer is a major land augmenting input because it improves the quality of land by raising yields per hectare.

Pesticides: The estimate for pesticides was positive and statistically significant at 10% for the farmers. This implies that an increase in the use of pesticides will lead to an increase in the output of maize.

Table 4.2: Estimates of technical efficiency model for the adopters of early maturing maize

Variable	Coefficient	Std Error	T-ratio
Constant (β_0)	5.911	0.470	12.57***
Farm size (β_1)	0.566	0.119	4.76***
Seed (β_2)	1.166	0.081	14.41***
Labour (β_3)	0.004	0.039	0.089
Fertilizer (β_4)	0.638	0.129	4.96***
Pesticides (β_5)	0.189	0.104	1.81*
Sigma squared	1.548	0.343	4.508***
Gamma	0.953	0.016	58.39***

*** P < 0.01, ** P < 0.05, * P < 0.1

4.2.2 Frequency distribution of the technical efficiency of the farmers

The general distribution of the farmer's efficiency presented in Table 4.3 showed that majority (78%) of the farmers fall between technical efficiency positions of 61% and 100% with a minimum of 1% and a maximum of 91%. The implication of the result is that farmers in the study area had wide differences in their technical efficiency operation. Result obtained by Bifarin *et al*. (2010) indicated that over 72% of the plantain farmers in Ondo State were operating above 50% technical efficiency. The mean technical efficiency of the farmers was 71%. This implies that the farmers can increase their technical efficiency level by 29% using available resources. Therefore, there is need to increase production by utilizing the available resources.

The mean technical efficiency of the farmers was 71%. This implies that on the average, the respondents are able to obtain about 71% of potential output from a given mix of production inputs. Thus, in the short-run, there is a scope for increasing maize production by 29%, by adopting the technologies or techniques used by the most technical efficient farmers in maize production. Generally, a negative sign on a variable means that the variable reduces technical inefficiency, while a positive sign increases technical inefficiency.

The mean technical efficiency (TE) indices ranged from 1 to 91% for the respondents in the sample, with an average of 71%. If the average farmer in the sample was to achieve the technical efficiency level of its most efficient counterpart, then the average farmer could realize a 21% cost savings (1 − [71/91]*100). Meanwhile, the most technically inefficient farmer reveals cost savings of 98% (1 − [1/91]*100). The coefficient of variation (CV) of 27% implies that the technical efficiency did not vary widely among the farmers.

Table 4.3: Frequency distribution of the technical efficiency of early maize farmers

Technical efficiency range	**Frequency**	**Percentage**
0.01-0.20	12	7
0.21-0.40	6	3
0.41-0.60	25	12
0.61-0.80	112	53
0.81-1.00	57	25
Total	**212**	**100**
Mean	0.71	
Minimum	0.01	
Maximum	0.91	
SD	0.19	
CV (%)	26.55	

4.2.3 Allocative efficiency of the farmers

Table 4.4 contains the estimates of the parameters for the stochastic frontier cost function for allocative efficiency and the variance parameters of the model. The variance parameter of sigma (δ^2) was 2.191 and statistically significant at 1% level. The gamma estimate was 0.955 and statistically significant at 1% level of probability, meaning that 96% variation in the cost of production was due to differences in their

allocative efficiencies. The mean allocative efficiency of the farmers was 48%. This indicates that about 48% of the variations in the total cost of production of early maize farmers were due to differences in their allocative efficiencies.

Seed: The estimated coefficient for seed (0.634) was positive and statistically significant at 1% level of probability, implying that cost of production increases by the value of the coefficient (0.634) as the quantity of the variable is increased by 1%. This finding agrees with Okoruwa and Ogundele (2006) who examined technical efficiency differentials in maize production technologies in Nigeria. They reported that the coefficient of seed was positive and significant for traditional technology and that increase in seed would increase output levels of maize farmers.

Farm size: The coefficient of farm size (0.159) was positive and statistically significant at 1% level meaning that cost of production increases by the value of the coefficient as the quantity of the variable is increased by 1%. This result agrees with the finding of Muhammad–Lawal *et al*. (2009) who worked on the technical efficiency of youth participating in agriculture programme in Ondo State, Nigeria. They reported that farm size was positive and significant and that increase in the farm size would increase output level of farmers.

Agrochemicals: The coefficient of agrochemical was 0.125 and statistically significant at 5% level of probability implying that the cost of production increases by the value of the coefficient as the quantity of the variable is increased by 5%. This finding agrees with the result of Amaza and Maurice (2005) who reported positive and significant coefficient of agrochemicals in rice-based production system in Nigeria.

Farm implements: The value of farm implements (0.089) was positive and statistically significant at 1% level of probability meaning the cost of production increases by the value of the variable as the quantity is increased by 1%. This agrees with several other studies such as Muhammad-Lawal *et al.* (2009) and Amaza and Maurice (2005) who reported that coefficient of farm implement was positive and significant and that increase in usage would result in increase in output levels in farm production.

