ECONOMICS OF EARLY MATURING MAIZE VARIETIES IN SAFANA LOCAL GOVERNMENT AREA OF KATSINA STATE, NIGERIA

BY

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DECLARATION

I declare that this thesis titled **"Economics of Early Maturing Maize Varieties in Safana Local Government Area of Katsina State, Nigeria"** has been written by me and it is a record of my research work. No part of this work has been presented in any previous application for another degree or diploma at any institution. All borrowed ideas have been duly acknowledged in the text and a list of references provided.

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CERTIFICATION

This thesis titled **"Economics of Early Maturing Maize Varieties in Safana Local Government Area of Katsina State, Nigeria"** by Ndonkeu Nathanel **NDAGHU.** The thesis meets the requirements and regulations governing the award of the Degree of Master of Science (Agricultural Economics) Ahmadu Bello University, Zaria, and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This research work is dedicated to God Almighty and to my lovely dad Adjudant-Chef Ndaghu Taboh Thomas.

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LIST OF ACRONYMS

AEZs: Agro-Ecological Zones

AMENFAN: Agricultural Machineries and Equipment Fabricators Association of Nigeria

ARD: Agricultural Research and Development

DDM: Double Difference Method

GDP: Gross Domestic Product

FAO: Food and Agricultural Development

FARA: Forum for Agricultural Research in Africa.

IAR4D: Integrated Agricultural Research for Development.

IITA: International institute for Tropical Agriculture

IP: Innovation Platform

KKM PLS: Kano-Katsina-Maradi Pilot Learning Site.

LK: Lake Kivu

NEPAD: New Partnership for Africa's Development

NVMA: Nigerian Veterinary Medical Association

NGO: Non-governmental Organisations

SSA-CP: Sub-Saharan Africa Challenge Program

SSTF: Sudan Savannah Task Force

ZMM: Zimbabwe-Malawi-Mozambique

ABSTRACT

This study examined the economics of early maturing maize varieties in Safana Local Government Area of Katsina State, Nigeria. Using random sampling techniques,300 maize farmers were selected randomly across 10 communities in the Local Government. Data obtained were analyzed using Descriptive statistics, Adoption Index, Probit & Tobit Regression Models, Food security line, Double Difference Method and Z-Statistics to estimate impact of early maturing maize varieties on income of farmers. The study divided the respondents into 137 adopters and 163 non adopters. The major findings showed that 88% of respondents were male headed, average age of household head was 44 years, average household size was 11 persons, dependency ratio was 1.49, level of education was Islamic education, average years of schooling was 5 years and average years of farming was 25 years. About 65% of farmers had access to extension agent, only about 10% had access to credit and labour force was mostly family labour. The level of awareness between adopters and non-adopters was 100% and 81.6% respectively. A larger proportion of farming households adopted 99EVDTWSTR (SAMMAZ 27) with an adoption rate of 28.67%. Results of probit model showed that farmers' size of land for maize cultivation (1%), farmers' participation in an association (1%), number of extension contacts (10%), age of farmer (5%) and income from sales of maize (1%) influenced the adoption of early maturing maize varieties. The result of Tobit model revealed that some socio-economic factors, such as farm size, labour force, number of extension contact and yield were significant in influencing the intensity of adoption of early maturing maize varieties by farmers in the study area. The average levels of technical, allocative and economic efficiencies in maize production were 0.881, 0.592 and 0.737 respectively. The socioeconomic factors that significantly influenced technical inefficiency were age of farmer, years of farming, extension contact, membership of cooperatives, and amount of credit; those that influenced allocative inefficiency were household size and amount of credit; and those that influenced economic inefficiency were amount of credit and extension contact. Based on the recommended daily calorie intake of 2260 kcal, 60.6% of adopters were food secure and 39.4% were food insecure. About 31.3% of the non-adopters were food secure and 68.7% were food insecure. Further, the calorie in-take for solely maize was 1874.2Kcal (43.14%) and 448.9Kcal (29.9%) for food secure and food insecure adopters respectively. As for the non-adopters, the daily calorie intake for maize consumption was 1079Kcal (31.9%) and 268.4 Kcal (27.3%) respectively. The mean difference analysis of the impact on adoption of early maturing maize varieties on income status between adopters and non-adopters of early maturing maize varieties shows that there is a positive mean income of ₦42,689.19. The result of the T-test showed that there was significant difference at 1% level of significance between adopters and non-adopters in relation to income level. Some of the constraints observed were lack of fertilizers, seed and credit. Research institutes, seed companies and/or seed producers should provide improved seeds and made available to the maize farmers timely and at affordable price. The government should subsidize farm inputs like fertilizers and provide agricultural loan to allow farmers to have access to these inputs and credit. Policy which provides adequately trained and equipped extension workers to disseminate improved agricultural technology has the potential to raise the efficiency in food crop production and income of farmers.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Nigeria is Africa's most populous country and is growing at a rate of about 3.2% per year (NPC, 2006). Aside from wheat, the country has been able to meet most of its own staple food needs (FAO, 2006). The development and adoption of agricultural innovations, especially maize and cassava varieties have important roles in this process. Agriculture accounts for about 40% of GDP despite the importance of petroleum, industries and services, and is the primary livelihood for the majority of Nigeria's population. Agriculture remains the mainstay of the Nigerian economy despite its decline in the 1970s. Greater proportions of the population depend on the agricultural sector for their livelihood and the rural economy is still basically agricultural. Agriculture (including hunting, forestry and fishing) contributed about 32% of Gross Domestic Product (GDP) in 1998 to the Nigerian economy (Kwanashie *et* al., 1998).

Maize is a major cereal and one of the most important food crops in Nigeria. It is one of the major crops grown in Katsina State. Its genetic plasticity has made it the most widely cultivated crop in the country, from the wet evergreen climate of the forest zone, to the dry ecology of the Sudan savanna. Being photoperiod sensitive, it can be grown anytime of the year giving greater flexibility to fit into different cropping patterns. It is one of the most dominant cereal crops in the southern and northern Guinea and Sudan savannas (Onyibe *et al*., 2006). Trends in maize production indicate a steady growth, mostly due to the expansion of cultivated area, but also the result of early maturing maize yields. In 1989 to 1991, the average maize yield in Africa of 1.2 tons per hectare was twice that estimated for the 1950s, before improved varieties were generally

available (Byerlee and Heisey, 1997). In West and Central Africa in the last 20 years widespread adoption of early maturing maize varieties in the savannas means that maize is no longer a backyard crop but a major cereal grown for both cash and food (Eckebil, 1994; Fajemish, 1994; Smith *et al*., 1997).The development and promotion of quality protein maize (QPM), a high lysine type of maize that can improve the nutrition—particularly for women and children—in places where maize comprises the major source of protein in human diets. QPM also boosts the productivity of monogastric farm animals (poultry and swine) when used in feeds, and is valuable where farmers cannot afford or obtain lysine supplements for feed (CIMMTY, 2008). Maize therefore has a considerable potential to enhance food security and the productivity and sustainability of the crop-livestock system, (Arege *et al.,* 2006).

However, despite the potential for further yield increases, maize production faces numerous problems including poor soil fertility, *Striga*, disease, drought, low and erratic rainfall, and long dry season (Tambo and Abdoulaye, 2011). Over years the International Institute of Tropical Agriculture (IITA) has in collaboration with national partners developed and disseminated a number of early maturing maize technologies that meet the requirement of their major clients and small-scale farmers in northern Nigeria and West Africa savanna at large.

IITA has made significant advances in improving the productivity of maize, by developing a number of improved varieties with generally high grain and yields, resistance to major insects, pests and diseases, (Alene and Manyong, 2007). Several of these varieties have been released in Nigeria but are not widely disseminated in northern Nigeria including Katsina State. Baseline studies carried out by Ayanwale *et al*. (2013)

shows limited adoption of improved technologies in Katsina State, and about 26% of the sampled farmers in Safana local government area were aware of early maturing maize varieties but zero percent has adopted citing unavailability of the seeds. Despite the development of a large number of early maturing maize varieties, farmers in northern Nigeria including Katsina State have continued to grow predominantly local varieties (Tarawali and Kureh, 2004). The limited use of improved varieties in a predominantly maize growing region may be due to several factors; lack of information on early maturing maize varieties, unavailability of seed, or the unacceptability of new varieties due to low market values or unsuitability for the farming system (Ellis-Jones *et al.,* 2009).

In order to reduce these constraints to crop production in Katsina State, the Sudan Savanna Task Force of the KKM PLS project which is funded by the Forum for Agricultural Research in Africa, (FARA) and led by IITA in collaboration with IAR and other collaborative bodies to disseminate improved agricultural technologies in the State? To achieve this, two Innovation platforms which comprising of a partnership of researchers, extension workers, farmer representatives, traditional leaders, private firms, non-governmental organisations (NGOs), and government policy makers who interact to support sustainable agricultural development have been setup in each of Musawa and Safana Local Government Areas of Katsina State by the Sudan Savannah Taskforce to improve agricultural productivity, farmers' incomes and food security. The objective of the Sudan Savannah Taskforce is to use the innovation platforms to enhance agricultural productivity and income of rural farmers along the value chain without degrading the natural resource base (Ellis-Jones *et al.,* 2009). The platforms tackled agricultural production constraints such as drought, *Strigahermonthica* parasitism, poor soil fertility,

and difficulty faced by farmers in accessing input and output markets. The platform promoted early maturing maize varieties that are tolerant to drought and resistant to *S.hermonthica*

1.2 Problem Statement

Nigeria like most sub Saharan African countries is mostly agrarian. More than 70% of the populace live in the rural areas and are mostly dependent on agriculture for living. The sustainable livelihoods of most Nigerians as many Africans therefore depend directly on their ability to produce and market agricultural products. Agricultural growth in Nigeria as in other Sub-Saharan African countries is therefore sine qua non for poverty reduction and food security. Substantial investments have therefore been made in the agricultural sector based on agricultural research and development (ARD) (Ayanwale et al., 2013b).This has overtime been observed to have debatable success and impact. Most researches and innovations were still found to be on research-shelves rather than farmer fields.

The Sub Saharan Africa Challenge Programme (SSA CP) was initiated in 2004, with the aim of facilitating a substantial increase in ARD for improved rural livelihood, increased food security and sustainable natural resource management throughout Sub-Saharan Africa. The SSA CP proposed a new approach to conduct agricultural research, named Integrated Agricultural Research for Development (IAR4D). This approach entails that for agricultural research to play a more effective role in catalyzing development, it should embrace a broader system of agricultural innovation that will facilitate systemic interaction and enhance flow of knowledge among all stakeholders in agricultural systems and value chains of specific commodities or production system.

This interaction gives the opportunity for joint problem identification, prioritization and innovation of viable solutions. To facilitate such collaboration between the different stakeholders, the SSA CP created innovation platforms (IPs) as a vehicle to bring the different stakeholder together and to improve and accelerate the agricultural innovation process.

The SSA CP's research has been organised around four projects: One Meta- Analysis project and three PLS projects in three different regions of Sub Saharan Africa (i.e. Lake Kivu (LK) in Eastern and Southern Africa, Kano-Katsina-Maradi (KKM) in West Africa, and Zimbabwe-Malawi-Mozambique (ZMM) in Southern Africa. Each PLS project comprise three sub- projects. The three sub projects that constitute the KKM project are distinguished by the agro-ecological zones (AEZs) where their research is based and focused. The relevant AEZs are the Sahel, the Sudan Savanna, and the Northern Guinea Savanna. This study focuses on the Sudan Savanna Task Force of the KKM only.

The Sudan Savannah Task Force (SSTF) was particularly concerned with agricultural intensification and integrated natural resource management to improve the rural livelihoods in the Sudan Savannah. The SSTF intervention was conducted in Kano and Katsina States enclave of the Sudan Savanna. This study however, focused on the intervention of SSTF in Katsina State only.

Food production in Katsina State is faced with problems of drought, parasitic weed infestation, pest and diseases, poor soil fertility, poor access to information, dysfunctional market and post-harvest losses. Besides, the prevailing negative effect of

climatic change occasioned by unpredictable bouts of droughts and floods has dire consequences on the food security in the region (CGIAR. 2010). The combination of these factors has led to low crop yields and food insecurity in rural communities. To lessen these constraints to crop production in Katsina State, the Sudan Savanna Task Force (SSTF) of the Kano-Katsina-Maradi Pilot Learning Site (KKM-PLS) project funded by the Forum for Agricultural Research in Africa, (FARA) and led by IITA in collaboration with IAR and other collaborative bodies to disseminate improved agricultural technologies in the State. Among the technologies promoted by the project in Katsina State are improved maize varieties such as: 2000 SYN EE (white), ACR 95 TZE COMP 5 W (white), EV 99 DT W STR (SAMMAZ 27) (white) and 99 TZEE Y STR (yellow). These varieties are of great importance being that they are early maturing, resistance to *Striga*, insects, diseases and high yielding (Dugje *et al.,* 2009).

After the intervention of this project, no work has been carried out on the rate and level of adoption of early maize maturing varieties, resource use efficiency, income level and food security status of farmers in the study area. This research therefore aims at analyzing the economics of extra early maize in Katsina State, Nigeria. As such,the study provided answers to the following research questions.

i. What is the rate and level of adoption of early maturing maize varieties?
ii. What are the factors influencing the rate and level of adoption of early maturing maize varieties?
iii. What are the constraints associated with the adoption of early maturing maize varieties in the study area?
iv. What is the technical, allocative and economic efficiency differential between adopters and non-adopters of early maturing maize varieties?

v. What is the impact of adoption of early maturing maize varieties on household food security?

vi. What is the impact of adoption of early maturing maize varieties on household farmers' income?

1.3 Objectives of the study

The general objective is to determine the economics of early maturing maize varieties on the livelihood of farmers in Safana Local Government Area of Katsina State in Nigeria.

The specific objectives are to:

(i) determine the rate and level of adoption of early maturing maize varieties,

(ii) determine factors that influenced the rate and level of adoption of early maturing maize varieties,

(iii) identify the constraints associated with the adoption of early maturing maize varieties in the study area,

(iv) estimate the technical, allocative and economic efficiency differential between adopters and non-adopters of early maturing maize varieties, and,

(v) evaluate the impact of adoption of early maturing maize varieties on household food security.

(vi) evaluate the impact of adoption of early maturing maize varieties on farmers' income.

1.4 Justification for the Study

Maize is a staple food for an estimated 50% of the population in Nigeria. It is an important source of carbohydrate, protein, iron, vitamin B and minerals. Nigerians consumes maize as a carbohydrate base in a wide variety of porridges, pastes, grits and

beer. 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 (IITA, 2009).

Various Agricultural Development Programs have evolved in Nigeria with the aim of modernizing and improving the farmer's technical knowledge and skills for greater output and higher standard of living (Olarinde *et al.*, 2007). Despite these agricultural programs, there still remains a dearth of food supply to meet the requirements of the rapidly growing population. A big gap still exists between national food supply and demand for food in Nigeria (Abdullahi, 1999 in Yanguba, 2004). This now enables research institution to search for solution to this problem through scientific research. The challenges have been to develop technologies that will enhance the productive potentials of small scale farmers who produce the bulk of the nation's food supply. These peasant farmers mostly relied on traditional ways of agriculture using low yielding local varieties that can only produce food for subsistence.

In Katsina State, efforts have been made to disseminate early maturing maize varieties that are adapted to the harsh environment in order to improve crop yields, ensure food security, and increase income. Since the introduction of the early maturing maize varieties technology into the study area, much works have not been done to access the extent to which these varieties have been adopted by the small scale farmers and their impact on the farmers' livelihood. This study is therefore important because it will identify those factors affecting adoption of the technology, impact on the adopter and proper solutions to those problems as well as offer prospects for future improvements of the technology. Researchers will find the information to be a sort of relevant feedback for their research work which may indicate new areas of interest for improvement.

Policy makers will need the findings for agricultural policy formulation that will contribute to the sector's development, while investors will be able to back up their decision on early maturing maize production with reliable data. It will improve investment in the sub-sector, thus contributing positively to improvements in maize farmers' standard of living, food security and national development.

1.5 Hypotheses

The following hypotheses were tested in this study;

i. There is no significant relationship between adoption of early maturing maize varieties and socio-economic characteristics of farmers.

ii. There is no significant difference in technical, allocative and economic efficiency of production between adopters and non-adopters of early maturing maize varieties.

iii. There is no significant difference in household food security between adopters and non-adopters of early maturing maize varieties.

iv. There is no significant difference in income between the adopters and non-adopters of early maturing maize varieties.

CHAPTER TWO

LITERATURE REVIEW

2.1 Maize Production in Nigeria: An Overview.

Maize *(Zea mays, L.)* is one of the main cereal crops of West Africa, and the most important cereal food crops in Nigeria. It comes after wheat and rice in terms of world importance (Onyibe *et al.,* 2006). Maize is becoming the miracle seed for Nigeria s agricultural and economic development. It has established itself as a very significant component of the farming system and determines the cropping pattern of the predominantly peasant farmers, especially in the Northern States (Ahmed, 1996). Maize has been of great importance in providing food for man, feed for livestock and raw materials for some agro-based industries. Maize constitutes a stable food in many regions of the world. It is a basic stable for large population groups particularly in developing countries (FAO and ILO, 1997).

In developed countries, maize is consumed mainly as second-cycle produce, in the form of meat, eggs and dairy products. In developing countries, maize is consumed directly and serves as staple diet for some 200 million people. Most people regard maize as a breakfast cereal. However, in a processed form it is also found as fuel (ethanol) and starch. Starch in turn involves enzymatic conversion into products such as sorbitol, dextrine, sorbic and lactic acid, and appears in household items such as beer, ice cream, syrup, shoe polish, glue, fireworks, ink, batteries, mustard, cosmetics, aspirin and paint (Plessis, 2003).

Maize is used as meal pap in Africa; corn bread is made from maize. Maize is still an important model organism for genetic and develops mental biology to date. Doebley

(1994) reported that maize can be boiled or roasted on the cob, the grains can be cooked fresh or dry and the dry grain can be made into popcorn (guguru) and eaten with roasted groundnuts. Maize is one of the most abundant food crops in Nigeria. About 80% is consumed by man and animals while 20% is utilized in variety of industries processes for production of starch, oil high fructose, corn sweetener, and ethanol, cereal and alkaline. Maize consists of 71% starch, 9% protein and 4% oil on a dry weight basis (Onuk *et al.*, 2010).

Nigeria has an annual maize production in excess of 7 million metric tons. In terms of volume produced, maize is the third most important cereal grown in Nigeria after sorghum and millet Maize will continue to play a large and important role in Nigeria's food production. Maize has several advantages to other crops: 1) it is a major source of energy and of all cereals gives the highest yield per man-hour invested; 2) it is usually the first crop to be harvested for food during the hunger period; 3) it is easy to grow as sole crop or intercropped with other crops; and 4) it is easy to harvest, it does not shatter and is not liable to bird damage. Its industrial demand is also increasing particularly in the food, beverage, and livestock feed industries (USAID/Markets, 2010).

2.2 Adoption as a Concept

Technology is the most important force in increasing agricultural productivity in the long-term. However, to affect productivity, technology must be adopted in the production processes. Largely, the rate of adoption of a new technology is subject to its profitability, degree of risk associated with it, capital requirements, agricultural policies, and socioeconomic characteristics of farmers (Rogers, 2003).

