ECONOMICS OF MAIZE PRODUCTION AND ITS EFFECT ON HOUSEHOLD FOOD SECURITY STATUS IN KADUNA STATE,NIGERIA

BY

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P16AGAE8004

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

DEPARTMENT OF AGRICULTURAL ECONOMICS,

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ZARIA, NIGERIA

FEBRUARY, 2021

DECLARATION

I declare that the work in this Dissertation entitled **Economics of Maize Production and its Effect on Household Food Security Status in Kaduna State, Nigeria,** have been written by me in the Department of Agricultural Economics and it is a record of my own research work. The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this dissertation was previously presented for another degree or diploma at this or any other institution.

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CERTIFICATION

This Dissertation titled **Economics of Maize Production and its Effect on Household Food Security Status in Kaduna State, Nigeria**, carried out by Ajuma Susan **AMEH,** meet the regulations governing the award of the Degree of Masters of Science (MSc) in Agricultural Economics of 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 my father, Prof D.A. Amehfor his support all through the period this research was carried out.

ACKNOWLEDGEMENTS

I am grateful to Almighty God for His provision, strength and guidance throughout the period of my study. My profound gratitude goes to the members of my supervisory committee led by Dr. Y. U. Oladimeji, and Dr. O.O. Ugbabe for their time and guidance that finally led to success of this research work.

I also acknowledge the Head of Department Dr. A. A. Hassan, the Post Graduate coordinator Dr. Y.U. Oladimeji, the seminar coordinator Dr. O.A. Ojeleye, and the entire staff of the department of Agricultural Economics, Faculty of Agriculture, Ahmadu Bello University, Zaria for their advice and contribution in various ways towards the completion of my dissertation.

I will be forever indebted to the maize farmers and their community heads for their time, effort, and sharing of knowledge.

To my family and friends, thank you for being there. I am saying a big THANK YOU to my parents Prof and Mrs D.A Ameh and my siblings,

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ABSTRACT

This study focused on economics of maize production and its effect on household food security status in Kaduna State, Nigeria. A multi-stage sampling technique was employed which followed the random selection of 258 maize farmers for the study. Primary data was collected through the use of structured questionnaire. Data were analysed using Descriptive statistics, net farm income, stochastic frontier production function and Tobit regression model. The result showed that mean age was 46 years with a standard deviation of 10.1. Majority of the farmers (76.75%) have one form of formal education or the other. A high number of farmers (41.86 %) had household size ranged from 6 - 10 persons. 89.92 % were not members of a cooperative society, about 75 % of the farmers did not have access to extension service while about 98.45 % of the farmers did not have access to credit. Finding also revealed that, the net farm income was ₦244,449.8 and return per naira invested is ₦2.99, indicating that for every ₦1 invested a profit of ₦1.99 kobo was made. The estimated mean technical efficiency for maize farmers was 0.73. The mean allocative efficiency of the maize farmers was 70 %, while the mean economic efficiency of the maize farmers was 51%. About 62.40 percent of maize farming households were found to be food secure while 37.60 % were food insecure. Of the insecure households, 4.3 % were marginally food insecure, 4.7 % moderately food insecure and 28.7 % severely food insecure. Maize farming had a positive relationship with household food security status. Of the ten independent variables used in determining the effect of maize production on household food security status, six (age of household head, household size, farm size, farming experience, off-farm income and extension contact) were found to be significant in affecting the food security status of the maize farming households. Finally, maize farmers attested to the fact that; inadequate access to credit facilities (57.4%), inadequate storage facilities (40.3%) and low information on improved technology/extension service (27.9 %) are most severe constrains militating the chances of increasing maize production. Immediate effort should be made by maize farmers to form or join cooperative societies, so as to be able to have increased access to micro-credit, access to modern farming techniques and access to extension agents and also to enjoy economies of scale on input and output as they can buy in large quantities at wholesale price.