Table 4.4: Maximum likelihood estimates of the stochastic frontier cost function for early maize producers.

Variables	**Coefficient**	**std error**	**t-ratios**
Constant	4.198	0.950	4.421***
In cost of seed	0.634	0.084	7.520***
In cost of farm size	0.159	0.054	2.952***
In cost of agrochemicals	0.125	0.062	2.032**
In cost of fertilizer	-0.015	0.021	-0.681
In cost of labour	-0.053	0.059	-0.887
In cost of farm implements	0.089	0.026	3.447***
Sigma (δ2)	2.191	0.361	6.063***
Gamma (γ)	0.955	0.010	99.711***
Log likelihood	-60.48		
Mean allocative efficiency	0.254		

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

4.2.4 Frequency distribution of allocative efficiency of the farmers

The frequency distribution of allocative efficiencies is presented in Table 4.5. The mean allocative efficiency of the farmers was 0.482, the maximum value was 0.977 and minimum was 0.095. This implies that if the average farmer in the study area was to achieve allocative efficiency of his most efficient counterpart, then the average farmer

could realize 51% cost savings (1 – (0.482/0.977) x 100. The most inefficient farmer could realize cost savings of 90% (1 – 0.095/0.977) x 100 to become the most efficient farmer.

Table 4.5: Frequency distribution of allocative efficiency of early maize farmers

Efficiency	**Frequency**	**Percentage**
0.01-0.20	56	26
0.21-0.40	8	4
0.41-0.60	130	61
0.61-0.80	8	4
0.81-1.00	10	5
Total	**212**	**100**
Mean	0.482	
Minimum	0.095	
Maximum	0.977	

4.2.5 Economic efficiency of the farmers

Economic efficiency was calculated as the product of technical efficiency and allocative efficiency.

Mean technical efficiency × Mean allocative efficiency = Economic efficiency

$0.71 \times 0.482 = 0.342$

The results show that the maize farmers in the study area are not economically efficient in producing maize though there is room for more improvement. Economic efficiency of 34% indicates that the farmers can still reduce input cost by 66%, while maintaining the same output, or they can increase output by 66% while still maintaining the same input cost and technology. The allocative efficiency scores were high as majority (70%)

lie between 41 and 100%. We therefore reject the null hypothesis, meaning that early maize variety adopters are economically inefficient.

4.3 Factors Influencing Adoption of Early Maize Varieties in the Study Area

The maximum likelihood estimates of the parameters of the logistic regression of factors influencing the adoption of early maturing maize varieties are presented in Table 4.6. The log-likelihood statistic of 36.0031 is significant at 1% probability level and this indicates the joint significance of the independent variables included in the model. The overall percentage of the adoption of early maize varieties correctly predicted seems good at 68% in comparison to the 100% prediction of a perfect model.

Major drivers of adoption of early maize varieties in the study area were found to be marital status of household head, farming experience, education, membership of cooperative societies, household income and extension contact. Age of household head, credit, farm size and household size were found to be insignificant in influencing adoption of early maize varieties in the study area.

Marital status: This was found to be positive and significant at 1% probability level with an odd ratio of 6.8544. This finding disagrees with Voh *et al.* (2001) who noted that marital status was not significant in influencing adoption of improved cowpea varieties in the Savanna ecology of Nigeria. This result indicates that a farmer produce not only for sale but to feed his family. The implication here is that the farms would have greater attention from responsible members of the family.

Farming experience: This was positively related to maize farming households' adoption of early maize varieties and was significant at 10% probability level. The odd

ratio of 1.0318 indicates that a unit increase in farming experience will increase the probability of the maize farming households' adoption of early maize varieties by a magnitude of 1.0318. This finding agrees with Ayoola (2012) who reported a positive and significant relationship between adoption of yam minisett technology and farming experience in the Middle belt region of Nigeria. This is expected because more experienced farmers may have better skills and access to new information about improved technologies. It could also imply that knowledge gained over time from working in uncertain production environment may help in evaluating information thereby influencing their adoption decision.

Education: Education was positively related to maize farming households' adoption of early maize varieties and was significant at 1% probability level. The odd ratio of 1.0773 indicates that a unit increase in the educational level of the maize farming households will increase the probability of adoption of early maize varieties by a magnitude of 1.0773. Education enables one to access information needed to make a decision to practice a new technology. This is in agreement with (Kudi *et al*., 2011; Ambali *et al*., 2012) who in their respective studies found that education is a significant factor in facilitating awareness and adoption of agricultural technologies. This is consistent with literature that education creates a favourable mental attitude for the acceptance of new practices especially of information-intensive and management-intensive practices. The implication of this is that farm households with well educated members are more likely to adopt modern agricultural production technologies than those without.