New technology adoption is an important source of productivity gains in various production systems. Producers benefit from the adoption of new technology through opportunities to lower their production costs, either by increasing outputs from the same inputs or by maintaining the same output from reduced inputs. One of the short-term impacts of a new agricultural technology is an increase in the incomes of farmers adopting the technology. However, the most important aspect is the effect of the technology on the pattern of income distribution among farmers. Previous studies have attempted to measure farm income inequality and to isolate and measure the net effect of new technology on farm income distribution.

New technology may change the optimal levels of inputs, but the profitability of adopting new technology depends on how the demands for inputs are changed and how large the productivity improvement is. Thus, an understanding of the effect of new technologies on productivity is crucial for a better understanding of the potential diffusion of the technology among farmers. Widespread adoption of new production technology is expected to have important market-level effects. This means that widespread adoption of a new technology is likely to have economic implications beyond the production system. Thus, an integrated economic model incorporating both production and marketing systems is required to assess accurately its impacts. Farm-level models are necessary to establish the output and revenue changes from the technology. Market supply responses can then be estimated by aggregating the farm responses under an assumed adoption rate, (Shideed, Kamil and El Mourid, 2005).

2.3 Adoption of other Agricultural Technologies/Innovation

Most adoption studies aimed at establishing factors underlying adoption of improved innovations. As a result, there is an extensive body of literature on the theory of

innovation adoption. Bonabana-Wabbi (2002), in her study, pointed out several of such factors that can affect adoption. According to her, they include among others; government policies, technological change, market forces, environmental concerns, demographic factors, institutional factors and delivery mechanism. Similarly, Abebaw and Belay (2001) documented farmers characteristics, farm characteristics and supply and institutional arrangements, while Adesina *et al.* (1999) presented socio-economic characteristics of farmers, land tenure rights and village specific characteristics as those factors influencing the adoption of alley farming in West and Central Africa. On this note, Chigona and Licker (2008) said that one of the first steps toward maximizing the rate of adoption of innovations is to understand these factors as they can influence adoption.

2.3.1 Socio-economic factors affecting adoption of agricultural technologies

Socio-economic factors have been reported to significantly influence adoption of agricultural technologies. In a survey report by the Institute of Agricultural Research (IAR, 2001) in Nigeria, women are being prohibited to be directly involved in farming activities in some communities in northern Nigeria because of religious limitations. The report therefore stated that sex composition in cowpea production is very vital as the role of each sex is seen as very crucial to the production of the crop. In her findings, Kamara (2010) reported that male adoption of soybean was higher than that of the female in Borno State. She however stressed the importance of the roles both sexes play in soybean production and again stated that majority of households who adopted the soybean technology were those headed by males. Yanguba (2004) in support of this said education of household head and farming experience is expected to have a positive effect on adoption of agricultural technologies. The role of a farmer's age in explaining technology adoption has been controversial. Older people are sometimes thought to be

less amenable to change and hence reluctant to change their old ways of doing things. In this case, age is expected to have a negative impact on adoption. On the other hand, older people may have higher accumulated capital, more contacts with extension and preferred by credit institutions predisposing them more to technology adoption than younger ones (Muyanga, 2009).

Bonabana-Wabbi (2002) classified age as the primary latent characteristic in adoption decision. Farmers perception that technology development and the subsequent benefits, require long duration to realize, can reduce their interest in the new technology because of their advanced age and the possibility of not living long enough to enjoy it (Caswell *et al.,* 2001; Khanna, 2001).

2.3.2 Institutional factors affecting adoption of agricultural technologies

Institutional factors and policy variables that include the extent of competitiveness of credit and labor markets, access to extension, the land tenure system, and social prescribed gender roles make up the other set of determinants of adoption and dis-adoption, (Tura et al., 2009). The effect of land tenure security is expected to be positive on both technology adoption and continuation. Farmer who does not own land may not be able to capture the full returns from investments in new technology, and thus, will be less willing to use new technology. This is either because they must share the increased product with a landlord or because the expected flow of returns exceeds their period of secure tenure. Inadequate infrastructure like roads and lack of seed are other external factors affecting technology adoption and dis-adoption. Households living near major towns have good access to both physical infrastructure and seed supplies hence are expected to be using previously adopted technologies.

Since prices of seed and fertilizer are the major cost components of production, a rise in input, coupled with other constraints, may render farm activities unprofitable which is in line with disenchantment theory of dis-adoption (Oladele, 2005). Another major factor that farmers in Central-Western Ethiopia as mentioned by Tura *et al.* (2009) which serves as a constraint to the adoption of hybrid seed is lack of credit. This is because according to them, farmers have found it increasingly difficult to get credit from official sources.

2.3.3 Technology related factors affecting adoption of agricultural technologies

Many research works have been done on the influence of technology characteristics on the rate of adoption. Yanguba (2004), said that a farmer adopts a new technology as a result of its relative utility. In his study, the utility of technologies was assumed to be determined by four major types of technology characteristics including profitability, initial cost, risk and complexity. Meaning, the more a technology profits farmers, the higher the demand for adoption if the cost of that technology is within their income. Adesina and Zinnah (1993), show that technology characteristic determines its diffusion. Farmers' perceptions on the post-harvest qualities of the improved cowpea variety namely: threshing quality and boiling quality are important in seed diffusion process. Thus, programs promoting farmer-to-farmer seed diffusion should ensure that crop varieties disseminated have acceptable post-harvest technology attributes. (Kormawa, Ezedinma and Singh, 2004).

Ngoc(2008) also mentioned perceptions of technologies, knowledge level of extension staff, methods of organization and management of the extension program and local conditions as the main factors affecting farmers' adoption of technologies. Ngoc (2008)

further stated factors such as low education, low perception, and lack of capital, small land, not good infrastructures and limited capacity of extension staff lead to low technology adoption.

2.4 Measurement of Adoption

The level of adoption is usually measured by the length of time required for a certain percentage of members of a system to adopt an innovation. Extent of adoption on the other hand is measured from the number of technologies being adopted and the number of producers adopting them Bonabana-Wabbi, (2002). Saka and Lawal (2009) measured adoption level as land area grown to rice variety by farmer i^{th} divided by total land area grown to rice by farmer i^{th}. Depending on the technology being investigated, various parameters may be employed to measured adoption.

Measurements also depend on whether they are qualitative or quantitative. For instance in the study investigating the adoption of improved seed and improved seed and fertilizers in Tanzania, Nkonya, Schroeder and Norman (1997) in Bonabana-Wabbi, 2002, estimated the intensity of adoption by examining the area planted of improved seed and the area receiving fertilizer. Another study that investigated the adoption of use of single-ox technology in Tanzania, pesticide and fertilizers use, the dependent variable was the number of farmers using pesticides and fertilizers.

In another study on factors affecting peanut producer adoption in Georgia, McNamara, Wetzstein and Douce (1991) in Jones, 2005, used the producers' decision to adopt or not to adopt and subdivided respondents into two groups: Adopters and non-adopters. While direct qualitative attributes are harder to measure, several studies have used

estimates of probabilities (Harper et al, 1990; Ng'ong;ola, 1993) in Yanguba, 2004. In soliciting respondents' subjective perceptions, researchers capture the qualitative aspects that influence farmers' decisions probably because farmers' technology choices are based on their subjective probabilities. Farmers' perceptions are interpreted as perceived profitability of a technology and translate into more recourses being devoted to it enhance adoption.

2.5 Empirical Studies on Adoption of Early Maturing Maize Technology

According to Kudi *et al.* (2011) on the analysis of adoption of early maturing maize varieties among farmers in Kwara state, reported that household size, level of education, farming experience, access to credit and yield of early maturing maize varieties influences adoption of new maize varieties. The household size was significant at 5% level of probability with negative coefficient which indicates that there is a negative relationship between household size and adoption of early maturing maize technology. The coefficient of educational status was positive and highly significant at 1% level of significant. Farming experience was also positive and significant at 10% level of probability. Access to credit also had a positive coefficient and was also significant at level of significant. This indicated that, adoption of early maturing maize varieties available and the most important sources of information on the early maturing maize varieties were extension agents and other farmers.

Odoemenem and Obinne (2007) found that the relationship between the adoption rate and frequency of extensions agent contact with farmers was positive. This implies that the more the farmers have access to extension services the more they become enlighten. Sserunkuuma, 2002 analyzed that the adoption and impact of early maturing maize

varieties on the welfare of Ugandan maize consumers and producers have a relationship. He investigated that, although the number of household using early maturing maize seed is fairly high and increasing the average area planted to early maturing maize varieties is still very low, suggesting a low intensity of adoption. There is very little or no use of fertilizers (organic and inorganic) among famers adopting early maturing maize varieties. The implication is that, many farmers are adopting high yielding maize varieties than low yielding varieties without using external inputs to replenish the lost nutrients. Mugisha and Diiro, (2010) reported a high levels of adoption (about 80%) on their study on explaining the adoption of early maturing maize varieties and its effects on yield among smallholder maize farmers in Eastern and Central Uganda. The authors also found out a low level of adoption intensity. The mean yield of early maturing maize varieties was significantly higher than the yield from local varieties. They concluded that adoption of improved seeds lead to increase yields.

According to Paudel and Matsuoka (2008) the adoption of maize varieties is influence significantly by rainfall, age, family size and education of household head, access to extension , land type either upland or lowland. They suggested the need to bring more area under maize cultivation during raining season especially in the low-lying area. Furthermore, there is need for special training, seminars, field demonstrations and technical support for the maize farmers. Majority of households have no formal education, the extension program should be intended to the less educated people. In addition, the credit facilities especially the procedure for loan should be made simple to improve the adoption rate of early maturing maize varieties in the study area. Also due to rising income in most developing countries and the subsequent growth in meat and poultry consumption resulting in a rapid increase in demand of maize .

2.6 Impact of Agricultural Technology on Income of Respondents

It is believed the adoption of new agricultural technology, such as the High Yielding Varieties (HYV), that led to the Green Revolution in Asia could lead to significant increases in agricultural productivity in Africa and stimulate the transition from low productivity subsistence agriculture to a high productivity agro-industrial economy (World Bank, 2008). In this regard, Mendola (2007) observes that the adoption of HYV has had a positive effect on household well-being in Bangladesh. In addition, empirical studies show that gains from new agricultural technology influenced the poor directly, by raising incomes of farm households, and indirectly, by raising employment and wage rates of functionally landless laborers, and by lowering the price of food staples. In the same line, Dontsop *et al.* (2011) in their work found out that, the mean difference analysis of the impact of NERICA adoption in terms of area cultivated, rice output, yield, household expenditures, annual per capita expenditures, annual income and poverty status between adopters and non-adopters of NERICA varieties. As for the welfare impact of NERICA, a straightforward comparison between both household income and per capita expenditure of adopters and non-adopters was considered. While household income indicates the ability of the household to purchase its basic needs of life, per capita expenditure reflects the effective consumption of households and therefore provides information on the food security status of households. The result shows that while there is a significant difference between the gross incomes of adopters and non-adopters, there was no significant difference in the amount spent per head by both groups. As is evident from the table, the incidence of poverty was higher among non-NERICA adopters (50.2%) than NERICA adopters (45.5%).

2.7 The concept of Food Security and Insecurity

The concept of food insecurity includes not only the lack of availability, access, and utilization or use of food (for example, food preparation and intra-household food distribution), but also perceptions (for example, that food is insufficient, inadequate, unacceptable, uncertain, or unsustainable) (Wolfe and Frongillo, 2001). For example, food insecurity has been defined as the inability to acquire or consume an adequate quality of sufficient quantity of food in socially acceptable ways, or the uncertainty that one will be able to do so (Radimer *et al*., 1992). Food insecurity as experienced in other locations is likely to be somewhat different but will include similar components that go beyond availability and access. Food security affects dietary intake and ultimately, nutritional status and physical well-being. Although measures of dietary intake of individuals can assess some aspects of food insecurity, such as caloric insufficiency and nutrient inadequacy, they do not assess the cognitive and affective components of uncertainty (expressed as anxiety), unacceptability, or un-sustainability. For example, current intake may be adequate, but food security may still be experienced because of concern over future intake. Alternatively, intake may be inadequate, but only temporarily to protect supplies and prevent future food insecurity (Wolfe and Frongillo, 2001). Furthermore, growth status is an indirect outcome, since it also depends on factors such as health and child care, in addition to access. Food insecurity is also related to available economic and social resources. Precursors such as income or total expenditure are correlated with caloric sufficiency, but they only capture this component of food insecurity and are quite indirect (Maxwell, 1992).

Food security, on the other hand, refers to the condition in which all people, at all times, have physical, social, and economic access to sufficient, safe and nutritious food that

meets their dietary needs and food preferences for an active and healthy life (FAO, 1996). Food availability, stability of supplies and food access are related determinants of food security. At the household level, food security implies an adequate access to food over time. This is possible when there is adequate food availability to the household, and an adequate income capacity for the purchase of the available food. Stability of food implies that the food availability is not affected by any shocks or risks affecting food production at all times. Food access has three components: 1) physical access to food, 2) economic access to food, and 3) sustainable access to food. Physical access implies food availability or food supply to the household, as there might be food available at the national level which, however, may not trickle down to the household level (Oluwatayo, 2009). Food insecurity is the result of a confluence of factors. The raging conflicts in Africa and drought in parts of southern Africa alone need not cause food insecurity. Food security, by definition, is not simply about availability of food, it also entails accessibility, that is, the ability of individuals or a nation to acquire food on a sustainable basis. Food security is also about the reliability and distribution of food. The former relates to utilization and consumption of safe and nutritious food, while the latter relates to the equitable provision of food to points of demand at the right time and place (Richard, 2002).

Food security is a broad concept that is more than food production and food accessibility. In reality, it revolves around four pillars, namely: food availability, food accessibility, nutritional factors and stability of food supply (Babatunde *et al*., 2007). A nation is food secure when food is available and accessible in sufficient quantity and quality for a productive livelihood for every individual (Kidane *et al*., 2005). On the other hand, food insecurity represents the inability to fulfill such conditions; that is

people have no access to sufficient, safe and nutritious food needed to maintain a healthy and active life. The most evident sign of food insecurity is the prevalence of hunger.

2.8 Measurement of Food Security

Food security measures are used to develop and validate quantitative measures of food security status of households. These measures are based largely on researches that involved quantitative, in-depth interviews with low-income, rural women with and without children who had experienced food insecurity (Radimer, 1990). Food insecurity is experienced differently at the household, adult and child levels; adults buffer the effects of food insecurity on children. Food insecurity has four components, two related directly to food (quantity and quality of food) and two are psychological and social in nature (certainty, which is related to worry about food, and acceptability, which is related to how food is acquired). (Wolfe and Frongillo, 2001). A number of methods have been used to gain an understanding of food insecurity and to apply this understanding to the development of measures. These include:

2.8.1 Ethnography

Ethnography involves in-depth interviewing of participants, usually by living in a community for an extended period of time. It can be used to help quantitative measures. For example, Chunk *et al.* (1997) used ethnography in south-central India to understand local perceptions, early signs, coping strategies and intra-household decision-making related to food security. From this, unique, locally defined indicators of food insecurity were developed (Chunk *et al*., 1997).

2.8.2 Rapid rural appraisal

A number of simple tools and techniques for assessing problems and situations at the community level have been developed as part of rapid rural appraisal (RRA) and the similar but more action-oriented, participatory rural appraisal (PRA). These often involve focus groups and in-depth interviews. Information gathered through RRA can be used to understand the food security situation and to help develop quantitative measures (Wolfe and Frongillo, 2001). Food security ranking involves asking a diversity of key informants to categorize village households according to the level of food security in the current year and in good and bad years. Criteria used for categorizing households, differences between years and causes given can be useful for understanding food security in that community. Food security calendars are useful for understanding the seasonal dimension of household food security in both good and bad years and the months in which the households eat until they are full and the months they suffer from hunger. Then the respondent is "interviewed," asking about consumption patterns and coping strategies for each group during each period of food security, as well as underlying causes of hunger. Activity calendars are similar and involve asking villagers in different food-security categories to distinguish between food-related activities they do in good versus bad years or seasons, including coping and investment strategies and activities that act as buffers against having to resort to coping.

2.8.3 Bean-ranking

Bean-ranking is a pictorial method used for a number of different purposes. It can be used to rank households into food-security groups and then "interview" the piles of beans to understand the coping strategies and other characteristics of each group, to

develop household "food charts," and to construct histogram-like seasonal charts for rainfall, harvests of staples, food consumption and illness.

2.8.4 Coping strategies

Maxwell (1992) developed a method for assessing household food security indirectly through food related coping strategies, that is, the actions people take when they do not have enough food or money to buy food. In-depth interviews were used to identify coping strategies, and then their relative severity was rated by target groups. A questionnaire assessing frequency of use each strategy was developed, from which a food-security score is derived by applying severity weightings.

2.8.5 Food-economy approach

The food-economy approach monitors household food security and early warning of food crises by quantify household access to food in normal years and the effects of external shocks on this. By using in-depth interviews and various RRA techniques, a "baseline picture" describing how different families in a geographic-specific "food-economy zone" normally obtain food and nonfood income is developed, describing sources and means of food and means of food and cash income and sometimes expenditure patterns. Potential changes in agricultural, economic, or security conditions that affect families' access to food are also quantified. A software program called Risk Map is then used to calculate the extent to which these changes affect different households' access to food and the amount this may be reduced by household-coping strategies. The results include an estimate of the shortfall in food income that people are likely to face, the costs of families and the likely effects of different levels and forms assistance.

2.9 Empirical Studies on Food Security

Food security is a broad term, which is defined in different ways by a number of organizations around the world. The basic definition of food security is that it refers to the ability of individuals to obtain sufficient food on a day-to-day basis. Internationally food security is defined as the ability of people to secure adequate food. More especially it has been defined by researchers as the access by all people at all times to enough food for an active healthy life (DAFF, 2009). According to the World Food Summit organized in Rome in 1996, food security exists when all people, at all times, have physical and economic access to sufficient, safe, nutritious food to meet their dietary needs and food preferences for an active life.

The Directorate: Food Security within the Department of Agriculture, Forestry and Fisheries, Food and Agriculture Organization of the United Nations (FAO), as well as the Centre for Poverty, Employment and Growth (CPEG) of the Human Sciences Research Council (HSRC) acknowledged that food security has three dimensions namely food availability, food access and food use. Food availability in the definition implies that a country must have sufficient quantities of food available on a consistent basis at both national and household level. Food access implies the ability of a nation and its households to acquire sufficient food on a sustainable basis. Food use refers to the appropriate use based on knowledge of basic nutrition and care, as well as adequate water and sanitation (Toit, 2011).

Literature by Anderson (1990) in Toit sees it fit to distinguish between food security at national and household level. This distinction is crucial since the approach to assess food security in those levels are not the same. Food security at national level refers to

the condition whereby the nation is able to manufacture, import, retain and sustain food needed to support its population with minimum per capita nutritional standards. At community level food security is defined as the condition whereby the residents in a community can obtain safe, culturally accepted, nutritionally adequate diets through a sustainable system that maximizes community self-reliance. At household level food security refers to the availability of food in one's home which one has access to. In this case, a household is regarded as food secure when the members of the family do not live in hunger or fear of starvation.