CHAPTER ONE

INTRODUCTION

1.1 Background for the Study

The agriculture sector in Nigeria is one of the leading sectors in terms of its contributions to domestic food supply, income, foreign exchange as well as providing employment. The agriculture sector in the 1960's was contributing 85 percent to Nigeria foreign exchange earnings, 90 percent employment generation, and about 80 percent to Gross Domestic Product, GDP (Central Bank of Nigeria, CBN 2010). However, the sector as at recentcontributed about 25 percent to the real GDP of the economy in 2018 (National Bureau of Statistics NBS, 2019).Despite the sector's contribution to the economy, the Nigerian agricultural production has been low(Ikenwa, Sulaimon and Kuye, 2017).

Maize (*Zea mays L.*) is the third most important cereal in the world after wheat and rice, and the second most cultivated crop in Nigeria in terms of area harvested which is about 6.5 million ha second to Cassava's 7.1 million hectare (Food and Agriculture Organization Corporate Statistical Database, FAOSTAT, 2018). Maize is high-yielding and easy to process. Every part of the maize plant has economic value. The grain, leaves, stalk, tassel and cob can all be used to produce a large variety of food and non-food products (IITA, 2013). As one of the most versatile emerging crops having wider adaptability under varied agro-climatic conditions, its importance lies in its wide industrial applications besides serving as human food and animal feed (Srikanth,Kausadikar, Jondhale and Gandhi, 2017).

The global production of maize in 2016/2017 was estimated to be 1,292 million metric tonnes (FAOSTAT 2018). United States of America (USA) was the highest producer of maize grain in 2016/ 2017 with a total production of 385 million metric tonnes (FAOSTAT, 2018). The Nigeria maize production in 2016/2017 was estimated to be 10.41 million metric tonnes which is about 14.7 percent and 0.98 percent of the production in Africa and the world respectively (FAOSTAT, 2018).

The concept of food security or insecurity includes both physical access (a situation where food is available at all times) and economic access (availability of resources to acquire food). The United Nations defines food security as a condition in which all people at all times have access to enough food to live an active and healthy life (FAO, 2011). Household food security therefore refers to physical and economic access to sufficient food that is adequate in terms of quantity and quality to lead healthy lives. Household food security is also closely related to the ability to secure sufficient food through production or purchasing for all members of the household.

1.2 Statement of the Problem

Nigeria is one of the leading maize producers in Africa. However, its average maize yield of 1.8 metric tonnes per hectare is one of the lowest among the top 10 maize producers in Africa (Sahel Report, 2018). It becomes imperative to assess factors underlying inefficiency in the use of resources that will enhance small scale farmers to be efficient in the use of available resources which is a major pivot for a profitable farm enterprise (Oladimeji and Ajao, 2014).
The bulk of maize production in Nigeria is largely produced by rural farmers who are poor, resource-constrained, risk-averse, and cultivate maize mainly on a small-scale basis thereby attributing to lower productivity and depletion in farming households' food security. This poses a serious threat to the social and economic status of small scale farmers. Addressing this low yield issue, Nigeria could become one of the largest maize producer in Africa and thus the world at large without increasing the area currently used for its cultivation. According toJimjel, Asabe and Elias (2014), despite the economic importance of maize to the increasing population, and its widespread contribution to the economy of the country and

particularly a panacea for food insecurity, research findings had shown that it has not been produced to meet the food and industrial needs of the country.

For example,Girei *et al.*, (2017) noted that the average annual demand for maize in Nigeria was about 10.9 million metric tonnes in 2017, while the average production was estimated to be 10.5 million metric tonnes thus, giving a gap deficit of 0.4 million metric tonnes. This could perhaps be attributed to low productivity from maize farms, or that farmers have not adopted improved technologies that would make maize production profitable (Jimjel*et al.*, 2014). The shortfall is being bridged by import, which depletes Nigeria's foreign reserve and exports the much-needed jobs to other countries.

The food security status of farming households largely depends on their profitability and efficiency in production. Having understood the fact that maize is an important cereal majorly consumed by rural households, it is noteworthy to also understand the food security status of farming households, whether they are food secure or food insecure and the extent of insecurity for the food insecure households be it marginally food insecure, moderately food insecure, or severely food insecure.