Membership of Cooperative: This was found to be positive and significant at 10% probability level with an odd ratio of 1.6704 which suggests that a unit increase in years

of participation in cooperative societies by the maize farming households will increase the probability of the maize farming households' adoption of early maize varieties by a magnitude of 1.6704. A plausible explanation for this is that the membership of social organizations such as cooperative society enhances the interaction and exchange of ideas on agricultural technologies among farmers and thereby influencing the adoption decision of their members.

Household income: This was negatively related to the probability of maize farming household that adopted early maize and was significant at 10% probability level. The odd ratio of 0.9999 indicates that a unit increase in the income of the maize farming households will have the tendency of reducing their adoption of early maize varieties by a magnitude of 0.9999. This result is against *a priori* expectation and a plausible explanation for this is that an increase in household income could stimulate the households to invest in other business ventures other than investing in the purchase of improved maize varieties or an increase in income could be channeled towards meeting pressing household needs instead of purchasing improved maize varieties. This finding is not in consonance with Bello *et al*. (2012) who posited a positive relationship between crops based technologies and income in Jenkwe Development Area of Nasarawa State, Nigeria.

Extension contact: This was negatively related to the probability of maize farming household adoption of early maize varieties. The result was significant at 10% probability level with an odd ratio of 0.9460 which indicates that a unit increase in extension contact will decrease the probability of the maize farming households' adoption of early maize varieties. This result is against *a priori* expectation. This could be due to the fact that full time farmers are always missing out on information because

of their long stay on the farm. Most of them occasionally do not attend trainings and also do not avail themselves of the opportunity to meet with extension agents through which Information about improved seeds could be obtained. The implication is that access to extension services creates the platform for acquisition of the relevant information that promotes technology adoption and therefore, access to information through extension services reduces the uncertainty about a technology's performance hence may change farmer's assessment from purely subjective to objective over time thereby facilitating adoption.

The non-significance of age of household head and farm size in influencing adoption of early maize varieties agrees with the finding of Ndjuenga *et al.* (2008) who also found out that age of household head and farm size were not significant in influencing adoption of modern groundnut varieties in Nigeria in a study of early adoption of modern varieties of groundnut in West Africa. Amount of credit obtained was not significant in influencing adoption behavior of groundnut farming households and this is in line with the findings of Saka and Lawal (2009) who also establish that there was no significant relationship between adoption of improved rice varieties and credit. Also, Alarima *et al.* (2011) established that there was no significant relationship between adoption of Sawah rice technology and credit. The non-significant relationship between adoption of early maize varieties and household size as well as farm size agrees with Akinola *et al.* (2007) who noted that household size and farm size were not significant in influencing adoption of balanced nutrient management systems technologies in the northern Guinea savanna of Nigeria.

Table 4.6: Logit regression estimates of factors influencing the adoption of early maize varieties

Variable	Coefficient	Standard error	T-value
Constant	-1.0798	0.7445	-1.4503
Age	-0.2359E-01	0.1755E-01	-1.3440
Marital status	6.8544	0.6163	3.1232***
Farming experience	1.03180E-01	0.1777E-01	1.7671*
Education	1.0773E-01	0.2677E-01	2.7814***
Household size	-0.1466E-01	0.2882E-01	-0.5086
Farm size	-0.3132E-01	0.3491E-01	-0.8972
Credit	-0.4250E-04	0.4159E-04	-1.0218
Cooperative society	1.6704	0.2800	1.8321*
Household income	-0.9999-06	0.5064E-06	-1.8969*
Extension contact	-0.9460E-01	0.3341E-01	-1.6616*
Log likelihood ratio test	36.0031		
Pseudo R-square	0.11		

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

4.4 Impact of Early Maize Varieties on the Income and Food Security Level of Maize Farming Households

4.4.1 Impact of early maize varieties on the income of maize farming households

From the result of the frequency distribution of the annual income of adopters and non-adopters of early maize varieties in table 8, 11% of the maize farming households that adopted early maize varieties fall within the highest annual income range of above ₦599, 000 while in the case of the non-adopters, about 18% fall within the annual income range of above ₦ 599,000. 10% of the adopters are within the lowest annual income range of less than ₦ 100, 000 as opposed to 14% of the non-adopters of the varieties. The mean annual income of the respondents that adopted early maize varieties (₦ 412,720) is higher than the mean annual income of non-adopters of the varieties (₦

276, 844) which implies that the adopters of early maize varieties realized higher income than the non-adopters of the varieties. The result of the T statistic in table 4.8 clearly shows that the difference between the annual income of the respondents that adopted early maize varieties and those who did not is significant thereby implying that adoption of early maize varieties had an impact on the income of the farming households that adopted the varieties which contributed in enhancing the income of the farmers. Similar results were observed in previous studies which show a positive impact of the adoption of agricultural technologies (de Janvry and Sadoulet, 2002; Mendola, 2007 and Diagne *et al.,* 2009). The standard deviation of the income of the farming households that adopted early maize varieties (369, 670) is higher than that of farming households that did not adopt the varieties (186,423) which imply that there is a higher variability in the income of adopters than the non-adopters.