The concept of food (in) security is closely linked with the poverty in country. The two concepts are interrelated and to some extent have an influence on one another. In any food security discourse, it is also essential to highlight in a nutshell the plight of poverty in the country. Poverty refers to the condition of not having the means to afford basic human needs such as clean water, nutrition, health care, education, clothing and shelter. United Nation Development Programme (UNDP) report of 2006 pointed out that food insecurity is closely linked to poverty, income and unemployment. The report reveals that poverty and unemployment have strong relationship with food insecurity and in most cases food insecurity manifest in multiple deprivations. Food insecurity begins with the loss of employment, which in turns leads to a significant degradation in living standard. Living in poverty creates additional challenges which limit the ability for people to search for employment and that contribute to a long term unemployment trap. Lack of income due to unemployment, contribute to food insecurity and leads to socials exclusion problems. The FAO report (2008) basically echoed the findings in the UNDP report. The report suggested that food insecurity creates a destructive cycle of improvement.

Hart (2009) pointed out that most definition of food security include the phrase "at all times" and as such does not distinguish between different durations and intensities of food insecurity. Furthermore, food insecurity has a temporal as well as an intensity dimension. Temporal dimension can be chronically (long term or persistent), transitory (referring to short periods of extreme scarcity of food availability and access) as well as seasonal or cyclical. The intensity dimension on the other hand refers to the magnitude of the food gap. It is also important to have a good understanding of the concepts vulnerability and food insecurity. Vulnerability has an external and internal dimension, and food insecurity has a temporal and intensity dimension (Hart, 2009). An understanding of these distinctions and dimensions associated with the concept of food (in) security are necessary for policy development and appropriate interventions to address food security issues.

2.10 Food Security Status in Nigeria

The Food and Agricultural Organization (FAO) report for 2008 indicates that international estimates of people experiencing chronic hunger increased dramatically over the period 1990 to 2007. According to the report the increase in numbers of chronically hungry people was due to increased food prices worldwide as a result of lower production of staple food around the world such as cereals. The price of oil also contributed to the high food prices in many parts of the world. Political instability, wars, and lack of agricultural inputs in many parts of African countries, played a role in food insecurity as arable land lay fallow.

Nigeria is indeed a blessed nation. The country is endowed with abundant natural resources. These include 68 million hectares of arable land, fresh water sources

covering 12 million hectares; 960 kilometers of coastline and an ecological diversity which enable the country to produce a wide variety of crops and livestock, forestry and fishery products. In spite of these natural endowments and favourable agro-ecologies, Nigeria is still far from attaining sustainable agricultural development. The per capita food production has not kept pace with the growing needs of the population. The country continues to import agricultural raw materials. Agriculture plays the most determinant long-term role in the Nigerian economy, accounting for 40 per cent of Gross Domestic Product (GDP) and providing 60 per cent of employment. Indeed, agriculture bellies the veritable growth reserves to drive Nigeria's economic greatness. But Nigeria's arable land, going by experts' submissions, still remain grossly underutilized with only 32 million hectares or 46 per cent of its arable land under cultivation. Close to 90 per cent of this is accounted for by households with less than two hectares under-cropping, with farm sizes ranging from 0.5 hectares in Southern Nigeria to four hectares in the north. Inputs supply to farmers, according to agriculture experts, have also been abysmally low and of poor quality. Not only that, fertilizer consumption in Nigeria, according to experts, is put or estimated at seven kilogram per hectare and is one of the lowest in the Sub-Saharan Africa. Also, less than 10 per cent of irrigable land is under irrigation.

Nigerian farmers have limited access to credit with lending to agriculture, representing a paltry 1.4 per cent of aggregate lending far below the six per cent in Kenya and 18 per cent in Brazil. It is also estimated that there is one extension worker per 15,000 farm households in Nigeria, compared to the Food and Agriculture Organization (FAO) best practice estimate of one to 500-1000 farm households. There are also about 30,000 tractors for 14 million farming households in Nigeria. In terms of agricultural

processing, Nigeria loses significant value of between 15 to 40 per cent of its post-harvest outputs due to many factors ranging from poor or non-existent roads, through poor practices to lack of processing facilities. Not only that, in livestock production, local supplies, as experts explained, have been inadequate with an estimated 30 per cent of livestock slaughters imported from neighboring countries.

The daily animal protein intake per head per day, as explained by Dr. Charles Chukwudike, President, Nigerian Veterinary Medical Association (NVMA), is currently estimated at 10 grammes compared to the FAO recommended 36 grammes. However, there is a growing concern among the Nigerian populace and it has to do with the ever-increasing prices of food items with its attendant effects on almost every household. Many Nigerians are saying agriculture is not performing the expected roles as much desired, and every attempt to unravel the reason (s) for this unfortunate situation has been attracting attention, yet, without a concrete solution.

Going by the submission credited to Dr. Gabriel Akinboye Oluwatosin, a principal research fellow in Soil Survey and Land Evaluation at the Institute of Agricultural Research, and Training (IAR & T), Apata, Ibadan, Oyo State, lack of access to food and its availability is of great concern to Nigeria and a fundamental challenge to human welfare and economic growth. Low agricultural production, he said, results in low incomes, poor nutrition, vulnerability to risks and lack of empowerment. The New Partnership for Africa's Development (NEPAD), in Dr. Oluwatosin's opinion targets an average annual increase of six per cent in agricultural productivity to ensure food security and sustained national economies. In the nation's agricultural sector, post-harvest handling is the stage of crop production immediately following harvest,

including drying, threshing, cleaning, sorting, packing and cooling. Immediately a crop is removed from the ground, or separated from its parent plant, it begins to deteriorate. Postharvest treatment largely determines final quality, whether a crop is sold for fresh consumption, or used as an ingredient in a processed food product.

Speaking with Engineer Anthony Egba, the National Secretary of Agricultural Machineries and Equipment Fabricators Association of Nigeria (AMENFAN), he explained that one of the major challenges facing food production in Nigeria is the issue of post-harvest losses of our agricultural produces. Nigeria produces so much food crops but most of them are lost during harvest and others are lost as a result of poor handling and poorer storage facilities. "So much emphasis had been placed on intensive land clearing, fertilizer distribution and other inputs, at highly subsidized costs with very little or no attention paid to post-harvest loss prevention. Whereas, no matter the tonnage of food that you produce, if you are unable to store them or add value to this food product by partial or full processing, there will still be food shortage and scarcity.
The Food and Agriculture Organization (FAO) and the World Bank are currently urging Nigeria and other Sub-Saharan African countries to invest in post-harvest technologies in a bid to reduce food losses that could significantly increase their food supply. This is contained in a new FAO/World Bank report that was released recently. The report, entitled: "Missing Food: The Case of Postharvest Grain Losses in Sub-Saharan Africa, " produced in collaboration with the United Kingdom's Natural Resources Institute, estimates the value of post-harvest grain losses in sub-Saharan Africa at around $4 billion (about N600 billion) a year. "This lost food could meet the minimum annual food requirements of at least 48 million people, "said FAO Assistant Director- General, Maria Helena Semedo. Egba further explained that "If we agree that sustainable

agricultural systems need to be developed to feed nine billion people by 2050, addressing waste across the entire food chain must be a critical pillar of future national food strategies." According to estimates provided by the African Post-harvest Losses Information System, physical grain losses prior to processing can range from 10 per cent to 20 per cent.

Nigeria produces a wide variety of fruits including citrus, mango, pawpaw, guava, pineapple, banana and watermelon. The country is also a leading producer of pepper and large amounts of tomatoes, plantain, onions, okra and other vegetables. Fresh fruits and vegetables are inherently more liable to deterioration under tropical conditions characterized by high ambient temperatures and humidity, and a high incidence of pests and diseases. Consequently, postharvest losses of fruits and vegetables are extremely high in Nigeria (30 to 50 percent)." Postharvest losses are a great threat to food security in Nigeria. It leads to food scarcity during the agricultural off season. If one travels round this country when a particular agricultural product is in season, one will see a lot of such products rotting away. For example, more than 50 percent of mangoes, 20 to 30 per cent of tomatoes and 30 per cent of grains are wasted during their seasons in Nigeria. If our crops are well handled using the appropriate post-harvest technology, it is very possible to eat fresh maize and mangoes round the year. The most painful aspect is that this wastage is not limited to the farm alone but during transportation. There are a lot of wastages as a result of poor roads, wrong packaging and wrong vehicles.

2.10.1 Measurement of household food insecurity status

For household food insecurity analysis, a combination of analytical tools is used. To analyze the food security status of households, a cost-of-calorie index is constructed.

Cost-of-Calorie Index: The cost-of-calorie method proposed by Greer and Thorbecke (1984) in (Amaza *et al.*, 2007) was used in a study to determine a threshold food security line. The method yields a threshold value that is usually close to the minimum calorie requirement for human survival. Two steps—identification and aggregation—are involved in constructing the index. Identification is the process of defining a minimum level of nutrition necessary to maintain a healthy living. This minimum level is referred to as the "food insecurity line". In the context of this study, the food insecurity line is the calorie level below which people are classified as being food insecure or are subsisting on inadequate nutrition in the study area. Calorie adequacy was estimated by dividing the estimated calorie supply for each household by the household size, adjusted for adult equivalent, and using the consumption factors for various age–sex configurations. This method has been applied in several studies with a main focus on food security (Hasan and Babu, 1991; Makinde, 2001).

Following the method, the food insecurity line is given as:

$LnX = a + bC$

Where;

X is the adult equivalent food expenditure and C is the actual calorie consumption per adult equivalent in a household. The recommended minimum daily calorie requirement per adult equivalent is 2250 kcal (see FAO, 1982; Food Basket Foundation International, 1995) and this was used to determine the food insecurity line, using the equation:

$S = e^{(a+bL)}$

Where,

S = the cost of buying the minimum calorie intake requirement

(i.e., the food insecurity line); a and b = parameter estimates in equation

1, and L = recommended minimum daily calorie intake level.

Based on the calculated S, households were classified as being food secure or food insecure, depending on which side of the line they fell.

But due to differences in household composition in terms of age and sex, there was a need to calculate the levels of expenditure required in households with different age–sex compositions. The approach used to achieve this was to divide household expenditure by household size to get the per capita expenditure as used by the World Bank (1996) and in several other studies. The household expenditure was then decomposed on per adult equivalent basis, using the conversion factor developed by Institut Panafricain pour le Développement (1981) and as adapted by Storck *et al*. (1991) in Amaza *et al*. (2007) .

2.11 Technical, Allocative and Economic Efficiency.

The stochastic frontier production function was independently proposed by Aigner *et al*. (1977) and Meeusen and Van den Broeck (1977) and is used in the estimation of technical efficiency and allocative. Efficiency in production is a way to ensure that products of farms are products in the best and most profitable way. To prevent waste of resources, efficiency is of great importance for every sector of the economy. The technical efficiency of an individual farm is defined in terms of the ratio of the observed output to the corresponding frontier output, conditioned on the level of inputs used by the farm. Technical inefficiency is therefore defined as the amount by which the level of production for the farm is less than the *frontier* output. Allocative efficiency from the output perspective is simply the revenue maximizing problem. In this case, allocative measures the firm's ability to allocate the input bundle in the cost minimizing way. Combining measures of technical and allocative efficiency yields a measure of

economic efficiency. Economic efficiency has two components: technical and allocative efficiency. Technical efficiency refers to the ability to avoid wastage either by producing as much output as technology and input usage allow or by using as little input as required by technology and output production. Technical efficiency has, therefore, both an input conserving and output promoting argument. According to Koopmans (1951) in Chiona 2011, a producer is technically efficient if an increase in any output requires a reduction in at least one other output or an increase in at least one input, and if a reduction in any input required an increase in at least one other input or reduction in at least one output. Therefore, a technically efficient producer could produce the same output with less of at least one input or could use the same input to produce more of at least one output.

Another definition exits which looks at relative technical efficiency. A producer is fully efficient on the basis of available evidence if and only if the performance of other producers does not show that some inputs or outputs can be improved without worsening some of its other inputs or outputs. With this definition, there is no need for recourse to prices and other assumptions of weights which are supposed to reflect the relative importance of the different inputs and outputs (Cooper *et al.,* 2004). The measurement of technical efficiency is important. According to Alvarez and Arias (2004), technical efficiency reduces production costs and makes a firm more competitive.

The allocative efficiency index measures a production unit's ability to choose the input combination that minimizes cost given the best available technology. It is the ratio between the minimum costs if it were technically efficient. Because allocative

efficiency implies substituting or intensifying the use of certain inputs based on their prices, inefficiencies may stem from unobserved prices, from incorrectly perceived price or from lack of accurate and timely information.

As pointed out in Alvarez (2004), various degrees of inefficiency in production seem to be the rule rather than the exception. Bravo-Ureta and Rieger (1991) in Folorunso (2011) studied technical, allocative and economic efficiency of a sample of a sample of New England dairy farms using the stochastic frontier approach and Cobb-Douglas production function. They found overall economic inefficiency of an average 30%. However, there was a little difference between mean technical (83%) and mean allocative efficiency (84%). It is important to note that technical inefficiency can only be estimated if the inefficiency effects are stochastic and has a particular distribution specification (Battese and Coelli, 1996). Some of the considered distributions for u_i are the truncated half normal, gamma and exponential distributions. Technical efficiency is estimated using frontier4.1c (Green, 2002). In the specification of the stochastic frontier production function, the model allow for specification of two equations on the right hand side. One equation specifies the main factors of production such as seed, fertilizer and labor and the other equation specifies the variables that are assumed to cause inefficiency such as access to credit and the gender of the household head. This is done in a one-stage process. Some of the main researchers who have utilized the stochastic frontier approach are: Aigner *et al*. (1977); Battese and Coelli (1995); Battese (1996); Abdulai and Huffman (2000); Thiam *et al*. (2001); Awudu and Eberlin (2001); Gautam and Alwang (2003); Khairo and Battese (2005).

According to Oyewo (2011) on his paper,Technical efficiency of maize production in Oyo state, he had the following result; using a cross sectional data obtained through a multistage sampling technique this study estimates the technical efficiency of maize producing-farmers in Oyo State, Nigeria and further examined the factors that determine the differential in efficiency index. A multistage sampling technique was used to select 120 maize farmers in the study area. Data were collected and subjected to inferential statistics; stochastic frontier production model was used in the analysis to determine the relationship between the maize output and the level of input used in the study area. The empirical results revealed that farm size and Seed were statistically significant at 10 and 1% level respectively in the study area. The estimated gamma parameter (γ) of 0.12 in the study area, indicates that 12% of the total variation in maize output is due to the technical inefficiencies. The mean technical efficiency (χ) was 0.961 while the return to scale (RTS) was 0.587 in the study, it was therefore concluded that there is scope for increasing maize production by 0.39% with the present technology. Therefore the study confirmed that more land can still be open for maize production in the area with the current level of input used.

Elibariki *et al.* (2008) in "An Analysis of Technical Efficiency of Smallholder Maize Farmers in Tanzania in the Globalization Era" used a stochastic frontier production model proposed by Battese and Coelli (1995), estimates the levels of technical efficiency of 233 smallholder maize farmers in Tanzania and provides an empirical analysis of the determinants of inefficiency with the aim of finding way to increase smallholders' maize production and productivity. Their results shows that smallholder productivity is very low and highly variable, ranging from 0.01t/ha to 6.77t/ha, averaging 1.19t/ha. Technical efficiencies of smallholder maize farmers range from

0.011 to 0.910 with a mean of 0.606. Low levels of education, lack of extension services, limited capital, land fragmentation, and unavailability and high input prices are found to have a negative effect on technical efficiency. Smallholder farmers using hand-hoe and farmers with cash incomes outside their farm holdings (petty business) are found to more efficient. However, farmers who use pesticides are found to be less efficient. Policy implications drawn from the results include a review of agricultural policy with regard to renewed public support to revamp the agricultural extension system, and interventions towards improving market infrastructure in order to reduce the transaction element in the input and output marketing.

According to Ezeh and Onyenweaku (2007), the estimate of economic efficiency showed the Maximum Likelihood Estimate of the cost frontier for cocoyam production, sigma as $\delta^2 = 0.53$ and gamma ($\gamma = 0.98$) are quite high and highly significant at 1.0% level of probability. The high and significant value of the sigma square (δ^2) indicate the goodness of fit and correctness of the specified assumption of the composite error terms distribution, Folorunso (2011). The gamma ($\gamma = 0.980$ shows that 98% of the variability in the output of cocoyam farmers are unexplained by the function is due to economic inefficiency.

2.12 Double Difference Method to Measure the Impact of Adoption of Early Maturing Maize on Farmers' Income.

The Double Difference (DD) Method essentially compares treatment and comparison groups in terms of outcome changes over time relative to the outcomes observed for a per-intervention baseline. That is, given two period setting where t=0 is before the programme and t=1 after programme implementation. Y_t^T and Y_t^c are the respective

outcomes for a programme beneficiary and non-treated units in time t. hence, the DD method will estimate the average programme impact as follows:

$$DD= E(Y_0^T/T_1=1) - E(Y_1^c / T_1=0) \ldots\ldots (1)$$

Where,

$T_1 = 1$ denotes treatment or the presence of the programme at t=1.

$T_1 = 0$ denotes untreated areas.

The DD estimate can also be calculated within a regression framework. The estimating equation is specified as follows:

$$Y_{it} = \alpha + \beta T_{i1}^t + P^T_{i1} + Y^t + E_{it} \ldots\ldots (2)$$

In equation (2) above, the coefficient β is the interaction between the post program treatment variable (T_{i1}) and time (t=1...........T) which gives the average DD effect of the programme (Khandker *et al*., 2010).

CHAPTER THREE

METHODOLOGY

3.1 Study Area

This study was conducted in Safana LGA Katsina State, Nigeria. Katsina State is located between latitude 11^0 and 13^0 N and longitude 6^0 and 9^0 E. It is bounded in the north by the republic of Niger, in the south by Kaduna State, west by Zamfara State and in the east by Kano State. It has a projected population of about 7,935,717 for 2013 based on 3.2 population growth rate and an area of 24,195 km^2 . The climate is tropical with an annual rainfall between 600-1000 mm in the dry and wet season respectively. It has an annual temperature between 26 and 28^0 C. the weather varies according to the season of the year. The state falls between Sahel/Sudan savanna vegetation zones.

Safana Local Government Area has a projected population of about 183,779 based on 3.2% growth rate (NPC, 2006) and an area of 282km^2 (KTARDA, 2012). The Local Government is located at 12^0 N and 7^0E of the equator. April is warmest with an average temperature of 37.9°C at noon. December is coldest with an average temperature of 13°C at night. Safana has no distinct temperature seasons; the temperature is relatively constant during the year. Temperatures drop sharply at night. February is on average the month with most sunshine. The wet season has a rainfall peak around August; the dry season is around the month of December. Safana has a semi-arid climate. The land area is not cultivated; most of the natural vegetation is still intact. The landscape is mostly covered with mosaic vegetation/croplands. The climate is classified as a subtropical steppe (low-latitude dry), with a subtropical dry forest bio-zone. The soils have texture running from sandy loam to sandy. The major occupation of the people is farming from which they get their livelihood. Majority is also engaged in livestock production. They rear different types of livestock including cattle, sheep,

goats, camels, horses and donkeys. The main crops cultivated in the local government are cotton, cowpea, sorghum, millet, maize, groundnut, onions, wheat, etc. The major ethnic groups are Hausa and Fulani.

3.2 Sampling Procedure

The target populations for this study were male and female maize farmers from the 10 communities of the Sorghum/Legume/Livestock platform in Safana LGA. These communities are Mai Jaura, Kunamawa A, Kunamawa B, Dogon Ruwa, Kanbiri, Sabon Garin Baure, Sabon Garin Gamji, Doga, Takatsaba, Kwayawa. There was no complete list of farmers in these communities but a list of maize farmers was generated with the help of both the village heads and extension agents in these communities. From each of the ten (10) communities, 30 respondents were randomly selected giving a total of 300 respondents. Out of the 300 respondents sampled 163 were non-adopters and 137 were adopters.

3.3 Method of Data Collection

Primary data were used for this study. Data were collected using structured questionnaire administered by trained enumerators. The information collected was on sex, age, marital status farm size, family size, quantity of input, quantity of output, income of farmers, and quantity of calorie intake based on 2012 farming season. The survey was conducted in March 2013.

3.4 Analytical Technique

The analytical tools that were employed for this study are:

(i) Descriptive statistics

(ii) Adoption Index

(iii) Probit Regression Model

(iv) Food security line

(v) Double Difference Method

(vi) Z-Statistics

3.4.1 Descriptive statistics

Descriptive statistics was used to achieve objectives i and iii in this study. It involves the use of frequency, percentages, mean, standard deviation, and coefficient of variance of the adoption level among farmers.

3.4.2(a) Adoption rate

Adoption rate was computed for every farmer. It was based on expressing the number of farmers adopting a particular variety as a percentage of the total number of farmers under study. It is expressed as:

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

Where:

β_v = Adoption rate for early maturing maize variety v

β_{vi} = Adopter of early maturing maize variety v by ith farming households

β = Number of maize farmers (300)

i = 1, 2…....n

$\sum$ = Summation

3.4.2(b) Level of adoption

Level of adoption can be calculated by measuring each of the agronomic practices like plant distance, time of planting and plant density. In this study level of adoption was computed using the percentage on the size of land cultivated for maize all over the total farm size of the i^{th} farmer as shown below.

Adoption Index = ——————————————— X 100

This will satisfy objective i of the study.

3.4.3(a) Probit regression model

The specification of the Probit model follows that in the process of planting early maturing maize varieties, farmers have to decide between two choices, and if *Y* is the outcome from the choice, then:

$Y_i = 1$, if the farmer plants the early maturing maize varieties introduced.

$Y_i = 0$, if the farmer does not plant the early maturing maize varieties introduced

Either choice yields a utility index, U_i, that the individual farmer, *I*, acts to maximize. If U_i^* is the critical or threshold level, at which decision to plant occurs, then:

$Y_i = 1$ if $U_i > U_i^*$

$Y_i = 0$ if $U_i \leq U_i^*$ ---------- (2)

The non-observable underlying utility function which ranks the preference of the *ith* farmer can be expressed thus:

$$\sum_{n=1}^{N} Bn\ Xni\ ei \text{ ---------- (3)}$$

Where

Xni = the nth variable of the *ith* observation

Bn = the nth parameter to be estimated

The probability Pi for the farmer i to adopt the varieties is then:

$P_i = P\ [Y = 1] = P\ [U_i > = U_i^*] = P\ [U_i^* < = U_i]$

Since U_i^* is a discrete random variables, if F [*] is its cumulative distribution function, then,

$P\ [Y = 1] = P\ [U_i^* < = U_i]\ F\ [U_i]$

$P[Y\text{-}1] = 1 - F\ [U_i]$ ---------- (4)

The form of F [*] is determined by the probability density function of the random variable U_i.

Equation [ii] is a form of generalized linear models which can be rewritten as follows:

The Linear form of the model is specified as:

$$Y_i = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \mu \ldots\ldots (5)$$

X_1 = Age of the farmer (in years)

X_2 = Years of formal education

X_3 = Number of years of farming experience

X_4 = Previous season farm income for maize (Naira)

X_5 = Farm size (hectares cultivated for maize per season)

X_6 = Access to credit (Amount of credit accessed during production season)

X_7 = Extension contact (Number of extension contacts during the production period)

X_8 = Household size (number of person in the household)

X_9 = membership of association (Years spent in association)

α = constant term

μ = disturbance term or error term

$\beta_1 \ldots \beta_9$ are the regression coefficients of the independent variables.

This model was used to achieve objective ii of this study.

3.4.3(b) Tobit regression model

The Tobit model was used in analyzing the extent of adoption of early maturing maize varieties by maize farmers. The model is appropriate in explaining relationship involving a continuous dependent variable and a set of independent variables (Bamire *et al.*, 2001). The advantage of the Tobit model over the dichotomous choice models such as the Probit and Logit models is that it permits the intensity of use of technology once adoption has taken place.

In its simplest form, the Tobit model is presented as:

$Y_i^* = BX_i + \mu$…… (6)

Algebraically expressed for the *ith* farmer,

$Y_i = B_0 + B_1X_1 +$ ----------B_nX_n, i= 1……..n…… (7)

0 if $Y^* \leq T$

$Y_i = Y$ if $0 < Y^* < 1$ (i= 1…n)…. …… (8)

$Y_i > T$

Where:

Y_i= the observed dependent variable *i.e.* the total land area under early maturing maize cultivation measured in hectares;

Y^*= the non-observable latent variable representing the use of maize variety;

T = the critical (cut off) value which translates into Y*

i >T as a farmer adopts, and Y*

i < Tas a farmer rejects the early maturing maize varieties; and n= the number of observations.

3.4.4 Stochastic frontier production model

This was used to estimate the economic efficiency of adopters and non-adopters. The farmer's economic efficiency will be estimated as the product of technical and allocative efficiencies. This model was used to estimate objective iv of the study.

A-Cobb-Douglas stochastic frontier production function

$\ln Y_i = \text{Ln } A + \sum_{i=1}^{5} \beta i Ln X_i + V_i - U_i$ .....(9)

$\ln Y = b_0 + b_1 lnX_1 + b_2 lnX_2 + b_3 lnX_3 + b_4 lnX_4 + b_5 lnX_5 + v - \mu$ .....(10)

Where,

Y = Output for maize in Kg

X_1 = Quantity of pesticides in liters

X_2 = Quantity of fertilizers used in Kg

X_3 = Quantity of labor in Mandays

X_4 = Quantity of seed in Kg

X_5 = Farm size in Ha

b_0 = intercept

b_{ij} = vector of production parameter to be estimated

v_i = random variability in production that cannot be influenced by the farmer.

u_i = Technical inefficiency.

The technical inefficiency effect u_i is defined by:

$u_i = \alpha_0 + \alpha_1 Z_{1i} + \alpha_2 Z_{2i} + \alpha_3 Z_{3i} + \alpha_4 Z_{4i} + \alpha_5 Z_{5i} + \alpha_6 Z_{6i} + \alpha_7 Z_{7i}$ .....(11)

Where:

u_i = Technicalin efficiency

X_1 = Age of the farmer (years)

X_2 = Years of formal education (years)

X_3 = Number of years of farming experience (years)

X_4 = Household size (number of person in the household)

X_5 = Access to credit (Amount of credit accessed during production season in naira)

X_6 = Extension contact (Number of extension contacts during the production period)

X_7 = Membership of association (Years spent in association)

α_0 = constant

X_1 -X_8 = parameters to be estimated

B-Cobb-Douglas stochastic frontier cost function

$\ln C_i = \text{Ln } A + \sum_{i=1}^{4} \beta i Ln P_i + V_i + U_i$ ……(12)

$\ln C = b_0 + b_1 lnP_1 + b_2 lnP_2 + b_3 lnP_3 + b_4 lnP_4 + v + \mu$ …… …....(13)

Where,

C = Total cost of production of i^{th} farm in Naira

P_1 = Cost of pesticides in Naira

P_2 = Cost of fertilizers used in Naira

P_3 = Cost of labor in Naira

P_4 = cost of seed in Naira

b_0 = intercept

b_{ij} = vector of cost parameter to be estimated

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

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

The stochastic frontier function estimated by the Maximum Likelihood Estimation (MLE) will be used. This was computed using the computer frontier Version 4.1 (Coelli, 1996).

Economic Efficiency (EE) = Technical Efficiency (TE) □ Allocative Efficiency (AE)

3.4.5 Estimation of food security

The food security line was used to estimate the food security status of farmers in the study area, which was used to achieve objective (v). This was used to classify farmers 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 capital calorie intake of 2260 kilo calorie (kcal) (FAO, 1996). A farmer whose daily per capita intake is up to 2260 kcal was regarded as food secure and those whose daily per capita intake is below 2260 kcal were regarded as food insecure. This method has been applied to several studies whose main focus was on food security (Babatunde *et al.*, 2007).

The food security line is given as: $Z = \frac{Y_i}{R}$……. …….(14)

Where:

Z_i = food security status of i^{th} farmer.

Y_i = daily per capita calorie intake of i^{th}household.

R = recommended per capita calorie intake (2260 kcal).

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 households based on the food security line. The shortfall index measures the extent to which poor households are food insecure while the headcount ratio measures the percentage of the population that is food insecure/secure.

Shortfall index = $\frac{1}{M}\left(\sum_{i=j}^{M} G_i\right) = \frac{1}{M}\left(\sum_{i=j}^{M} \frac{Y_{i-R}}{R}\right)$ ..... (15)

Head count ratio $= \frac{M}{N}$..... (16)

Where:

M = the number of food insecure households.

G_i = per capita calorie intake deficiency for i^{th} household

N = number of households sampled.

3.4.6 Double Difference Method

$$DD = \left[\left(\frac{1}{N_A}\sum_{1=i}^{N_A}\left(\bar{Y}_1^A - \bar{Y}_0^A\right)\right) - \left(\frac{1}{N_{NA}}\sum_{1=j}^{N_{NA}}\left(\bar{Y}_1^{NA} - \bar{Y}_0^{NA}\right)\right)\right] \ldots\ldots\ldots\ldots\ldots\ldots\ldots (17)$$

Where,

$\bar{Y}_0^A$ = Average income (₦) of the adopters 2008

$\bar{Y}_1^A$ = Average income (₦) of the adopters 2012,

$\bar{Y}_0^{NA}$ = Average income (₦) of the non-adopters 2008,

$\bar{Y}_1^{NA}$ = Average income (₦) of the non-adopters 2012,

N_A = number of adopters

N_{NA} = number of non-adopters

DD = the difference between the average changes in the income for the adopters and non-adopters.

It is common to find difference in difference estimators presented in a table as follows:

Table 1 Double difference estimate of the impact of adoption of early maturing maize varieties on farmers' income

	2008	**2012**	**Difference between periods**
Adopters	$\bar{Y}_0^A$	$\bar{Y}_1^A$	$\bar{Y}_1^A - \bar{Y}_0^A$
Non-adopters	$\bar{Y}_0^{NA}$	$\bar{Y}_1^{NA}$	$\bar{Y}_1^{NA} - \bar{Y}_0^{NA}$
Difference between	$\bar{Y}_0^A - \bar{Y}_0^{NA}$	$\bar{Y}_1^A - \bar{Y}_1^{NA}$	$\bar{Y}_1^A - \bar{Y}_1^{NA} - (\bar{Y}_0^A - \bar{Y}_0^{NA})$

groups

This tool was used to achieve objective (vi).

3.4.7 Z-statistics

Z-Statistics was used to test significant difference between the two populations. It is ex pressed as:

$$Z = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}} \quad \text{..... (18)}$$

Where,

$\bar{x}_1$ = Mean value of income for adopters

$\bar{x}_2$ =Mean value of income for non-adopters

$S^2{}_1 \; and \; S^2{}_2$ = variance of income for adopters and non-adopters respectively

$n_1 \; and n_2$ = corresponding sample size associated with adopters and non-adopters respectively.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Socio-economic Characteristics of Respondent Farming Households

4.1.1 Demographic/socio-economic characteristics of respondents

This section examined the distribution of respondents by gender, age, household size, education, farming experience, extension contacts, sources of information, membership of association, credit facilities and labour force.

Gender: The result of the analysis showed 88% of households were headed by males and 12% were female headed in the study area. The result is in agreement with findings of Yanguba (2004) who reported that 96% of farm households surveyed in Katsina State were male headed. Mbavai (2013) reported similar trend in a study of cowpea farmers in Musawa LGA of Katisna States. Idrisa (2009) reported that 70% of households were headed by male in a study of farm households in southern part of Borno State. This result shows that men are more involved in maize farming. Because of the influence of tradition and religion women are generally restricted to their compounds who process food for consumption. Some household heads prefer to engage their wives in non-farm activities.

Age: Results from the study show that majority of the farmers were between the ages of 35-54. Thirty-six percent of the respondents were aged 35-44 years while 32.7% were aged 45-54%. The average age of respondent was 44years. Mbavai (2013) reported active age of 25-54 years for farm households surveyed in Musawa LGA of Katsina State, Nigeria. Idrisa (2009) reported 40 years as active age of farmers for farm households in Southern Borno, Nigeria. This result agree with those of Mbavai (2013),

Idrisa (2009), Kamara (2009), Akudugu, Guo and Dadzie (2012), Mignouna *et al*. (2013) which showed the farming population in the study area and that of northern Nigeria generally is relatively young. This means that there is an active labour force available for farming.

Table 2: Socio-economic characteristics of respondent farming households

Variables	**Adopters**	**Non-adopters**	**Pooled**
Male-headed households (%)	92.7	84.0	88.0
Age			
<24	0.6	-	0.3
25-34	8.6	14.6	11.3
35-44	37.4	34.3	36
45-54	31.1	34.3	32.7
55-64	14.1	13.1	13.7
>65	8.0	3.6	6
Age of household heads (Average)	42	43	44
Average Household size	9	13	11
Dependency ratio	1.36	1.61	1.49
Level of Education (%)			
No formal	11.7	16	14
Primary	12.4	12.3	12.3
Secondary	13.9	7.4	10.3
Tertiary	5.1	2.5	3.7
Islamic	56.9	62	59.7
Average years of schooling	6	5	5
Years of farming experience (%)			
1-10	16.1	17.8	17
11-20	35	29.4	32
21-30	24.1	25.4	24.7
31-40	19	21.8	20.6
41-50	5.8	5.8	5.7
Average years of farming	25	24	25
Contact with Extension Agent (%)			
Contact	86.9	68.1	76.67
No Contact	13.1	31.9	23.33

Household size: Result from the study shows that about 80% of responding households had not less than nine members. The average household size in the study area was 11 persons per household. Household size determines the available human labor force that can be employed in carrying out crop production activities. The major source of human labor supply in traditional agricultural production, which is labor intensive, is family labor. It is expected that family labor would be more available where the farmers are married and it also determines the size of a household. Agwu (2004) in his work discovered an average of seven people per household, Amos (2007) found average household size to be Nine persons; Idrisa (2009) in his findings recorded an average of Seven persons while Mignouna *et al*. (2013) in his result documented an average of Nine persons per family. According to them, household size determines the availability of household labour supply.

Dependency Ratio: The result from this work showed the dependency ratio of 1.49. This implies that there are more dependents (children below 15 years old and adults above 64 years old) compared to adults (>15 years and <64 years old) in the study area. This finding is in-line with Mignouna *et al*. (2013) whose result showed a dependency ratio of 1.29 and they concluded that the sampled population in their study area was more dependents.

Education: The result shows that 14% of the respondents had no formal education, 12.3% had primary school education, 10.3% had secondary school education, 3.7% had tertiary education and Islamic education had 59.7% which is the highest. Education increases the ability to assess, interpret, and process information about a new technology, enhancing farmers' managerial skills including efficient use of agricultural inputs. From

the result majority of respondents had Islamic education. This is due to the fact that the study area is a predominantly Muslim community where Islamic knowledge is given a high priority. The low level formal education in Safana LGA might limit adoption of the technology. This result contradict the results of Bonabana-Wabbi (2002) in Uganda, Jones (2005) in Togo-Benin, Muyange (2009) in Kenya, Kudi et al. (2011) in Kwara (Nigeria) who reported high level of formal education among households in their study areas. High level of formal education in a study area would mean that majority of farmers are expected to accept new technology within a relative shorter period of time.

Farming Experience: The distribution of respondents based on years of farming experience shows that 17% of maize farmers in the study area had experience in maize production from 1 and 10 years, 32% had been producing maize for eleven and twenty years, 24.7% had experience for twenty-one to thirty years, 20.6% had experience for thirty-one to forty years and 5.7% had experience for more than forty-one years. The mean years of experience for the farmers were 25 years. This implies that majority of maize farmers had long period of farming experience and therefore would be conversant with constraints to increased maize production. Yanguba (2004) found similar result in his work that farmers in Katsina had 24 years farming experience. Agwu (2004) found that, the average number of years of farming experience of the farmer was 22.6 years.Bello *et al.* (2012) found out that most (83.70%) of the respondents in Jenkwe Development Area of Nasarawa State, Nigeria had above 10 years of farming experience. Years of experience in farming were important because management skills of farmers improved with experience.

Contact with extension agents.

The result from Table 2 showed that both adopters and non-adopters had contact with extension agents to a percentage greater than 60%. About 86.9% of the adopters had contact with an extension agent while 13.1% had no contact with extension agents. About 68.1% of non-adopters had contact with extension agents while 31.9% did not. Farmers must have information about the intrinsic characteristics of improved varieties before they can consider planting them or not. Contact with extension agents exposes farmers to information on new ideas and technologies. The contact with extension agents among both adopters and non-adopters was quite encouraging because a farmer had at least one contact with an agent. This was probably due to the fact that the Sudan Savanna Taskforce through it researchers and extension agents was always available to train and supervise it adopters. Ayayi and Solomon (2010), Ede (2011), Gama (2013) found that about Fifty-Three percent and above of the respondents in their study area had contact with extension agents.

4.1.2 Sources of information on early maturing maize varieties

The result on Table 3 reveals that majority (41%) of farmers got the information on early maturing maize varieties from extension agents. The impact of this information on farmers' decisions varies according to its channel, sources, content, motivation and especially, frequency of visit. Also, it could be due to the various interventions received by Safana LGA through different Governmental and Non-Governmental Organizations. Access to extension or training is typically thought to reduce the risk of farmers not accepting improved technologies. The role of information in influencing improved farm management was significant in a study by Feather and Amacher (1994) on Best Management Practices in the US. Giving producer's information regarding the economic profitability and environmental benefits of the innovation led to higher

acceptance rate. Adesope *et al.* (2012), Ango *et al.* (2013) found in their study that respondents (farming households) had good source of information on agricultural technologies.