Table 4.7: Frequency distribution of the annual income of adopters and non-adopters of early maize varieties

Income range(₦)	**Adopters**		**Non-adopters**	
	Frequency	**Percentage**	**Frequency**	**Percentage**
<100,000	22	10	8	14
100, 000 - 199, 000	63	30	14	25
200, 000 - 299, 000	44	20	12	21
300, 000 - 399, 000	40	19	7	12
400, 000 - 499, 000	8	4	3	5
500, 000 - 599, 000	12	6	3	5
> 599, 000	23	11	10	18
Total	**212**	**100**	**57**	**100**
Minimum	82,000		63,000	
Maximum	2,242,000		1,150,000	
Mean	412,720		276,844	
Standard deviation	369,670		186,423	

T-test of impact on income of farmers

The result of the T test as presented in table 4.8 shows a significant difference between the income status of adopters and non-adopters. The mean annual income of the respondents that adopted early maize varieties (₦ 412,720) is higher than the mean annual income of non-adopters of the varieties (₦ 276, 844) which implies that the adopters of early maize varieties realized higher income than the non-adopters, and it is significant at 10% probability level. This implies that there is significant different between the income of households who adopted early maize varieties and those that did not adopt. Therefore, the null hypothesis is rejected and the alternative accepted. This suggests that early maize varieties contribute in enhancing the income of the adopters of the varieties and therefore, non-adopters can increase their income level through adoption of early maize varieties.

Table 4.8: T-test of impact on income

Category	Mean income	N	Standard Deviation	t-value	t-critical
Adopters	412,720	212	369,670	1.886*	1.652
Non-adopters	276,844	57	186,423		

*P<0.10

4.4.2 Impact of early maize varieties on the food security level of the farming households

The result of the food security status of the respondents is presented in Table 4.9. In this study, a one month (30 days) recall method was used. The food security line of daily 2260 kcal by FAO (1996) was adopted in this study. The household's calorie intake was

obtained through the household's consumption and expenditure data. From the data, the quantity of every food item consumed by the households in the 30 days period was estimated. The quantities were converted to gram and the calorie content estimated using the nutrient composition table of commonly eaten foods in Nigeria (Oguntona and Akinyele, 1995). Per capita calorie intake was calculated by dividing estimated total household calorie intake by the family size after adjusting for adult equivalent using the consumption factors for age-sex categories. To get the household's daily per capita calorie intake, the household's per capita calorie intake was divided by 30. A household whose daily per capita calorie intake is up to 2260 kcal was regarded as food secure and those below 2260 kcal were regarded as food insecure households.

Based on the recommended daily calorie intake (R) of 2260 kcal, the headcount ratio shows that 79% of the adopters with an average daily per capita household calorie consumption of 3606.30 kcal were food secure and 21% of this group with an average daily per capita calorie consumption of 1673.62 were food insecure. The headcount ratio for non-adopters indicates that 44% of the households were food secure with an average daily per capita calorie consumption of 3190.68 kcal and 56% were food insecure with an average daily per capita calorie consumption of 1599.17 kcal. Adopters had a surplus index of 0.60 and the least shortfall index of 0.26 indicating that food secure households under adopters exceeded the calorie requirement by 60% while the food insecure households in this group fell short of the recommended calorie intake by 26%. A shortfall index of 0.29 and a surplus index of 0.64 for non-adopters indicate that food insecure households in this group fell short of the recommended calorie intake by 29% while food secure households exceeded the calorie requirement by 64%. This is similar to results obtained by Agbola *et al.* (2008) in their study on the impact of income diversification strategies on food insecurity status of farming households in

Africa. They reported that based on the recommended daily calorie intake of 2260 kcal, 82% of the households were food secure and 18% were food insecure for households that combined crop production with livestock production. Based on the headcount ratio, it is expedient to infer that early maize adopters were more food secure ($P<0.10$) than non-adopters.

From the food security profile of the adopters and non-adopters of early maize varieties, it can be deduced that the adopters had a lower food insecurity level than the non-adopters and this implies that adoption of early maize varieties has contributed in enhancing food security among adopters of the varieties. Therefore, adoption of early maize varieties can be a panacea for food insecurity among maize farming households and hence, the fight against the menace of food insecurity among rural farming households who are into maize production can be fostered by encouraging adoption of early maize varieties among the households. This result is consistent with other related studies on the impact of agricultural technologies on food security (Mendola, 2007; Mignouna *et al*., 2011; Omilola, 2009).

Table 4.9: Distribution of the respondents by their food security level

Statistical estimates	Adopters		Non-adopters	
	Food secure	Food insecure	Food secure	Food insecure
No of observation	168	44	32	25
Average daily calorie intake (kcal)	3606.30	1673.62	3190.68	1599.17
Maximum daily calorie intake (kcal)	19231.90	2248.63	7248.80	2245.83
Minimum daily calorie intake (kcal)	2261.31	926.14	2279.24	726.50
Shortfall/surplus Index (P)	0.60	-0.26	0.64	-0.29
Head count ratio (H)	0.79	0.21	0.56	0.44
Standard deviation	1544.47	391.01	1310.37	382.23

T-test of hypothesis III of the study

Table 4.10 shows the result of the hypothesis test comparing the means of the food security status of adopters and non-adopters. The result showed a significant difference between the food security status of adopters and non-adopters of the early maize varieties. Since the average calorie intake of adopters is greater than the average calorie intake of non-adopters with a significant t- value ($P<0.10$), the null hypothesis which states that adoption of early maize variety has no significant impact on food security level of the maize farming households is therefore rejected. This implies that there is a significant difference in the food security level of adopters and non-adopters of early maize varieties. Therefore, the adoption of early maize varieties has contributed in

enhancing food security status of farming households who adopted early maize varieties in the study area.

Table 4.10: T-test of hypothesis II

Category	Mean income	N	Standard Deviation	t-value	t-critical
Adopters	2778.010	212	1530.228	1.628*	1.962
Non-adopters	2484.903	57	1375.723		

*P<0.10

4.5 Constraints Faced by Farmers in Maize Production

Table 4.11 shows the distribution of farmers based on constraints faced in maize production and are discussed according to their ranking. These problems were affecting the profits they could realize.

4.5.1 High cost of inputs

The farmers ranked high cost of inputs such as fertilizers, agrochemicals and improved seeds as their 1st constraint. About 94% of the respondents identified this as a problem. Most of the farmers are forced to buy their fertilizer from the open market. Most times when new yields like early maize varieties are released into the market, farmers rarely get them because some people hoard them to resell at expensive rates, thereby forcing farmers to rely on the old varieties they are familiar with because the cost per hectare will be too exorbitant for them. High cost of agrochemicals also cannot be unconnected to the fact that farmers are made to buy these chemicals from open markets as against

government provision. This increases their cost of production and subsequently reduces their profit.

4.5.2 Inadequate finance

The sampled maize farmers identified inadequate finance as a constraint; hence, it was ranked the 2nd constraint by the maize farmers (91%). Only a few farmers had access to the banks through cooperative societies with strict conditions to borrow. The farmers did not have the necessary collaterals required by banks and therefore depend on personal savings.

4.5.3 High cost of labour

Ranked 3rd constraint by the farmers was problem of High cost of labour. It was highlighted by about 82% of the respondents. The farmers said they experienced problems (high cost of labour) as it becomes very expensive during the peak period of operations.

4.5.4 Poor market price

About 70% of the maize farmers reported Poor/low maize price at harvest. It was ranked 4th among the constraints. This was because most of the maize farmers sold their products at harvest time when there is over supply or glut in the market. This cannot be unconnected to the unorganised nature of our rural markets. Market information flow as regards good prices is a major challenge in this aspect. Markets are located in far areas which induce the farmers to sell at give away prices. This makes farmers not to have steady pricing trend which they can predict at any time. The inconsistent trend of prices forces farmers to sell their produce as soon as they notice a rise in price.

4.5.5 Low extension contact

Some of the maize farmers stated that Low of extension services (57%) in terms of accessibility to information on improved farm technologies is hindering their maximum productivity. It ranked least (5^{th}) among the identified constraints.

4.5.6 Problem of transportation

Harvested farm produce are transported with great difficulties from the farms to market or points of processing. The farm products are mostly transported to the market for sale. Therefore, both categories of farmers ranked high cost of transportation 6^{th} constraint among the constraints encountered by them. About 47% of had this challenge. This cannot be unconnected to the bad roads in the area which makes some roads inaccessible by vehicles rather they use motorcycle, hence, charges are high. Erratic fuel prices and its scarcity is also a factor in this case. The difficulty in getting transport to market their produce leads to these farmers being exploited by hawkers and people with their own private transport, thereby causing a decline in returns.

Table 4.11: Distribution of farmers based on constraints faced in maize farming

Constraints	**Frequency**	**Percentage**	**Rank**
High cost of Inputs	252	94	1
Lack of finance	246	91	2
High cost of labour	222	82	3
Poor/low maize price at harvest	188	70	4
Low extension contact	152	57	5
Problem of Transportation	126	47	6

*Total frequency is more than 269 due to multiple responses

CHAPTER FIVE

SUMMARY, CONCLUSION, RECOMMENDATIONS AND CONTRIBUTION OF STUDY TO KNOWLEDGE

5.1 Summary

The study investigated impact of adoption of early maturing maize technology on productivity and food security status in Gwagwalada and Kuje Area councils of Abuja. The specific objectives were to examine the rate of adoption of early maize technology, determine the economic efficiency of the farmers that adopted early maize varieties, determine the factors that influence the adoption of early maize variety, determine the impact of adoption of early maize varieties on income and food security of farmers in the study area, and identify the problems faced by maize farmers in the study area. A multi-stage sampling technique was used to select the maize farming household for this study to give a sample size of 269. Data collected with the aid of structured questionnaire were analysed using descriptive statistics, stochastic frontier production function, adoption index, logit regression model, T-statistic, and food security index.