Table 3: Classification of responses based on sources of information on early maturing maize varieties

Sources of Information	**Adopters**	**Non-adopters**	**Pooled**
0	4(2.9)	32(19.6)	36(12.0)
1	0	1(0.6)	1(0.3)
1, 2	11(8.0)	19(11.6)	30(9.9)
1, 2, 5	2(1.5)	3(1.8)	10(3.3)
1, 3	5(3.6)	4(2.4)	5(1.6)
1, 3, 5	5(3.6)	2(1.2)	9(3.0)
1, 5	9(6.5)	10(6.1)	7(2.3)
1, 2, 3	5(3.6)	5(3.1)	19(6.3)
2	3(2.2)	7(4.3)	11(3.6)
3	24(17.5)	5(3.1)	29(9.7)
3, 5	0	2(1.2)	3(1.0)
4	3(2.2)	1(0.6)	4(1.3)
5	5(4.4)	7(4.3)	13(4.3)
6	58(42.3)	65(39.9)	123(41.0)
Total	137(100)	163(100)	300(100)

0=no response, 1=market visit, 2=TV/Radio, 3=other farmers, 4=middlemen, 5=friend/relative, 6=extension agents. Figures in parenthesis are percentages

4.1.3 Membership of Association of early maturing maize varieties farmers

Analysis on Table 4 shows the distribution of respondents based on membership of associations. Obviously, the percentage of membership was higher among the adopters (72.1%). About 46.6% of the non-adopters had nothing to do with an association. The average years spent in an association was five years for adopters and three years for non-adopters. The overall mean number of years respondents were registered as members of an association was 4 years. Membership of an association enables farmers to interact with other farmers, share their experiences and assist themselves. Interaction of farmers with other farmers is an avenue through which innovation diffusion can occur. According to Oboh *et al*. (2008) membership of an association or any farming group is a strong determinant of adoption of cassava varieties in Benue State. Similarly, Idiong *et al*. (2006) found that membership of associations enabled women to acquire more land compared to those who were not members.

Table 4: Membership of Association of early maturing maize varieties farmers

Variable	**Adopters**	**Non-adopters**
Member	99(72.3)	87(53.4)
Non Member	38(27.7)	76(46.6)
Total	**137(100)**	**163(100)**

Figures in parenthesis are percentages

4.1.4 Credit facilities on early maturing maize varieties

The result presented on Table 5 shows that only 11.7% adapters had access to credit and 10.4% for non-adopters. The importance of agricultural credit in production cannot be over emphasized. It increases the purchasing power of farmers and adoption of

improved technology. The study observed that the crop farmers in the study area used different amounts of credit to finance their production activities. Results from this study showed that very few farmers have access to credit which may limit their ability to expand production of maize. This finding agrees with Idrisa (2009), Ayayi and Solomon (2010), Adesope *et al.* (2012) found out that credit availability was very essential for agricultural productivity.

Table 5: Access to Credit on early maturing maize varieties

Variable	**Adopters**	**Non-adopters**
Yes	16(11.7)	17(10.4)
No	121(88.3)	146(89.6)
Total	**137(100)**	**163(100)**

Figures in parenthesis are percentage

4.1.5 Labour force on early maturing maize varieties

The result on the Table 6 indicated that about 49.6% of adopters and 38.7% of non-adopters used only family labour, while about 11.7% and 36.8% employed solely hired labour for adopters and non-adopters respectively, and 38.7% and 24.5% combination of family and hired labour respectively. The crop farmers were distributed based on the source of human labour employed in their crop production process. This further explains why household size is large.

Table 6: Labour force on early maturing maize varieties

Variables	**Adopters**	**Non-adopters**
Family Labour	68(49.6)	63(38.7)
Hired Labour	16(11.7)	60(36.8)
Family and Hired Labour	53(38.7)	40(24.5)
Total	**137(100)**	**163(100)**

(*Figures in parenthesis are percentages)*

4.2 Rate and Level of Adoption of Early Maturing Maize Varieties in the Study Area.

4.2.1 Awareness

Awareness represents the knowledge of the innovation's existence. This type of knowledge can motivate the individual to learn more about the innovation and, eventually, to adopt it. This variable is intended to capture the target populations' existing awareness of the innovation and whether more time will be needed for the target population to become aware that the innovation exists and is suitable for their local environment. Analysis on Table 7 shows that there was really no significant difference in awareness between the two groups. Adopters had 100% awareness whereas non-adopters had 81.6% and 18.4% for awareness and no awareness respectively for early maturing maize varieties. Baseline reports shows that as at 2008 level of awareness on early maturing maize varieties was 36% in sorghum-legume-livestock (SLL) IP, Ayanwale (2013). This implies that there has been an increase in the level of awareness due to field demonstration which is an important method of extension to create awareness among the farm community. The finding indicates that there is scope for increasing the adoption of improved early maturing maize varieties in Safana since the farmers are aware of the technologies. It is one of the types of knowledge of an innovation that is a prerequisite for adoption (Rogers, 2003). The result of Kudi *et al*. (2011) is in conformity with this research work. Their study revealed that all the farmers in the two wards were 100% aware of the early maturing maize varieties and the most important sources of information on the early maturing maize varieties were extension agents and other farmers. This research finds contradict that of Ayayi and Solomon (2010) who found out in their study that majority of the

respondents were not aware of some of the major oil palm technologies which probably lead to non-adoption of most of these major technologies.

Table 7: Level of Awareness of Early Maturing Maize Varieties

Variable	Adopters	Non-adopters
Aware	137(100)	133(81.6)
Not Aware	00	30(18.4)
Total	**137(100)**	**163(100)**

Figures in parenthesis are percentages

4.2.2 Adoption rate of early maturing maize varieties in the study area

The estimated adoption rate of early maturing maize varieties is showed in Table 8. The result shows that a larger proportion of farming households adopted 99EVDTWSTR (SAMMAZ 27) with an adoption rate of 28.67% this implies that 28.67% of the adopters of early maturing maize varieties in the study area adopted SAMMAZ 27. 2009EVDTWSTR had an adoption rate of 10% which implies that 10% of adopters adopted this variety. The variety 99TZEEYSTR had an adoption rate 1.33%. ACR95TZE COMP5W had the lowest adoption rate of 0.67%. 2000 SYNEE had adoption rate of 5% indicating that 2000 SYNEE was only adopted by 5% of the adopters of early maturing maize varieties in the study area.

Result from the study showed that out of three hundred maize farmers sampled, 137 farming household adopted the varieties with a general adoption rate of 45.67% this indicated an increase in adoption. Ayanwale *et al*. (2013) in the baseline report reported that as at 2008 adoption rate of early maturing maize varieties in Safana LGA was 36%. This implies that there is an increase in adoption rate by 9.6%. This result coincide with that of Saka and Lawal (2009), whose result shows that farmers in their study area responded appreciably to intervention programme that promote the use of improved rice

varieties with an adoption rate of 68.7% which has resulted in an estimated proportional production increase of 19.4%.

The variation in adoption rate of the varieties as indicated by respondents could depend on farmers' interest in the technology. It is logical that farmers will adopt more of a variety or technology if they are interested. In a nutshell, awareness and interest of a technology is a motivational factor that affects the adoption of any technological package. In this study, it was discovered that most of the respondents adopted 99EVDTWSTR (SAMMAZ 27). This is because this variety has high yield, drought tolerant, food security and *striga* resistant, as any other variety introduced in Safana. Results of this study is in-line with Salisu *et al*. (2007), who noted that farmers adopted various aspect of improved livestock technology interest if they are interested. Kamara (2010) found TGX 1448-2E soybean variety to be the popular because it was the single variety introduced to the farmers during the first three years of the project. Yanguba (2004) found 95 TZEE W 1 (Extra-early, White) to be the preferred maize variety reason been that it pure white grain is used to replaced sorghum for their local dish called *tuwo*.Mihiretu (2008) in a study on onion in Ethiopia found that Bombay Red variety was the most preferred reason been that they are improved, good yield, large bulb size and good bulb colour over other varieties.

Table 8: Estimated adoption rate of early maturing maize varieties of farmers in the study area

Early maturing maize Varieties	**Frequency of adopters**	**Adoption Rate (%)**
99EVDTWSTR (SAMMAZ 27)	86	28.67
2009EVDTWSTR	30	10
99TZEEYSTR	4	1.33
ACR95TZE COMP5W	2	0.67

4.2.3 Factors influencing the adoption of early maturing maize Varieties

Nine variables were hypothesized to influence the probability of farmers' adoption of early maturing maize varieties as showed on Table 9. These factors are: age of household head, education level of household head, household size, farm size, years of farming experience, membership of an association, number of extension contacts, amount of credit, and previous farm income for maize.

Table 9: Factors Influencing the Adoption of early maturing maize Varieties.

Variables	Coef.	Std. Err.	Z	P>|z|
Educational Level of farmer	0.20009	0.05722	0.35	0.727
Age of farmer	-0.29155**	0.14038	-2.08	0.038
Income	0.02342***	7.59	2.79	0.005
Household Size	0.004197	0.01457	0.29	0.773
Farming Experience	0.016099	0.01292	1.25	0.213
Number of Extension Contacts	0.078975*	0.044	1.79	0.073
Years of Participation in an association	0.074580***	0.02271	3.28	0.001
Amount of Credit	-2.04	0.000012	-0.02	0.986
Size of Farm	3.04290***	0.36916	8.24	0.000
Constant	0.03640	0.80978	0.04	0.964
Log likelihood = -142.88251				
Pseudo R^2 = 0.3091				

***P<0.01; **P<0.05, *P<0.10

Out of the 9 variables hypothesized to influence the probability of farmers' adoption to early maturing maize varieties, five (5) were found to be significant at 1%, 5% and 10%

probability levels. These variables include farmers' size of land for maize cultivation, farmers' participation in an association, number of extension contacts, age of farmer and income from sales of maize.

The role of a farmer's age in explaining technology adoption has been controversial. In this study, age of farmer was negative and significant at 5% level of probability, suggesting that the older the farmer, the lesser his adoption level. Younger farmers are likely to take up new technology than older farmers being that they are risk bearers in decision making, less responsibility and more adventurous than older farmers. On the other hand, it may be that older farmers may have extra resource that makes it more likely for them to try new technologies. This result is similar to the findings of Muyanga (2009) and Yanguba (2004), which suggest that older people are sometimes thought to be less amenable to change and hence reluctant to change their old ways of doing things. In this case, age is expected to have a negative impact on adoption. On the other hand, older people may have higher accumulated capital, more contacts with extension and preferred by credit institutions predisposing them more to technology adoption than younger ones. This is in-line with Kamara (2010) who found in her study that the adoption of soybean in Borno State was positively influenced by female farmers suggesting that younger women are less involved in farming thereby limiting their participation in project activities.

The estimated parameter for income was significant at 1% probability level and it was positive. This implies that the higher the income of respondent, the higher their level of adoption. The more famers adopt early maize varieties, the more the sales and income they will get and invariably, the better their standard of living. This finding is in line

with Bello *et al*. (2012) who confirmed that the positive relationship between income and adoption of Crop-Based Technologies. This implied that availability of income enhanced farmers' ability to purchase the inputs embodied in the new technology and paid for hired labor needed for the use of these inputs and improved management practices for greater productivity.

The parameter estimate for farmers' contact with extension agents was found to be positive and significant at 10% level of probability. This implies that farmers who had more interactions with extension workers adopted more of the early maturing maize seeds as production technology compared to farmers who had less interaction with extension agents. Increased frequency of interaction between extension agents and farmers results in better technical support received by farmers. This greatly increases farmers' knowledge of the benefits of technologies. Hence, it can motivate farmers into using more of the technology. This is in-line with the findings of Ebojei *et al*. (2012) which also suggested that participation in hybrid maize could be motivated by frequent contacts with extension agents. Extension agents popularize innovation by making farms exchange idea, experiences, and make it cheaper to source information, knowledge and skills in order to enable farmers to improve their livelihood. Farmers who have frequent contacts with extension agents had a higher probability of participation in the innovation. This was presumed; as farmers were privileged with materials and managerial support, followed by cheap and timely availability of knowledge and skills, which apparently helped them, apply new technology.

Membership in an association was found to be positive at 1% significant level of probability. This implies that membership in an association will lead to an increase in

adoption of early maturing maize varieties. The membership of social organizations and cooperatives enhances the interaction, exchange and cross-fertilization of ideas among farmers. Hence, it offers an effective channel for extension contact with large number of farmers as well as opportunities for participatory interaction with extension organization. This result is similar to that obtained by Zavale (2005) which says that membership of organization or cooperative indicates the intensity of contacts with other farmers. Kamara (2010) also found out that membership of an association was significant in influencing the adoption of improved soybean production among male and female farmers in Borno State. Farmers who do not have contacts with extension agents may still be informed about new technologies by their peers.

Farm size was also found significant at probabilistic level of 1%. This variable is expected to have positive relationship with farmers' adoption decisions. Farmers with larger farms will be more willing to devote portion of the land to an untried variety compared to those of smaller farms. This is because the lager the farm size cultivated the higher the tendency to adopt. Therefore farm is expected to have a positive impact on adoption. The Farm size influences households' decision to adopt or to reject new technologies. Hence, land holding was hypothesized to have positive and significant relationship with adoption and intensity of adoption. The finding corresponds with that of Kamara (2010) and Bamire *et al* (2010). Feeder *et al.* (1985) in Ebojei *et al*. (2012), assert that, the positive and significant coefficient of farm size indicates its positive influence on participation in technology adoption. They said it may be because the farm size is a surrogate for a large number of factors such as size of wealth, access to credit, capacity to bear risk, access to information and other factors.

Farming experience, household size and educational level of farmer, amount of credit had no significant influence on the adoption of early maturing maize varieties in the study area.

In this study, it was hypothesized that there is no significant relationship between adoption of early maturing maize varieties and socio-economic characteristics of farmers. This hypothesis was examined by testing the variables using the probit regression model. The result of the probit model shows that five (5) were found toinfluence the probability of farmers' adoption to early maturing maize varieties.This implies that the null hypothesis which states that there is no significant relationship between the adoption of early maturing maize varieties and socioeconomic characteristics of farmers will be rejected.

4.2.4 Adoption Level of early maturing maize varieties in the study area

Adoption level in this study was based on the varieties used by respondents. The adoption level represents the size of plot allocated for that variety as a percentage of the total size of farm land for production. In this study, five varieties were given to farmers. Below are the adoption indexes for each variety on Table 10.

The mean level of adoption of 99EVDTWSTR (SAMMAZ 27) is 64.91%, with maximum and minimum of 80.3 and 45.45 respectively. Out of 137 adopters, farmers who adopted this variety are 86 meaning it is the most adopted. This implies that the level of awareness for this variety was very high as compared with the other varieties.
Out of 137 adopters, 30 farmers adopted 2009EVDTWSTR with mean level of 59.47%. The minimum and maximum adoption levels are 47.57 and 69.88 respectively. This variety is the second most preferred with frequency of 30. 99TZEEYSTR was adopted

by only 2 farmers with mean of 55%. The maximum mean is 65% while minimum mean is 45%. This implies that out of 137 farmers only 2 farmers adopted this variety. The mean intensity of ACR95TZE COMP5W is 100%, with maximum and minimum intensity of 100% and 0%. Out of the total number of adopters (137) just 2 farmers adopted this variety. This variety had the lowest level of adoption. This could be the cause of no or low awareness, limited extension contact and no training. With 2000 SYNEE which has a mean intensity of 81.3%, 15 farmers out of 137 farmers adopted the variety with maximum and minimum mean intensity of 86.15% and 50% respectively.

Table 10: Estimated adoption level of early maturing maize varieties of farmers in the study area

Early Maturing Maize Varieties	**Range of Adoption**		**Adoption Level**		
	01-50	**51-100**	**Min**	**Mean**	**Max**
99EVDTWSTR (SAMMAZ 27)	38(44.19)	48(55.81)	45.45	64.91	80.9
2009EVDTWSTR	14(46.67)	16(53.33)	47.57	59.47	69.88
99TZEEYSTR	2(50)	2(50)	45	55	65
ACR95TZE COMP5W	00	2(100)	00	50	100
2000 SYNEE	2(13.3)	13(86.7)	50	81.3	86.15

(Figures in parenthesis are percentages)

4.2.5. Factors that determine the extent of adoption of early maturing maize varieties.

The factors that determine the extent of adoption of early maturing maize varieties by farmers in the study area was examined, using the Tobit model. The factors that determine the extent of adoption was measured in terms of percentage of land allocated to early maturing maize varieties by farmers. The study revealed that some socio-economic factors, such as farm size, labour force, number of extension contact and yield

(Table 11) were significant in influencing the intensity of adoption of early maturing maize varieties by farmers in the study area.

Farm size: The analysis on Table 11 shows positive and significant relationship between size of farm holding and the extent of early maturing maize varieties. The regression value was positive and significant at 1% level of probability. Farm size has bearing on the capacity of farmers to adopt improved technologies and new farm practices. Farmers with large farm size can afford to devote part of their farms for maize production without significantly affecting the total land left for the production of the staple food crops compared to small land holders. Land size is also one of the indicators of the level of economic resources available to farmers (Ajibefun, 2006).

Number of extension contacts: Frequency of contact between farmers and extension personnel ($\rho \leq 0.05$) positively and significantly influenced the extent of adoption of early maturing maize varieties by the respondents. Extension contact determines the information that farmers obtain on production activities and the application of innovations through counseling and demonstrations by extension agents Idrisa, Ogunbameru and Madukwe (2012). For instance, Onu (2006) found that farmers who had access to extension contact adopted alley farming technologies 72% greater than farmers who had no access to extension contact. This could be because increased farmers' interaction with extension personnel in the form of multiple visits by extension agents, and technical support to farmers greatly increases farmers' knowledge of available technologies and their potential benefits, hence acting as a trigger mechanism for intensive adoption. The result agrees with the findings of Lawal and Oluyole (2008) in their study on adoption of research results and agricultural technologies among cocoa farming households in Oyo State, Nigeria; reported that frequency and timely contact

with extension workers will increase a farmer's probability of adopting technologies and it is significant at 1% level of probability.

Labour: Results in Table 11 also revealed a positive and significant relationship between labour and the extent of adoption of early maturing maize varieties in the study area. The value was significant at 5% level of probability. Labour has been recognized (Bamire *et al*., 2002) to play a vital role in the adoption of any particular technology or farm practice. On the one hand, family provides the human labor and management inputs. This can affect the level of use of technologies in terms of quality of management decision and the availability of labor required by the technology in question. On the other hand, family size can create certain demand which may motivate the adoption of new practices or technologies that would increase the farmers' income as a means of meeting these demands.

Analysis on Table 11 revealed that **yield** from maize production was positive and significant at 1% level of probability. This implies that there is a positive relationship between yield and the extent of adoption of early maturing maize varieties in Safana LGA. Thus, increase in yield will lead to increase in adoption of early maturing maize varieties by the farmers. Yield is a direct measure of seed's performance, and a crop variety that is high yielding stands to be adopted by farmers since high yield would raise output and gross earning. This finding collaborate the findings by Kamara (2010) on factors influencing the adoption of soybean production among male and female farmers in Borno State which stated that yield was found to significantly influence adoption of improved soybean varieties among women. This finding is also in-line with the finding

of Kudi *et al*. (2011) that reported that yield significantly influenced farmers' decision to adopt new maize varieties in Kwara State, Nigeria.