DMR-ESR Y CIF2 was identified as the variety adopted by a larger proportion (21%) of the maize farming households in the study area, followed by COMP 3 DT C3 which had an adoption rate of 10%, TZE-W DT STR C4 was estimated to be 11%, AC 90 POOL 16 DT STR had an adoption rate of 17%, and TZE- WDT STR QPM C0 with 7%. Reasons for their adoption could be traced to the fact that they contain certain attributes of drought escape and could adapt better to late season moisture stress than late maturing counterparts especially in the erratic rainfall pattern of the SGS agro-ecology. The results show that the maize farmers in the study area are not very efficient in producing maize though there is room for more improvement. Economic efficiency

was calculated as the product of technical efficiency and allocative efficiency to be 0.342. This indicates that 34% of the farmers can still reduce input cost by 66%, while maintaining the same output, or they can increase output by 66% while still maintaining the same input cost and technology.

Major drivers of adoption of early maize varieties in the study area were found to be marital status, farming experience, education, membership of cooperative societies, household income and extension contact. Age of household head, credit, farm size and household size were found to be insignificant in influencing adoption of early maize varieties in the study area. Findings from the research showed that 11% of the maize farming households that adopted early maize varieties fall within the highest annual income range of above ₦599, 000 with 18% for non-adopters. 10% of the adopters are within the lowest annual income range of less than ₦100, 000 as opposed to 14% of the non-adopters of the varieties. The mean annual income of the respondents that adopted early maize varieties (₦ 412,720) is higher than the mean annual income of non-adopters of the varieties (₦ 276, 844) which implies that the adopters of early maize varieties realized higher income than the non-adopters of the varieties. The result of the t statistic clearly shows that the difference between the annual income of the respondents that adopted early maize varieties and those who did not is significant thereby implying that adoption of early maize varieties had an impact on the income of the farming households that adopted the varieties.

Based on the recommended daily calorie intake (R) of 2260 kcal, the headcount ratio shows that 79% of the adopters with an average daily per capita household calorie consumption of 3606.30 kcal were food secure and 21% of this group with an average daily per capita calorie consumption of 1673.62 were food insecure. The headcount

ratio for non-adopters indicates that 44% of the households were food secure with an average daily per capita calorie consumption of 3190.68 kcal and 56% were food insecure with an average daily per capita calorie consumption of 1599.17 kcal. From the food security profile of the adopters and non-adopters of early maize varieties, it can be deduced that the adopters had a lower food insecurity level than the non-adopters ($P<0.10$). The T statistic shows a significant difference in the food security status of adopters and non-adopters of implying that adoption of early maize varieties had an impact on the poverty status of the maize farming households that adopted early maize varieties.

5.2 Conclusion

The study concluded that the cultivation of early maize varieties can be enhanced through increased availability of the varieties. The adoption of early maize varieties has contributed to the increased income and food security status of farming households in the study area. This suggests that early maize varieties contribute in enhancing the income of the adopters. It can also be concluded that the adopters of the early maize varieties had a lower food insecurity status than non-adopters and this implies that adoption of these varieties has contributed in enhancing food security among adopters.

5.3 Recommendations

Based on the findings of this study, the following recommendations were made:

1. Adoption of early maize varieties can be enhanced through the increased availability of early maize varieties as some farmers are very much interested in cultivating these varieties but do not have access to the varieties.

2. Adequate seed policy should be put in place to fast track seed multiplication and distribution and on-farm trials through effective extension service delivery so as to intensify and sustain the adoption of early maize varieties.

3. The adoption of early maize varieties will be a panacea for food insecurity and veritable tool for increasing income of maize farming households through sensitization of farmers on the benefits of cultivating early maize varieties especially farmers who are not yet aware of the existence of these varieties.

4. Arising from the significant influence of farmers association on adoption of early maize varieties, farmers should be encouraged by extension agents to join co-operative societies so as to foster their interaction and exchange of ideas on early maize varieties and also, accessibility to these varieties thereby influencing the adoption decision of the farmers.

5.4 Contribution to knowledge

1. Empirical evidence of this research work revealed a high adoption rate for early maize varieties with adopters being economically efficient in producing maize though there is room for more improvement. Economic efficiency was calculated as the product of technical efficiency and allocative efficiency to be 0.342.

2. Major drivers of adoption of early maize varieties in the study area were found to be marital status ($p<0.01$), farming experience ($p<0.10$), education ($p<0.01$), membership of cooperative societies ($p<0.01$), household income ($p<0.01$) and

extension contact ($p<0.01$). Age of household head, credit, farm size and household size were found to be insignificant in influencing adoption of early maize varieties in Nigeria.

3. The mean annual income of the respondents that adopted early maize varieties (₦ 412,720) is higher than the mean annual income of non-adopters of the varieties (₦ 276, 844) which implies that the adopters of early maize varieties realized higher income than the non-adopters of the varieties. Furthermore, evidence from this research work revealed that adopters are more food secured than non-adopters. This is buttressed by the fact that 79% were food secured and 21% were food insecured for adopters while 44% were food secured and 56% food insecured for non-adopters.

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APPENDIX I

FARMERS QUESTIONNAIRE

SECTION A: SOCIO- ECONOMIC CHARACTERISTICS OF THE FARMERS.

1) Name of Respondent_____

2) Age_____

3) Sex male ( ) female ( )

4) Village _____

5) Local govt. Area_____

6) Marital Status Married ( ) Single ( ) others ----------

7) Household size (people living together and eating from the same pot):

a)

Age group (in years)	Number of males	Number of female
< 1		
1-4.9		
5-9.9		
10-14.9		
15-59.9		
>59		
Total		

8) How many members of the household go to the farm farm(s) ---------?

9) Educational status (No of years spent in school)

a) Adult education ( ) b) Qur'anic education ( ) c) Primary school ( ) d) Secondary school () e) Tertiary school ( )

10) Is crop farming your major occupation? Yes ( ) No ( )

11) If not farming, what other things do you do?

a) Trading ( ) b) Tailoring ( ) c) Civil Servant ( )

d) Livestock farming ( ) e) others (specify) ----------

12) Number of years spent in maize farming _____

13) Do you belong to a cooperative society Yes ( ) No ( )

14) If yes to 13 above, how many years of membership……

15) Do you have access to credit Yes ( ) No ( )

16) If yes to 15 above, what is the source?

a) Commercial banks ( ) b) friends and relatives ( )

c) Traditional savings (adashe) ( ) d) others (specify) ----------

17) How much credit did you use last season? _____

18) Have you been visited by an extension agent (s)? Yes ( ) No ( )

19) If yes to 18 above, how often did extension agent(s) visit your farm / you last cropping season? ……

20) Name the various early maize varieties you know

……...……

……

…….

21) Which of the varieties do you prefer?

……..……

……

……

22) Give reasons for No. 21 above

……...……

……

……..

23) Which of the varieties do you plant?

……

……

……

24) Give reasons for planting or not planting the varieties (planting [ ] Not planting [ ])

……
……
……
……

25) Estimate the percentage of farmers that planted the type early maize variety that you planted……

26) Do you know of any other variety being planted by other farmers? Estimate the percentage of the farmers that planted the variety in the last cropping season……

27) Is the percentage increasing or reducing over the years?

.....

SECTION B: FARMING ACTIVITIES

28) How did you acquire your farmland(s)?

i. Through inheritance ( ) ii. Purchase ( ) iii. Rent ( ) iv. Gift ( )

29) How many farms do you have for maize production? _____

i) Farm no 1 ------ (ha) ii) farm no 2 ------ (ha)

30) If the land was rented, how much did you pay per season/ha --------?

31) If the land was purchased, what was the amount paid/ha ----------

32) What was the mode of land preparation on the maize field?

i. Animal traction ( ) ii. Tractor hiring ( )

iii. Manual implements ( ) iv. Others--------

33) If you employed any in 24 above, how much do you pay per hectare----------?

34) State the labour contribution of your family members and hired labour during the last cropping season.\

A) Family labour:

FARM OPERATIONS	No OF WORKERS BY TYPE OF LABOUR			ACTUAL HOURS SPENT			No OF DAYS WORK		
	MA	FA	C	MA	FA	C	MA	FA	C
Land clearing									
Ridging/Ploughing									
Planting									
Fertilizer Application									
Weeding 1st wedding 2nd wedding									
Spraying									
Harvesting									
Transportation									
Others (Specify)									

MA = Male adult (15-64yrs), FA= Female adult (15-64yrs), C= children (7 – 14years)

B)Hired labour:

FARM OPERATIONS	No OF WORKERS BY TYPE OF LABOUR			ACTUAL HOURS SPENT			No OF DAYS WORK		
	MA	FA	C	MA	FA	C	MA	FA	C
Land clearing									
Ridging/Ploughing									
Planting									
Fertilizer Application									
Weeding 1st wedding 2nd wedding									
Spraying									
Harvesting									
Transportation									
Others (Specify)									

MA = Male adult (15-64yrs), FA= Female adult (15-64yrs), C= children (7 – 14years)

35) FARM INPUT RECORD

INPUTS	Quantity	Unit Price(N)	Total(N)
i. Seeds(kg)			
ii. fertilizers(kg)			
iii.Agrochemicals(litres)			
iv. farm implements			
v. manure(kg)			
vi. others (specify)			