Table 11: Tobit Estimate of Factors determining the Extent (Intensity) of adoption of early maturing maize varieties

Variable	Coef	Std Err	T	p>(z)
Constant	-126.206***	28.403	-4.443	0.000
Age	-0.195	0.426	-0.459	0.646
Education	2.481	12.888	0.193	0.847
Household Size	0.579	1.053	0.549	0.583
Credit	0.0002	0.003	0.060	0.952
Size of Farm	98.024***	12.675	7.734	0.000
Gender	1.809	12.881	0.140	0.888
Number of Extension Contact	4.754**	2.236	2.127	0.034
Years of Participation	1.663	1.229	1.353	0.176
Yield	0.282***	0.099	8.258	0.005
Labour	1.327**	0.595	2.231	0.026

***P<0.01, **P<0.5

4.3 Constraints Faced by Farmers in the Project Area.

The result of the analysis of constraints faced by farmers in the project is shown on the Table 12. The result showed that inadequate fertilizer was the highest (92.67%) constraint. An important factor in explaining adoption pattern is the availability of complementary inputs. Most farmers will not adopt high yielding varieties such as early maturing maize varieties unless both seed and fertilizers are available. High cost of fertilizer was the second constraint with 70.67% which implies that the cost of fertilizer in Safana LGAs is very expensive beyond the reach of the poor farmer as it was purchased in the open market. Inadequate credit as the third constraint (61.67) reduces farmers' availability to purchase the necessary complementary inputs. Inadequate seed

was the fourth constraint (57), this unavailability of seed and inadequate fertilizer was a constraint to adoption as all of the varieties need fertilizer for maximum output to be realised. This implies that cost of production will be high on them. Similarly, Gyasi *et al*., (2003) discovered that inadequate seeds and fertilizer were the major constraints to the adoption of early maturing maize varieties in northern Ghana. Drought and low yield were the, fifth and sixth constraints faced by farmers in the study area with percentages, 51.67 and 50 respectively. Other constraints were high cost of seed, disease, pest, *striga* infestation, low market prices and high labour cost.

The implication of this finding is that the maize farmers in the study area are producing under small/little profit resulting from high costs of production inputs and low output prices. This ultimately forced them to produce mainly for subsistence purpose to feed themselves and their families. This finding is in conformity with Kudi *et al*. (2011). They found out that the major constraints identified in their study were high cost of fertilizer and cost of labour, inadequate of capital, inadequate of contact with extension agents and inadequate of market for produce. Kamara (2010) also revealed that fertilizer both in terms of availability and affordability was a major problem in her study.

Table 12: Constraints Faced by Farmers in the production of early maturing maize varieties

Constraints	Frequency*	Percentage	Rank
Inadequate fertilizer	278	92.67	1st
High cost of fertilizers	212	70.67	2nd
Inadequate credit	185	61.67	3rd
Inadequate seed	171	57.00	4th
Drought	155	51.67	5th
Low yield	150	50.00	6th
High cost of seeds	142	47.33	7th
Disease	124	41.33	8th
Striga infestation	114	38.00	9th
Low market prices	109	36.33	10th
High labor cost	94	31.33	11th

Multiple Choice*

4.4 Technical, Allocative and Economic Efficiency of Farmers

4.4.1 Farmers' technical efficiency

Technical efficiency is a component of economic efficiency and reflects the ability of a farmer to maximize output from a given level of inputs. The estimation of the Cobb–Douglas stochastic production functions simultaneously with the technical inefficiency effects using Frontier 4.1 (Coelli, 1996) generated the results shown in Table 13. The sigma squared (σ^2) was significant at 5% level of probability for adopters and 1% for non-adopters, indicating a good fit and the correctness of the specified half normal distributional assumption made on the efficiency error term. The gamma parameter (γ) lies between 0 and 1; with a value equal to 0 implying that technical inefficiency is not present and the ordinary least square estimation would be an adequate representation and a value close or equal to 1 implying that the frontier model is appropriate. The value of gamma (λ) = 0.793 was statistically significant at the 1% level, which implies that

about 80% of the residual variation in maize production by the sampled farmers is due to the inefficiency effect. The result revealed that technical inefficiency effects were present in maize production. Hence, the hypothesis that the parameter estimate of gamma equals zero is strongly rejected. The log likelihood ratio value represents the value that maximizes the joint densities in the estimated model. Thus, the Cobb-Douglas functional form is an adequate representation of the data.

All the coefficients of the inputs in the production function are positive and statistically significant at the 1% and 5% levels, implying direct relationship between each of the inputs and maize output. The production elasticity for all the inputs has the expected positive signs. The coefficient (1.576) of fertilizer (X_2) was found to be positive and significant at 1% level. This means that by increasing quantity of fertilizer use by 1% will lead to 1.58% increase in maize output. The coefficient (0.119) of labour (X_3) was positive and statistically significant at 5% level. This implies that labour positively influences the output of maize. The coefficient (0.119) of seed (X_4) was positive and statistically significant at 1% level. This implies that among the five production inputs, seed has direct impact on yield. This is due to the fact that yield is directly depended on the number of plants per hectare, and population of plants is directly related to the quantity of seed used. The coefficient (0.433) for farm size (X_5) is statistically significant at 1% level and has the expected positive sign, which is in conformity with the *a priori* expectation. The coefficient of output for land among all other coefficients is the second largest which shows that land as an input has major influence on output. Since the farming activity is traditional, availability of land determines the level of output that can be obtained from the farm.

Pesticides (X_1) was not statistically significant.

Table 13: Maximum likelihood estimates of the Cobb-Douglas stochastic frontier production function

Variables	Parameters	Coefficients	
		Adopters	Non-adopters
Stochastic frontier			
Constant	β_0	2.548(6.891***)	0.926(10.469)***
ln Pesticides(X_1)	β_1	0.019(0.322)	0.003(0.063)
ln Fertilizers (X_2)	β_2	1.576(11.415***)	0.119(1.755)*
ln labour (X_3)	β_3	0.119(1.756**)	-0.041(-0.877)
ln Seed (X_4)	β_4	0.115(2.858***)	0.019(0.322)
ln Farm size (X_5)	β_5	0.433(9.784***)	0.114(1.065)
Inefficiency model			
Constant	α_0	8.904(2.581***)	0.525(6.47)***
Age of farmer (years)	α_1	-9.042(-2.094**)	0.0006(0.055)
Years of schooling	α_2	0.221(0.059)	-0.009(-1.526)
Years of Experience	α_3	-0.410(-2.082**)	-0.013(-2.64)**
Family Size	α_4	0.031(0.289)	-0.019(-1.329)
Credit(Dummy)	α_5	-3.311(-2.002*	0.0013(0.591)
Extension visit dummy	α_6	-0.331(-7.683***)	0.0017(0.1005)
Membership in Association	α_7	-0.482(-6.343***)	-0.029(-3.065)***
Variance Parameters			
Sigma squared	σ^2	0.182(2.154**)	0.08(3.11)***
Gamma	λ	0.793(5.157***)	0.67(17.02)***
Log likelihood function		-107.766	-100.987
Number of observations	N	137	163
Mean Technical Efficiency	TE	0.881	0.828

*** P<0.01, **P<0.05
(figures in parenthesis are t-values)

Gamma for adopters in the study area is 0.793 (Table 13). This implies that on the average the farmers are able to obtain over 80% of potential output from a given mix of production inputs. Thus, in a short run, there is a room for increasing maize production

by about 20%, by adopting the technology and techniques used by the best farmers.

The inefficiency parameters are specified as those relating to farmers' specific socioeconomic characteristics. These include the age, educational levels, farming experience, household size, access to credit, access to extension contact and their participation in association. Generally, a negative sign on a parameter means that the variable reduces technical inefficiency, while a positive sign increases technical inefficiency. This is shown on Table 13. The coefficient of age variable is estimated to be negative and statistically significant at 5% level. This indicates that farmers who are older are relatively less efficient in maize production and vice versa. Thus, because maize production in the study area is relatively about intensive, especially weeding and harvesting operations, younger farmers tend to be more productive. Also, the younger farmers are likely to be more progressive and, hence more willing to adapt new practices, thus leading to higher efficiencies in maize production. This finding is consistent with a study by Amaza, Bila and Iheanacho (2006).

The coefficient of farming experience variable is estimated to be significant and negative. The negative sign on the years of farming experience variable indicates that an increase in the number of years in grains production decreases technical inefficiency; this relationship is significant at the 1% level. This finding is consistent with that of Oyewo (2011).

The coefficient of credit (dummy) variable is estimated to be negative as expected and statistically significant at 1% level. This suggests that farmers who have greater access to credit tend to be more efficient in maize production. However, maize production is

capital intensive, substantial part of the credit is used to purchase inputs like seed and fertilizer, which has positive effect on the productivity of farmers and also to pay for hire labour. This finding is consistent with a study by Amaza, Bila and Iheanacho (2006).

The coefficient of the extension (dummy) variable is estimated to be positive and statistically significant at the 1% level. This indicates that increased extension services to farmers tend to increase technical efficiency in maize production. The significance of extension in this study corroborates the findings of Amaza, Bila and Iheanacho (2006) who reported significant influence of extension contact on efficiency in their study of Identification of Factors that Influence Technical Efficiency of Food Crop Production in West Africa: Empirical Evidence from Borno State, Nigeria.

The coefficient of membership in an association is estimated to be negative and statistically significant at the 1% level. This indicates that the more the farmers identify themselves in an association, the higher the technical efficiency in production. This finding agreed with the result of Oyewo (2011) in his work Technical Efficiency of Maize Production in Oyo State.

4.4.1.1 Farmers' technical efficiency indices

Table 14 shows the frequency distribution of technical efficiency of maize farmers in Safana LGA. The results reveal that technical efficiency level varied from one farmer to another and ranged from a minimum of 0.352 to a maximum of 0.999, with a mean of 0.881 for adopters; non-adopters had mean of 0.994, minimum of 0.227 and maximum of 0.824. The results show that all the sampled farmers had technical efficiency level ranging from 0.31 to 1 for adopters and 0.21 to 1 for non-adopters. Majority of the

farmers had technical efficiency level between 0.81 and 1.0, 65.7% for adopters and 85.27% for non-adopters. About 27.75% of the adopted farmers and 11.66% of non-adopters farmers had technical efficiency level between 0.61 and 0.80. The remaining 6.57% of adopters and 3.07% of non-adopters had efficiency level between 0.21 and 0.60.

The implication of the results is that an average adopter of early maturing maize variety requires 11.81%, that is, (1-(0.881/0.999) x 100} and 16.70%, that is, {1-(0.828/0.994) x 100} for non-adopters cost savings to attain the status of the most efficient maize farmer. The least performing adopter would need 64.76% cost savings which is {1-(0.352/0.999 x 100} to become the most efficient farmer whereas; the least non-adopter would need 77.16% cost savings which is {1-(0.227/0.994 x 100} to become the most efficient farmer. The fact that the technical efficiencies of all sampled maize farmers are less than 1 implies that no farmer reached the frontier of production. This means that the farmers had the potentials to increase their efficiency level. With a mean technical efficiency index of 0.881 for adopters and 0.828 for non-adopters, there is still scope for an increase in farm output by 0.119% and 0.172% respectively. Kibaara (2005) indicate that the mean technical efficiency of Kenya's maize production is 49 percent; however, this ranges from 8 to 98 percent. There is distinct intra and interregional variability in technical efficiency in the maize producing regions. In addition, technical efficiency varies by cropping system; the mono-cropped maize fields had a higher technical efficiency than the intercropped maize fields.

Table 14: Frequency Distribution of Farmers' Technical Efficiency

Level of Efficiency	Adopters	Non-Adopters
0.21-0.3	00	2(1.23)
0.31-0.4	1(0.73)	00
0.41-0.5	2(1.46)	00
0.51-0.6	6(4.38)	3(1.84)
0.61-0.7	12(8.76)	6(3.68)
0.71-0.8	26(18.99)	13(7.98)
0.81-0.9	42(30.66)	44(26.99)
0.91-1.0	48(35.04)	95(58.28)
Total	137(100)	163(100)
Mean	0.881	0.828
Min	0.352	0.227
Max	0.999	0.994

(*Figures in parenthesis are percentages*)

4.4.2 Farmers' allocative efficiency

Maximum likelihood estimates of the parameters of the stochastic cost frontier model are presented in Table 15. All the parameter estimated have the expected signs with the cost of pesticides, fertilizer, labour and seed were highly significant at 1% level meaning that these factors are significantly different from zero and thus are important in maize production. The cost elasticity with respect to all input variables used in the production analysis are positive and imply that an increase in the cost of pesticides, cost of fertilizer, cost of labour, and cost of seed increases total production cost as follows:

1% increase in the cost of pesticides will increase total cost by 0.07%, 1% increase in the cost of fertilizer will increase total cost by 0.14%, 1% increase in the cost of labour will increase total cost by 0.2%, 1% increase in seed will increase the total cost by 0.9%.

The estimated gamma (λ) for adopters = 0.810 was highly significant at 1% level of the measurement error and other random disturbance, thus indicating that 81% of the variation in the total cost of production among the sampled farmers was due to difference in their cost efficiencies. Sigma-squared (σ^2) on the other hand was 0.775 and was statistically significant at 1% level. Since the figure is significantly different from zero, it indicated a good fit and correctness of distributional form assumed for the composite error term. In the case of non-adopters, gamma was significant at 1%, sigma squared on the other hand was 0.338 and statistically significant at 5%.

Table 15: Maximum likelihood estimates of the Cobb-Douglas stochastic frontier cost function

Variables	Parameters	Coefficients	
		Adopters	Non-adopters
Stochastic frontier			
Constant	β_0	1.712(14.511***)	7.240(43.738)***
In Cost of Pesticides(P_1)	β_1	0.072(3.701***)	0.367(10.446)***
In Cost of Fertilizers (P_2)	β_2	0.136(5.729***)	0.112(2.625)***
In Cost of labour (P_3)	β_3	0.204(4.361***)	0.072(2.591)***
In Cost of Seed (P_4)	β_4	0.861(4.307***)	0.044(3.858)***
Inefficiency model			
Constant	α_0	-3.05(-0.969)	-1.527(-0.174)
Age	α_1	-0.0079(-0.412)	0.129(0.321)
Education	α_2	0.234(1.324)	0.026(0.297)
Farming Experience	α_3	0.321(0.621)	0.008(0.795)
Household Size	α_4	-3.716(-1.668*)	0.112(2.379)**
Credit(Dummy)	α_5	-0.014(-2.275***)	-0.340(-6.783)***
Extension Contact(Dummy)	α_6	0.671(0.991)	0.006(0.198)
Membership in Association(Dummy)	α_7	-4.518(-0.928)	-0.060(-3.301)***
Variance Parameters			
Sigma squared	σ^2	0.775(3.956***)	0.338(2.280)**
Gamma	λ	0.810(7.549***)	0.748(3.420)***
Log likelihood function		136.593	-188.446
Number of observations	N	137	163
Mean Allocative Efficiency	AE	0.592	0.420

*** P<0.01, **P<0.05; *P<0.10
(figures in parenthesis are t-values)

The estimated coefficient in the inefficiency model is presented Table 15. In the inefficiency model a negative coefficient means an increase in efficiency. The socio-economic variables tested were age of farmer, educational level, farming experience, access to credit, extension visit and membership in association.

The coefficient for household size was negative and statistically significant at 10%.The negative coefficient for household size implies that the larger the household size of the famer the more cost efficient the famer becomes. This is in conformity with Ogundari, Ojo and Ajibefun (2006) who said large family size increases cost efficiency.

The coefficient for access to credit was negative and statistically significant at 1% level. This suggests that availability of credit is an important factor for attaining a higher level of allocative efficiency. Farmers who are allocatively inefficient can possibly get more efficient in the short run by having access to credit. The availability of credit will ease the timely acquisition of inputs, thus reducing the inefficiency level of the farmers.

4.4.2.1 Farmers' allocative efficiency indices

The analysis on Table 16 shows the frequency distribution of allocative efficiency of sampled farms in the study area. Of the sampled farmers of early maturing maize varieties, 2.92% and 30.67% of adopters and non-adopters respectively had allocative efficiency level between 0.11 and 0.20, 8.1% and 18.4% had allocative efficiency level between 0.21 and 0.30, 6.57% of both groups of farmers had allocative efficiency level between 0.31 and 0.40, 13.14% and 7.36% had efficiency level between 0.41 and 0.50, 13.14% and 6.75% had allocative efficiency indices between 0.51 and 0.60, 20.44% and 6.75% had efficiency indices between 0.61 and 0.80, 13.87% and 11.04% had between 0.81 and 0.90 and 1.46% and 5.52% had between 0.9 and 1. The predicted allocative efficiencies vary widely with minimum and maximum values of adopters and non-adopters with 0.117(0.995) and 0.285(0.95) respectively and mean allocative efficiency value of 0.592 and 0.42 for adopters and non-adopters respectively. This implies that if the average adopted farmer in the sampled area was to achieve allocative efficiency level of the most efficient counterpart, then the average farmer could realize 40.5% {1-

(0.592/0.995) x100} cost savings. A similar calculation also goes for the non-adopted farmer with of 56.4% {1-(0.42/0.963) x100}. It is evident from these results that allocative inefficiency constitutes a more serious problem than technical inefficiency in the study area.

Table 16: Frequency Distribution of Farmers' Allocative Efficiency

Level of Efficiency	**Adopters**	**Non-Adopters**
0.1-0.2	4(2.92)	50(30.67)
0.21-0.3	11(8.10)	30(18.40)
0.31-0.4	9(6.57)	11(6.75)
0.41-0.5	18(13.14)	12(7.36)
0.51-0.6	18(13.14)	11(6.75)
0.61-0.7	28(20.44)	11(6.75)
0.71-0.8	28(20.44)	11(6.75)
0.81-0.9	19(13.87)	18(11.04)
0.91-1.0	2(1.46)	9(5.52)
Total	137(100)	163(100)
Mean	0.592	0.420
Min	0.117	0.285
Max	0.995	0.963

(*Figures in parenthesis are percentages*)

4.4.3 Farmers' economic efficiency

Economic efficiency indicates the welfare and the economic status of the respondents. The result presented in Table 17 is the product of technical and allocative efficiencies. The positively significant value of the sigma-square conforms to the expectation of the data being fit into the model of the stochastic function. The gamma coefficient of the

economic efficiency for adopters' lies between 0 and 1 as expected (0.642). This implies that about 64% of the variations in the economic status of adopting households are attributable to differences in their economic efficiencies. This implies that economic inefficiency significantly contributes to the production of maize in the area of study**.** On the other hand, non-adopters' gamma coefficient was 47.8% though it lies between 0 and 1, it is less than that of adopters.

Fertilizer, labour, seed and farm size revealed positive effect on economic efficiency of adopting households in the study area. The positive relationship of these variables to economic efficiency implies that an increase in the use of these variables by 1% would result to an improvement in the economic status of the respondents. The combination of larger farm size and application of fertilizer to maize would lead to increased output vis-a-vis income of the respondents; thereby, improving the living standard of the respondents. This is in conformity with the assertion of larger farm holding bringing about higher output as well as encouraging adoption of innovation. On the other hand pesticides were not significant implying that there was no effect on economic efficiency of the responding households. If volume of pesticides used for the production of maize is increased by 1%, economic efficiency would not change.

The estimated parameter for extension contact was negative and significantly related to economic inefficiency at 1 % level of probability. This implied that increase in extension contact would reduce economic inefficiency. The coefficients obtained for access to credit and memberships in an association were also negative and significant at 1% level of probability. These variables would increase economic efficiency.

Table 17: Economic efficiency of Maize Responding Households in Safana LGA

Variables	Parameters	Coefficients	
		Adopters	Non-adopters
Stochastic frontier			
Constant	β_0	4.362(99.995***)	6.704(457.893)***
Pesticides	β_1	0.00137(1.192)	0.001(0.658)
Fertilizers	β_2	0.214(65.397***)	0.013(4.607)***
Labour	β_3	0.0242(7.658)***	-00.3(-2.272)**
Seed	β_4	0.099(12.309)***	0.00084(1.242)
Farm Size	B_5	0.433(9.784)***	0.114(1.065)
Inefficiency model			
Constant	α_0	27.157(2.5009)***	0.802(-1.126)
Age	α_1	-0.071(-0.863)	0.0000077(0.0177)
Education	α_2	0.052(0.078)	-0.00023(-0.453)
Farming Experience	α_3	-0.132(-1.293)	-0.00010(-2.098)**
Household Size	α_4	-0.115(-0.482)	-0.0021(-3.162)***
Credit(Dummy)	α_5	-0.0464(-4.555)***	-0.00044(-4.009)***
Extension Contact(Dummy)	α_6	-0.222(-7.614)***	0.000010(0.0199)
Membership in Association(Dummy)	α_7	-2.178(-5.886)***	-0.0017(-10.118)***
Variance Parameters			
Sigma squared	σ^2	0.141(8.521)***	0.027(7.091)***
Gamma	λ	0.642(38.93***)	0.478(58.208)***

*** P<0.01, **P<0.05
(figures in parenthesis are t-values)

4.4.3.1 Farmers' economic efficiency indices

The stochastic frontier production and cost functions were used to estimate the economic efficiency indices of sampled farmers in the area. Economic efficiency indices were estimated as the product of technical and allocative efficiency levels. Thus, the level of technical efficiency of a particular firm is characterized by the relationship

between observed production and some ideal or potential production (Greene, 1993 in Gama 2013).The frequency distribution of the predicted economic efficiencies of the farmers is presented in Table 18. The combined multiplicative effect of technical and allocative efficiency shows that the average economic efficiency level for adopters and non-adopters were 0.487 and 0.42 with minimum of 0.107 and 0.029, and maximum of 0.995 and 0.881 respectively. The results show that 0% for adopters while 9.82% of non-adopters had economic efficiency level between 0.01 and 0.10; 4.38% and 28.22% of adopters and non-adopters had economic efficiency level between 0.11 and 0.20. About 13.87% of adopters and 14.72% of non-adopted farmers had economic efficiency between 0.21 and 0.30, 13.24% and 7.36% of adopters and non-adopters respectively had economic efficiency level between 0.31–0.40, 19.71% for adopters and 7.36% for non-adopters had economic efficiency level between 0.41 and 0.50 while 21.71% and 7.98% of adopters and non-adopters had economic efficiency level between 0.51 and 0.60. About 16.79% of adopters and 8.59% of non-adopted farmers had economic efficiency between 0.61 and 0.70, 5.84% and 11.66% of adopters and non-adopters respectively had economic efficiency level between 0.71–0.80. Furthermore, 2.19% and 4.29% of adopters and non-adopters had economic efficiency level between 0.81 and 0.90, while 2.19% for adopters and 00% for non-adopters had economic efficiency level between 0.91 and 1.0. The average best farmer needs a cost saving of 51.06%, that is, {1-(0.487/0.995) x 100} to attain the frontier while the worst farmer requires a cost saving of 89.23%, that is {1-(0.107/0.995) x100} to become the most efficient farmer the adopters' group while, for non-adopters, the average farmer needs a cost saving of 52.33%, that is, {1-(0.42/0.881) x 100} to attain the frontier while the worst farmer requires a cost saving of 96.71%, that is {1-(0.029/0.881) x100} to become the most efficient farmer. Chiona (2011), in her study Technical and Allocative Efficiency of

Smallholder Maize Farmers in Zambia, she observed that the farmers were not fully efficient.

Table 18: Frequency Distribution of Farmers' Economic Efficiency

Level of Efficiency	Adopters	Non-Adopters
0.01-0.1	00	16(9.82)
0.11-0.2	6(4.38)	46(28.22)
0.21-0.3	19(13.87)	24(14.72)
0.31-0.4	18(13.14)	12(7.36)
0.41-0.5	27(19.71)	12(7.36)
0.51-0.6	30(21.71)	13(7.98)
0.61-0.7	23(16.79)	14(8.59)
0.71-0.8	8(5.84)	19(11.66)
0.81-0.9	3(2.19)	7(4.29)
0.91-1.0	3(2.19)	00
Total	137(100)	163(100)
Mean	0.487	0.420
Min	0.107	0.029
Max	0.995	0.881

(*Figures in parenthesis are percentages*)

4.4.4 Efficiency differential among farmers and z-test

The result on Table 19 shows the efficiency differential between adopters and non-adopters of early maturing maize varieties in Safana LGA.

The results demonstrated that efficient maize production has enormous potential to improve general welfare gains from technological interventions as well as enhance

farmers' incentives to invest in maize production. Moreover, adopters of early maturing maize varieties were found to operate closer to their efficient frontiers than non-adopters. Results indicated that the mean technical efficiency for maize production was 85 percent. The technical efficiency was found on an average 0.90 for adopters and 0.83 for non-adopters. It was also found that, farmers in the study area had scope to increase maize productivity by attaining full efficiency through reallocating the resources. Economic differential for technical efficiency was 0.053 and was significant at 1% level of probability. One percent increase in productive input will increase technical efficiency by 5.5%.

Results of the cost function showed the mean cost efficiency for adopters as 59 percent and 42 percent for non-adopters. This implies that adopters are above frontier cost indicating that they are efficient in allocating their scarce resources. The allocative differential is positive and significant at 1 percent level of probability. This is indicated that a 1% increase in variable cost will increase allocative efficiency by 17.2%.

Mean economic efficiency for adopters was 48 percent and 42 percent for non-adopters. This result however indicates a 52% and 58% improvement on adopters and non-adopters economic efficiency level for maize production. The economic differential is 0.067 for economic efficiencies indices. It is positive and significant 1% level of probability. This implies that a unit increase in variable input will increase economic efficiency by 6.7%.

Table 19: Efficiency Differential among farmers and z-test

Efficiency	Adopters	Non-adopters	Differential	z-test
Technical	0.881	0.828	0.053	6.22***
Allocative	0.592	0.420	0.172	3.71***
Economic	0.487	0.420	0.067	4.75***

*** P<0.01

4.5 The impact of the Project on Farmers' Food Security.

In view of its importance to the nutritional wellbeing of individuals, food constitutes a larger proportion in the expenditure pattern of most rural households. Food security index with a food security line of 2260 Kcal daily per capita consumption was used to classify the rural households either as the food secure or food insecure as showed on Table 20. With a daily per capita calorie consumption of 4344.5 Kcal, about 60.6% of the adopted households are food secure. This shows that food insecure households of adopters were 60.0% short of the food security line while the food secure households are above the food security line by 39.4%. Even though the daily per capita calorie consumption exceeded the recommended calorie intake requirement, the study area is only on the threshold of food adequacy.

Table 20: Distribution of respondents by their food security status

Food security indices	Adopters		Non-Adopters	
	Food secure household	Food insecure Households	Food secure households	Food insecure households
Recommended calorie intake per adult equivalent (R)	2260			
Number of Households	84	53	51	112
Percentage of households	60.6	39.4	31.3	68.7
Households daily per capita calorie intake (Y)	4344.5	1503.7	3378.6	982
Maize calorie intake	1874.2	448.9	1079	268.4
Food security index (Z)	1.92	0.67	1.47	0.43
Head count ratio	0.61	0.39	0.31	0.69
Short fall index	—	0.006	—	0.05
Surplus index	0.01	—	0.01	—

Besides, the study revealed that about one- third of the households were food-insecure with a daily per capita calorie consumption of 1503.7 kcal and 448.9Kcal for maize consumption which is about 0.6% less than the recommended daily requirement while about two-third of the entire households that are food secure exceeded the commended calorie requirement by 1%. This is as presented in the shortfall/surplus index which measures the extent of deviation from the food security line by the households. The headcount ratio shows that only 61 % of the individuals in the study area were food-secure and that 39% were food-insecure. This shows that about two-third adopters are meeting up with the daily per capita calorie requirement.

For the non-adopters on the other hand, the headcount ratio shows that 31% of non-adopters with daily per capita calorie consumption of 3378.6 kcal and 1079Kcal for

maize consumption were food secure and 68.7% with daily per capita calorie consumption of 982.0 were food insecure. Food secure household had a surplus index of 0.01 and a shortfall index of 0.05 indicating that, food secure household of non-adopters exceed the calorie requirement by 1% while the food insecure household fell short of the recommended calorie intake by 5%. This result is similar to that gotten by Agbola *et al*. (2008) in their study on the effect of income diversification strategies on food security status of farming household 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 household who combined crop production with livestock production.

Table 20 also reveals that, out of 4344.9 Kcal which is total consumption of adopters', 1874.2Kcal was for the consumption of maize. Maize consumption for adopters' secure households takes about 43.14% of total consumption the farming households. This implies that as the level of adoption of early maturing maize varieties increases the incidence of food insecurity is likely to decrease. The unsecure households for adopters' have about 29.85% (448.9Kcal) of total consumption. On the part of non-adopters, 31.94% (1079Kcal) was their percentage of maize consumption from total consumption of secure households. Those of unsecure households had about 27.33% (268.4Kcal) of total consumption.

Analysis on Table 21 shows the result of hypothesis test comparing the mean of food security status of adopters and non-adopters of early maturing maize varieties. From the result, it is seen that there is a significant difference between the food secure adopters and the food secure non-adopters with an average calorie intake of 4344.5 kcal and

3378.6 kcal respectively. Since the average calorie intake of adopters is greater by 965.9 kcal with a significant z-test value of 2.04 showing 5% significant level, the null hypothesis which states that there was no significant difference between the food security status of adopters and non-adopters of early maturing maize varieties is therefore rejected.

Table 21: Z-test of hypothesis on food security status of adopters and non-adopters

Category	**Number**	**Mean Calorie intake**	**z-test**
Food secure adopters	84	4344.5	2.04**
Food secure non-adopters	51	3378.6	

**P<0.05

The analysis on Table 22 shows the result of hypothesis test comparing the calorie intake for solely maize consumption of adopters and non-adopters of early maturing maize varieties. From the result, it is seen that there is a significant difference between the food secure adopters and the food secure non-adopters with calorie intake of 1874.2 kcal and 1079 kcal respectively. Since the calorie intake for maize of adopters is greater by 795.2 kcal with a significant z-test value of 2.21 showing 5% significant level, the null hypothesis which states that there was no significant difference between the food security status of adopters and non-adopters of early maturing maize varieties is therefore rejected.

Table 22: Z-test on maize consumption of adopters and non-adopters

Category	**Number**	**Maize Calorie intake**	**z-test**
Food secure adopters	84	1874.2	2.21**
Food secure non-adopters	51	1079	

**P<0.05

4.6 Estimation of the Impact of the Project on Farmers' Income.

The double difference estimate of the impact of adoption of early maturing maize varieties on farmers' mean income on Table 23 shows those adopters of early maturing maize varieties enjoyed an increase of 52% in their income (₦62,002.5- ₦129,189.78), resulting in a difference of income of ₦67,187.28 which is significant at 1%. The non-adopters had an increment of 26.9% (₦ 66,625.37 - ₦91,123.46) but not as high as that of non-adopters in their income within the same period of time. Double difference analysis result further proved the fact that the increase in income realized by the adopters was attributed to their usage of early maturing maize varieties based on the positive mean income value obtained which was significant at 1 % level of probability. The finding is in-line with Simonyan and Omolehin (2012) who found a positive mean double income difference of about ₦ 30,973.4 was realized between beneficiaries and non-beneficiaries before and after Fadama II project. The difference in income was significant at 10% level.

Table 23: Double difference estimate of the impact of adoption of early maturing maize varieties on farmers' mean income.

	2008	**2012**	**Difference (2012-2008)**
Adopters	62,002.5	129,189.8	67,187.28***
Non-adopters	66,625.37	91,123.46	24,498.09***
Difference between groups	-4,622.87	38,066.32	42,689.19***

*** P<0.01

The annual incomes of adopters and non-adopters of early maturing maize varieties between 2008 and 2012 are shown on Table 24. The income of adopters ranges from

₦27,500 to ₦98,390 and ₦ 85,000 to ₦175,050 in 2008 - 2012 respectively. Whereas, that of non-adopters ranges from ₦35,600 to ₦100,510 in 2008 and ₦60,000 to ₦155,000 in 2012.

A T-test was run to determine the impact of adopting early maturing maize varieties on farmers' income. The result indicated that the difference (₦42,689.19) is significant at 1% level of significance between adopters and non-adopters in relation to income level. The result shows that the difference between the annual income of the maize farming households that adopted early maturing maize varieties and those who did not is significant, implying that adoption of early maturing maize varieties had an impact on the income of the maize farming households that adopted early maturing maize varieties which contributed in enhancing the income of the farmers.

Table 24 T-test result of Adopters versus Non-adopters in relation to income

Estimate	**Adopters (X_1)**	**Non- Adopters (X_2)**
2008		
Observation	137	163
Maximum	98,390	100,510
Minimum	27,500	35,600
Mean	62002.5	66,625.37
Standard deviation	2253166.59	193651.42
2012		
Maximum	175,050	155,000
Minimum	85,000	60,000
Mean	129,189.78	109123.46
Standard deviation	3294187.42	1759636.45
Mean difference	67,187.28	24,498.09
Differential	42,689.19	
Standard error	346817774.34	
t – value	8.42***	

*** P<0.01

The mean difference analysis of the impact on adoption of early maturing maize varieties on income status between adopters and non-adopters of early maturing maize varieties shows that there is a positive mean income of ₦42,689.19. Household income indicates the ability of the household to purchase its basic needs of life. This implies that there was an impact of the project on adopters' income. This result is similar to that of Dontsop *et al*. (2011) who say that there is a significant difference between the gross incomes of adopters and non-adopters of NERICA.

Table 25: Z-Test on income of adopters and non-adopters

Category	**Number**	**Mean Income**	**z-value**
Adopters	137	95,596.14	3.53***
Non-adopters	163	87,874.45	

*** P<0.01

A Z-test was run to determine the impact of adopting early maturing maize varieties on farmers' income. The data on the income of farmers was disaggregated into groups – adopters and non-adopters for comparison. The incomes for before intervention and after intervention were combined to get the result shown on Table 25. From the Table, the mean income of adopters (₦95,596.14) is higher than the mean income of non-adopters (₦87,874.45) by ₦7,721.725 and it is significant at 1% probability level. This implies that there was a significant difference in the adoption of early maturing maize varieties among adopters and non-adopters. Therefore, adopting these maize varieties had contributed in enhancing the income of the maize farming households in the study area. Morris, Tripp and Dankyi (1999), in their work Adoption and Impacts of Early maturing maize Production Technology: A Case Study of the Ghana Grains Development Project sited that Farmers who reported increased income from maize

sales use the income to pay children's school fees. The next most common reported uses included purchasing building materials to expand or renovate the farmer's house, investing in merchandise for a family-owned retail trading business, and purchasing additional agricultural land. The additional income earned through maize farming (much of which presumably can be attributed to the adoption of GGDP-generated technologies) for the most part seems to have been invested productively, rather than spent on short term consumption.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

Maize is a widely cultivated cereal crop and it is important as a food crop in local diet, animal feed, income for farmers and agro-industrial raw material. Early maturing maize varieties, which is improved and capable of escaping drought was developed to enhance maize production in the dried environment of the Sudan and Sahel Savannas where the growing season had hitherto prevented maize cultivation.

The study examined the economics of early maturing maize varieties in Safana Local Government Area of Katsina State, Nigeria. The specific objectives specific were to determine the rate and level of adoption of early maturing maize varieties, identify factors that influenced the rate and level of adoption of early maturing maize varieties, identify the constraints associated to the adoption of early maturing maize varieties, estimate the technical, allocative and economic efficiency differential between adopters and non-adopters of early maturing maize varieties, evaluate the impact of adoption of early maturing maize varieties on household food security, evaluate the impact of adoption of early maturing maize varieties on farmers' income in the study area.

Data for the study were obtained mainly from primary sources. The data were obtained through the use of structured questionnaire administered to some 300 maize farmers. Descriptive statistics and econometric analysis were used to analyze the data that were collected. The descriptive statistics such as frequency counts, percentages and mean computations were used to achieve objectives i, & iii and these were presented in tables. The Probit and Tobit models estimation framework was used to examine objective (ii)

(the factors influencing the adoption and extent of adoption of early maturing maize varieties in the study communities). To satisfy objective (vi), the food security line was used to determine the impact of adoption of early maturing maize varieties on household food security. Objective (v) was achieved by using the, Cobb-Douglass frontier production function and lastly, to achieve objective vi, the double-difference indicator was used to determine the impact of adoption of early maturing maize varieties on farmers' income. The study divided the respondents into adopters (farmers who have grown early maturing maize varieties for at least one planting season) and Non adopters (farmers who have never grown early maturing maize varieties).

Results of the study indicated that majority (88%) of the household are male headed, the mean age of the farmers was 44 years indicating that middle-aged farmers were into maize production. The average household size is 11 per household and the dependency ratio is 1.49. About 95.7% of the farmers were married. Majority of farmers had Islamic education with the average period of formal education as 5 years. Farming experienced ranges from 1-50 years with an average experience of 25 years. About three-quarter of farmers were aware of the varieties and had contact with extension agent. Out of those farmers that were aware, 64.42% compared that though they were aware of the varieties they could not adopt because of inadequate of seeds. About half of the farmers were members of an association.

The result of the findings showed that five (5) varieties of early maturing maize varieties that was introduced in the project area by the Sudan Savanna Taskforce. A larger proportion of farming households adopted 99EVDTWSTR (SAMMAZ 27) with an adoption rate of 28.67% and mean adoption level of 64.91%. This implies that

28.67% of the adopters early maturing maize varieties in the study area adopted SAMMAZ 27. 2009EVDTWSTR had an adoption rate of 10% which implies that 10% of adopters adopted this variety. The mean adoption level of this variety was 59.47%. The variety 99TZEEYSTR had an adoption rate 1.33% and mean adoption level of 55%. ACR95TZE COMP5W had the lowest adoption rate of 0.67% but the mean intensity was the highest at 100%. 2000 SYNEE had adoption rate of 5% with a mean intensity of 81.3%. This indicates that 2000 SYNEE was only adopted by 5% of the adopters of early maturing maize varieties in the study area. General adoption rate for these varieties was 45.67%.

Analysis showed that there was really no significant difference in awareness between the two groups. Adopters have 100% awareness whereas non-adopters had 81.6% and 18.4% for awareness and no awareness respectively. Major constraints encounter by farmers in the study area were inadequate fertilizers, high cost of fertilizers, inadequate credit, inadequate seed, and drought and low yield.

Result of the probit model shows that adoption of early maturing maize varieties in the study area was strongly influenced by factors such as age of farmer, income gotten from maize sales, extension contacts, membership in an association and size of farm allocated for maize production. Among the farmers' socio-economic characteristic, only farmers' age that was negatively related to adoption of early maturing maize varieties. All the other characteristics mentioned above were positively related to adoption of the maize varieties.

Result of the Tobit Model reveals that labour and contact with extension agent had positive effect to the extent of adoption and were significant at 5% level. Whereas, size of land and yield were also positively significant at 1% meaning that there is a strong relationship between farm size and adoption intensity.

Maximum likelihood estimates for the parameters of the stochastic production and cost functions showed that estimated coefficients of fertilizer, labour, seed and farm size were positive and significant at 1% except labour that was significant at 5%. As for the cost function, all the variable costs were positive and significant at 1% level of probability. Likewise the economic efficiency, all the inputs except pesticides were significant at 1% and positive too. Gammas were 0.793, 0.810 and 0.642 for technical, allocative and economic efficiencies respectively. Sigmas squared and log ratio tests were 0.182, 0.775 and 0.141; 37.39, 21.15 and 790.799 for technical, allocative and economic efficiencies respectively.