36) CROP OUTPUT DATA AND INCOME LEVEL

Quantity harvested (bag of 100kg)	Total Quantity (kg)	Unit Price per bag (N)	Total revenue (N)

37) What quantity of maize was consumed at home) _____

38) What quantity was given out as gifts? i) _____

(C) MARKETING INFORMATION

39) Where do you sell your maize? i) On the farm ( )

ii) Village market ( ) iii) Urban market ( ) iv) others (specify) _____

40) When do you sell your maize? i) Immediately after harvest ( )

ii) 1 week after harvest ( ) iii) others (specify) ----------

41) Why do you sell your output in the specified period in question (30) above? ---------

---

	Item purchased last season for household		Amount produced last cropping season (Quantity/units)	Amount consumed from food purchased (quantity/units)	Amount consumed from production (quantity/units)	Value of Foods eaten outside the household last one month (~~N~~)
	Quantity or units	Price paid/unit				
Maize						
Grain						
Flour						
Sorghum						
Grain						
Flour						
Rice						
Imported						
Local						
Cassava						
Tubers						
Gari						
Cassava						

chips						
Yam						
Tubers						
Yam flour						
Cocoyam						
Corms						
Groundnut						
Shelled						
Unshelled						
Soybean						
Grain						
Flour						
Cowpea						
Okra						
Tomato						
Onion						
Pepper						
Egg plant						
Carrot						
Pumpkin						
Green leaves						
Guava						
Citrus						
Mango						
Others specify:						
1						
2						
3						

Units refers to local measures (e.g., Mudu, Tiya, baskets, etc) and Kilogramme (kg)

(43) Indicate the amount purchased of the following items for household consumption

Item	**Quantity purchased**	**Purchase value (₦)**	**Quantity consumed**
Salt/Potash/Maggi			
Groundnut oil			
Palm oil			
Other oils, specify:			
1.			
2.			
3.			
Fish (Fresh/dried/smoked)			
Meat (beef/mutton etc)			
Sugar			
Bread			
Drinks, specify:			
1.			
2.			
3.			

(E) Constraints facing maize production

Please tick as appropriate

(i) Low extension contact ( )

(ii) Problem of finance ( )

(iii) High cost of labour ( )

(iv) Transport problems ( )

(v) High cost of inputs ( )

(vi) Poor/low maize price at harvest ( )

(vii) Others (specify) a)……

b)…….

c)……

44) What can you suggest for improvement with regards to the problems mentioned above?

APPENDIX II

Calorie content of some commonly eaten foods in Nigeria

Food items	Kcal/kg	Food items	Kcal/kg
Staple foods		Mango	590
Cassava Tube	1500	Pawpaw	300
Cassava flour	3800	Pineapple	320
Cassava chips	3000	Apple	570
Garri	3840	Coconut	580
Yam Tuber	1100	Guava	730
Yam flour	3810	Sugar cane	360
Yam chips	3000	***Meat and animal products***	
Sweet potato Tuber	1100	Cow meat	2370
Sweet potato chips	900	Goat meat	2370
Irish potato	1200	Sheep meat	2370
Cocoyam Tuber	3830	Pork	2370
Maize green	3100	Bush meat	2370
Maize grain	4120	Chicken	2380
Maize flour	4120	Turkey	2380
Sorghum grain	3500	Fish	2230
Sorghum flour	3500	Snail	2245
millet grain	3500	Shrimps	2230
Millet flour	3500	Crayfish	2200
Rice	1230	Crabs	2200
Wheat grain	3400	Eggs	1400
Wheat flour	3300	***Dairy products***	
Cowpea (beans)	5920	Milk	4900
Groundnut	5950	Cheese	4000
Soybeans	4050	Yoghurt	4100
Soybeans flour	2600	Ice cream	4100
Melon (shelled)	5670	Beverages	
Plantain	770	Cocoa	1200
Banana	960	Tea (leaves)	1200
Vegetables		Tea (liquid)	1200
Okra	4550	Coffee (powder)	1340
Tomato	880	Coffee (liquid)	1340
Pepper	3930	***Drinks***	
Onion	440	Soft drinks	620
Carrot	400	Orange juice	400
Egg plant	440	Apple juice	550
Cucumber	270	Pineapple juice	560
Chochorus/ewedu	500	Local beer	740
Spinach	220	Bottled beer	460
Bitter leaf	220	Wine	330
Water leaf	180	***Condiments and spices***	
Cabbage	230	Magi	220
Pumpkin	440	Salt	180

Source: Oguntona and Akinyele, (1995)

APPENDIX III

Adult equivalent scale for adjusting household size

Age category (years)	Male	Female
< 1	0.00	0.00
1-4.9	0.25	0.20
5-9.9	0.60	0.50
10-14.9	0.75	0.75
15-59.9	1.00	0,90
>59.9	0.80	0.65

Source: Stefan and Pramila, (1985)