The determinants of technical inefficiency model reveal that age, years of experience; credit, extension contact and membership of an association were negatively related to technical inefficiency and statistically significant at 5% and 1% level of probability. Results of the determinants of allocative inefficiency showed household size and access to credit were negative and statistically significant at 10% and 1% level of probability respectively. In terms of economic inefficiency, access to credit, extension contact and membership of an association were negatively related to economic inefficiency at 1% significant level.

The results of the distribution of technical, allocative and economic efficiency levels revealed that sampled farmers in the study area were operating below the frontier but the adopters were better off than the non-adopters. In the case of the adopters, the results showed the mean technical efficiency level to be 88.1%, allocative efficiency to be 59.2%, and economic efficiency to be 48.9%, while that of non-adopters revealed the mean technical efficiency level to be 82.8%, allocative efficiency to be 42%, and economic efficiency to be 42%. The socio-economic factors of technical inefficiency model reveal that age, farming experience, access to credit, extension contact and membership of association, were negatively related to technical inefficiency and statistically significant at 1% and 5% level of probability. Results of the socio-economic factors of allocative inefficiency showed that household size and access of credit were negative and statistically significant at 1% level.

Based on the recommended daily calorie intake of 2260 kcal, 60.6% of adopters were food secure and 39.4% were food insecure. About 31.3% of the non-adopters were food secure and 68.7% were food insecure. Further, the calorie in-take for solely maize was 1874.2Kcal (43.14%) and 448.9Kcal (29.9%) for food secure and food insecure adopters respectively. As for the non-adopters, the daily calorie intake for maize consumption was 1079Kcal (31.9%) and 268.4 Kcal (27.3%) respectively.

The mean difference analysis of the impact on adoption of early maturing maize varieties on income status between adopters and non-adopters of early maturing maize varieties shows that there is a positive mean income of ₦ 42,689.19. The result of the T-test showed that there was significant difference at 1% level of significance between adopters and non-adopters in relation to income level.

5.2 Conclusion

The goal of this study was to assess the economics of early maturing maize varieties in the study area. The new maize varieties were introduced in the study area about five years ago, to enable farmers produce maize where the short rainy season had not permitted maize production.

The adoption of early maturing maize varieties has contributed in increasing the income of maize farming households as well as enhancing the status of maize farming households and this suggests that the adoption of early maturing maize varieties by maize farming households was very instrumental in enhancing the income and well-being of the maize farming households.

The estimated mean values for technical, allocative and economic efficiencies in maize production suggests that some scope exist for farmers to increase their levels of technical, allocative and economic efficiencies by allocating the existing resources more optimally. These results suggest that substantial gains in output and/or decrease in cost can be attained given existing technology. It could be concluded that despite the role that higher efficiency levels can have on output, productivity gains stemming from technological innovations remains of critical importance in agriculture.

5.3 Contribution of Major Research Findings to Knowledge

i. The most preferred variety was 99EVDTWSTR (SAMMAZ 27) with an adoption rate of 28.67%.This is attributed to its high yielding, *striga*resistant, drought tolerant and early maturing. The high yielding of this varietyhas led to an increase in productivity.

ii. The adoption of early maturing maize varieties has contributed to food securitystatus of farming households as indicated that 60.6% of adopters were food secured to 31.3% of non-adopters. The Z- statistic valueof 2.06 indicated that there was a 5% significant difference between adopters and non-adopters.

iii. The adoption of early maturing maize varieties has contributed in enhancing the income status of farming household as their mean income was N42,689.19 and the Z-statistic value was 3.53 indicating a 1% level of significant.

5.4 Recommendations

Based on the findings of the study, the following recommendations are given:

- The adoption rate and frequency of 99EVDTWSTR (SAMMAZ 27) was high. This implies that the Sudan Savanna Taskforce project should promote more of this variety because it seems to be farmers' favorite.
- The problem of limited access or inadequate of early maturing maize seeds has been identified as one of the constraints of the early maturing maize varieties. This implies that increased access to early maturing maize seeds has the potential to further push adoption to higher level. There is need to facilitate the emergence of community producers. The study recommends that community seed production should be encouraged and promoted to facilitate easy access to improved seeds by farmers.
- Extension contact was found to be an important factor that had a positive influence on the adoption of early maturing maize varieties. It is recommended, therefore, that the extension system should be strengthened. More effort should

be intensified on the part of extension agent in educating the farmers so as to boast their efficiencies in maize production.

- Increase in income and food security is impact derived from adopting early maturing maize varieties. It is therefore, recommended that every effort and policy needed to motivate other farmers to adopt these varieties should be made as this has a great potential of increasing their income and also being food secure.

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QUESTIONNAIRE

ECONOMICS OF EARLY MATURING MAIZE VARIETIES IN SAFANA LOCAL GOVERNMENT AREA OF KATSINA STATE, NIGERIA

A. IDENTIFICATION AND LOCATION INFORMATION

Questionnaire No: ☐ **Time of interview:**

Begin	End

GPS Position:……

Date of Interview (D/M/Yr)

☐

Name of Enumerator: ----------

A: SOCIO-ECONOMIC CHARACTERISTICS OF FARMERS

S/N	Variables	Response	Codes
A1	Name of village:		1= Mai Jaura,2= Kunamawa A, 3=Dogon Ruwa,4= Kunamawa B, 5=Kaniri 6=Sabon Garin Baure,7= Sabon Gari Gamji,8= Doga,9= Takatsaba, 10=Kwayawa bo,
A2	Name of Respondent:		
A3	Gender		1=Female, 2=Male
A4	Age Range of Respondent in years		1=15-24yrs, 2=25-34yrs, 3=35-44yrs, 4=45-54yrs, 5=55-64yrs, 6=65yrs and above
A5	Marital status		1=Single, 2=Monogamously married, 3=Polygamous married, 4=Widowed, 5= Divorced, 6 =Other (specify).
A6	Type of farmer:		1=Lead farmer, 2 = Seed farmer, 3 = None of the two
A7	Type of household		1 =Male headed (monogamous), 2 = Male headed (polygamous), 3 = Male headed (single), 4 = Male headed (polygamous), 5 = Male headed (divorced), 6 = Male headed (widowed), 7 = female headed (husband absent), 8 = female headed (single), 9 = female headed (widowed), 10

			=Other (specify)
A8	Level of education of respondent		1 = No formal, 2 = primary, 3 = secondary, 4 = post secondary/tertiary , 5 = Quran, 6 = others (specify) ----------
A9	Educational level of spouse 1		1 = No formal, 2 = primary, 3 = secondary, 4 = post secondary/tertiary , 5 = quranic, 6 = others (specify) ----------
A10	Educational level of spouse 2 (if married to more than one spouse)		1 = No formal, 2 = primary, 3 = secondary, 4 = post secondary/tertiary , 5 = Quranic 6 = others (specify) ----------
A11	What was your total Farm income before 2008?		
A12	What was your total farm income after 2012?		

B1. Household Workforce

Age category	Total in the household		No of people working full time on the farm		No of people who work part time on farm		No of people who work off-farm		No of able bodied who do not do anything		No of disabled (too young, too old, or physically enabled)	
	M	F	M	F	M	F	M	F	M	F	M	F
Up to 6years												
7-14												
15-60												
Above 60												

B2. Information on the household head

B2.1. How long have you been farming? _____ Years

B2.2. Did extension staff visit you last growing season to give you farm advice?

(a) Yes [ ] (b) No [ ]

B2.3. If **Yes**, how many times did extension staff visit you this cropping season? _____

B2.4. Do you belong to any association?

1= Yes 2= No

B2.5. If Yes, which associations? _____

B2.6. For how long have you been participating in the association? _____

C. Adoption specific questions

C1. Do you grow maize? Yes=1 No=2

C2. What is the quantity of maize seed planted? _____Mudus

C3. Are you aware of new improved maize varieties? Yes=1 No=2

C4. Have you grown new improved maize varieties on your own farm?

Yes=1 No=2

S/N	Variables	Response	Code
C5.	If **No,** in **C4**, why?		1=Low maize prices 2=lack of seeds 3= Lack of credit 4=Lack of fertilizer 4=others, (specify)……

C6. If **Yes** to question **(C4)** above, indicate the various varieties of maize grown on your fields, origin of seeds, source of information and use status.

Row	Maize varieties	Ever heard? Yes=1 No=0	Source of information 1=IITA/SS TASKFORCE, 2=ADP/KTARDA, 3= market retailer, 4 = EAs, 5 = friends/relatives, 6 = other farmers, 7=Field days, 8=Radio, 9=Newspaper 10=others (specify) ----------	Year of information	Ever Tried on your fields? 1=yes 2 = no	Year of adoption 1=2009 2= 2010, 3 = 2011, 4 = 2012.		Origin of seeds1=SS TASKFORCE/II 2 = KTARDA 3=Marketretailer 4=EAs5= friends/relatives, 6=other farmers, 7=Seed companies 8=others (specify)	Size of plot	Yield (# of bags)	Use status 1 = currently using 2 = started but abandoned
						Year	Qty of seed				
1.	99EVDTWSTR (SAMMAZ 27)										
2.	2009EVDTW STR										
3.	99TZEEYSTR										
4.	ACR95TZE COMP5W										
5.	2000 SYNEE										
6	Other Varieties										

S/N	Variables	Response	Codes
C7	Do you have contact with Extension?		1= Yes 0=No
C8	If yes, what extension structure		1=NGO 2= Researcher 3= ADP/KTARDA 4= other (specify)----------
C9	Extension services requests (number of requests of extension in current farming season):		1=once a week, 2 =twice per month, 3 = once per month, 4 =less than once per month, and 5= never
C10	Have you ever participated in any maize related extension activities promoted by SS Taskforce during the implementation of its activities?		1= Yes 2= No
C11	If yes, indicate the extension activities		1=Training in maize production, 2=Training in maize utilization, 3= Field day, 4=Demonstration trials, 5= others (specify)
C12	If yes, with which extension institution or agency?		1=SS TASKFORCE/IITA, 2= KTARDA/ADP. 3=NGO, 4= Ministry, 5= Others (specify)-------
C13	How often were you visited by extension agents in the last cropping season?		1= Weekly, 2 = Bi-weekly, 3 = Monthly, 4= Quarterly, 5= Never
C14	How would you rate the usefulness of your contact with extension activities?		1 = very useful, 2 = useful, 3 = not useful, 4 = can't tell
C15	Do you regularly have information on market price?		1= yes, 2 = no
C16	If yes, indicate the source(s) of your market information		1 = market visits, 2 = media (TV/Radio) 3 = other farmers, 4 = middlemen, 5 = friends/relatives, 6 = extension agents, 7= others (specify)----------
C17	What is your assessment of the market price of maize over the past 12 months?		1 = good market price, 2 = not so good, 3 = low market price
C18	Do you have access to credit for maize promotional activities		1 = yes, 2 = no
C19	If yes, state the sources from which you obtain credit		1 = Banks, 2 = Sudan Savanna Taskforce, 3= KTARDA/ADP, 4 = Relatives and friends,

			5 = money lender, 6 = government credit scheme, 7 = others (specify) ----------

D. Economic factors

D1. What is your (household head) primary occupation? (Use code) _____

D2. Secondary occupations (Use code) _____

1= Farming 2= Trading 3= Government salaried job 4= Private salaried job

5= Crafts and artisans 6= Others, (specify)_____

D3. Are there other working members in your household?

1= Yes 2= No

D4. If **Yes**, state their income in the table below

S/No	Job Type	Daily	Weekly	Monthly
1				
2				
3				
4				
5				
6				

D5. Tick as many enterprises as your household is into:

(i) Staple food crop [ ] (ii) Livestock [ ] (iii) Cash crops [ ] (iv) Tree crops [ ]

(v) Others, (specify)_____

D6.Give the output of the following crops in the last cropping season, and the quantity sold, consumed and given out as gifts. Specify units used (e.g., *Mudu, Shakade, Tiya*, baskets, etc.) and kilograms (kg)

Crops	Yes=1 No=2	Quantity produced	Quantity sold	Quantity consumed	Quantity given out as gifts
Maize					
Sorghum					
Millet					
Wheat					
Rice					
Cowpea					
G'nut					
Soybean					
Carrot					
Pepper					
Tomato					
Okra					
Bambara nut					
Roselle					
Onion					
Cotton					
Sesame					

D7. Do you work off-farm? 1= Yes 2= No

D8. If Yes, what type of activities do you engage in during this off-farm time?

(i) _____ (ii)_____

(iii) _____ (iv) _____

D9. How much does your household earn from the following sources of income?

S/No.	Income Source	Amount in Naira/Month

1	Self-employment (trading, tailoring, carpentry, crafts, bricklaying, blacksmithing, barber's work, shoe cobbling, repairing of bicycles and motorcycles, etc.)	
2	Government employment (salary)	
3	Private employment (salary)	
4	Money earned from interest on capital lent out and rent on building or dividend on shares, etc.	
5	Remittances (money sent by children and relatives)	

D10.Did you benefited from credit last cropping season 1=Yes 2=No

D11. If Yes in **D10**, how much?

i. Agric. bank (NACRDB) □:_____

ii. Commercial banks □:_____

iii. Cooperatives □:_____

iv. Friend/Relatives □:_____

v. Others, (specify) _____ □:_____

D12. Kindly indicate if you own any of the following assets.

Item	Yes= 1 No=2	No.	Are you the sole owner of this item or do you share ownership with someone? Sole = 1; share = 2	How many years ago did you acquire this item?	Did you purchase this item or did you receive it as a gift? Purchase =1;gift=2 3=inherited
Extra land					
Bicycle					
Motorcycle					
Motor vehicle					
Radio/TV Set					

Oxen					
House					
Handset					

D13a. Did your household have sufficient food during the previous year? 1=Yes 2=No

D13b. If No in A above, Why?

(i) Low yield (ii) Crop failure (iii) Others(Specify) ……..

D13c. Kindly provide information on the following crops (only on those you have purchased or produced).

Item	Item purchased last season for household consumption			Amount produced last cropping season		Amount consumed from last season's production		Value of prepared foods purchased outside household last week (□)
	Units	No of units	Price/ unit	Units	No of units	Units	No of units	
Maize								
Grain								
Flour								
Sorghum								
Grain								
Flour								
Millet								
Grain								
Flour								
Rice								
Imported								

Local								
Cassava								
Tubers								
Gari								
Cassava chips								
Yam								
Tubers								
Yam flour								
Cocoyam								
Groundnut								
Shelled								
Unshelled								
Soybean								
Grain								
Flour								
Cowpea								
Okra								
Tomato								
Onion								
Pepper								
Egg plant								
Carrot								
Pumpkin								

Green leaves								
Guava								
Citrus								
Mango								
Others (specify)								

1 Units refers to local measures (e.g., *Mudu, Shakade, Tiya*, baskets, etc.) and kilograms (kg)

D14. Kindly indicate how many livestock you own and also provide other related information.

	Number of livestock presently owned	How many did you have last year?	How many have you sold this year?	How many have you consumed this year?	Amount of animal products consumed last week (quantity/units?	Amount of animal products sold last week (quantity/unit)
Cattle						
Sheep						
Goats						
Chickens						
Ducks						
Guinea fowls						
Turkey						
Others(specify)						

E. Household expenditure

E1. Indicate the amount purchased of the following items for household consumption.

Item	Item purchased last week household consumption.	
	Yes=1, No= 0	Purchased value (N)
Salt/Potash/Maggi		
Groundnut oil		
Palm oil		
Other oil (specify) 1.		
2.		
Fish (fresh/dried/smoked)		
Meat (beef/mutton, etc.)		
Sugar		
Bread		
Non-food Item		
Cigarettes, tobacco, kola nuts		
Drinks (local sweet drinks, minerals)		
Shoes (leather, plastic, slippers)		
Clothing (fabric and clothing)		
Purchase of motor vehicles		
Purchase of motor cycles		
Festivals		
Marriage		
Funerals		

Agro-services (tractor hiring, spraying, threshing, etc.)		
Electricity bills		
Transportation (money spent on transport)		

F. Farm-specific factors

S/N	Variables	Response	Codes
F1	Kindly indicate the ownership type of the land you cultivate.		1= Individual 2= Family 3= Community 4= Rented 5= Other, (specify)_____
F2.	Kindly give a rough estimate of the total size of land cultivated by the household		
F3.	What is the cost price of these improved maize seeds you planted?		1=99EVDTWSTR (SAMMAZ 27) 2=2009EVDTWSTR 3=99ZEEYSTR 4=ACR95STZECOMP5W 5=2000SYNEE 6=Others(Specify)…….
F4	What type of modern farm tool do you use on your farm?		1= Tractor 2= Animal ploughing 3= Sprayer 4= others, (specify)_____
F5	Which of the following farm inputs		1= Improved seeds 2= Fertilizer

	did you use on your farm last cropping season? (Choose as many as possible.)		3=Pesticides 4= Herbicides 5= others, (specify)_____
F6	What is the average distance between your village and the source of inputs?		
F7	What is the distance between your village and the market?		

F8. State the labor contribution of your family members during the last cropping season in the following farm operations and hired labor.

Operation	Family labor			Hired labor	
	Days used (#)	Adult members (#)	Children (#)	Days (#)	Person hired (#)
Land clearing					
Planting					
Weeding					
Fertilizing					
Spraying					
Harvesting					
Threshing					
Transportation					
Caring for livestock					

F9. What is the cost of the following inputs applied on the farm?

Inputs	Quantity used(liters, Kg)	Unit price (□)	Cost (□)
Improved maize seeds			
Fertilizer			
Pesticides			
Herbicides			
Others,(specify)			

F10. Assess your maize yield vis-à-vis quantity of seeds used in the past 4 years (2009-2012) [ASSYILD]

	Varieties	2009		2010		2011		2012	
		Qty	Yield	Qty	Yield	Qty	Yield	Qty	Yield
1.	99EVDTWSTR (SAMMAZ 27)								
2.	2009EVDTW STR								
3.	99TZEEYSTR								
4.	ACR95TZE COMP5W								
5.	2000 SYNEE								
6.	Other Varieties								

***KEY**: Quantity of seeds planted is in mudu; Yield is per 100 kg bag or specify where needed.*

F11. How many times did your household eat the following food items in the past months? (if eaten=1, not eaten=2).

Item	Yes=1 No=2	No. daily	No. weekly	No. monthly
Maize				
Sorghum				
Maize(improved)				
Rice				
Groundnut				

Beans				
Millet				
Egg				
Meat				
Fish				
Groundnut oil				
Butter				
Tea/beverages				
Fruits				
Vegetables				
Others (specify)				

G. Problems

G.1 Out of the problem tabulated below, which one affects your improved maize varieties production.

Problems		Response code 1=Yes 2= No	Rank 1=most important etc
1	Lack of seed		
2	High cost of seeds		
3	Lack of fertilizer		
4	High cost of fertilizers		
5	Drought		
6	High labor cost		
7	Lack of training on maize utilization		
8	Lack of information on improved seeds		
9	Pests		
10	Disease		
11	*Striga* infestation		
12	Low market prices		
13	Low yield		
14	Others (specify)		
15			