Generally, in agricultural production, an efficient use of the existing resources by farm households improves their productivity, increases their output, and thereby improves their living standard (Gaspard, 2017). In view of the strategic importance of maize production in Kaduna state, there is the need to investigate the efficiency in production of maize farmers in the study area. However, few researches have considered rational resource allocation for the improvement in efficiencyin Kaduna state. Moreover, the Forum for Agricultural Research in Africa (FARA) (2009)reported that maize yields had increased only marginally over the last two decades, with most of the increase in production coming from expansion in the area harvested rather than from increases in yield. Many studies had been carried out on maize, and such include Oyewo and Fabiyi, (2008), Oladejo and Adetunji (2012), Jimjel*et al.*

(2014), Adesiyan (2015), Aliyu (2015), Amudalat (2015) and Offiah (2015). All these studies focused mainly on profitability and/or economic viability without empirical evidence ascertaining the effect of maize production on food security of farming households. Some of the factors influencing farmers' efficiency in maize production, as well as their food security are also not empirically known. This study enables us to obtain adequate, sufficient and reliable data for analysis geared towards meaningful policy formulation for maize production in Kaduna state. The study did not only examine the profitability of maize production in the study area, but also established the effects of maize production on food security status of farming households. In an attempt to do this, the study provided answers to the following research questions:

i. what are the socio-economic characteristics of maize farmers in the study area?
ii. how profitable is maize production?
iii. is maize production economically efficient?
iv. what is the food security status of maize farming households?
v. what are the effects of maize production on household food security status?
vi. what are the constraints associated with maize production?

1.3 Objectives of the Study

The broad objective of this study wasto analyse maize production and its effect on household food security status in Kaduna state, Nigeria. The specific objectives were to:

i. describe the socioeconomic characteristics of maize farming households;
ii. determine the profitability of maize production;
iii. estimate the economic efficiency of maize production;
iv. determine the food security status of maize farming household;
v. estimate the effect of maize production on household food security status; and

vi. describe the constraints associated with maize production in the study area.

1.4 Justification for the Study

Sustaining increased agricultural productivity mostly emphasizes the development of strategies aimed at maintaining improved yields without depleting natural resources or destabilizing the environment (Ugwumba, Okoh, Nnabuife and Orji, 2010). It is the aim of every maize farmer to improve the living standard of his family and the community he lives in. In order to fulfil this responsibility, there exist a variety of decisions the farmer has to make on available production system. To achieve this, sound research knowledge of the potentials of maize production both in the present and the future is a prerequisite. This study not only enables us to know the economic potentials for maize production in the study area, but also assists the government in making decisions towards improved and sustained maize production.

Food production efficiency is vital to improvement of the agricultural sector productivity if resources available are optimally utilized. Many resources are employed by the small-scale farmers at the farm-level with low level of output (Taphee, 2015). Since increased productivity is directly related to production efficiency, it is therefore important to know how the productivity of maize farmers will be raised in order to help them reduce inefficiency. Productivity measures the quantity of outputs of a production process relative to the level of inputs. The more output resulting from a given level of input, the more productive the process (Ball, Wang, Nehring and Mosheim 2015). High demand for maize has made it less affordable for poor consumers, thus the need for its increased productivity can never be over-emphasized. The expansion of arable land is necessary but it is insufficient and barely a significant approach to increasing maize production (Offiah, 2015). The measurement of productivity analysis of one firm relative to other firms or to the “best practice” in an industry has long been of interest to agricultural economists.

Achieving food security in its totality has been seen to be a major challenge not only to developing nations but also to the developed world. According to FAO (2018), an estimated 821 million people worldwide are still undernourished and almost 20.4 percent of people in Africa are chronically undernourished. The situation in Sub-Saharan Africa is particularly severe with the number of hungry people increasing by 20 percent since 1990 (Braun, 2005). In Nigeria the situation is not different. Kumolu (2010);Nkeme, Udo and Udousung, 2017 reported that about 40 million people in Nigeria are believed to be hungry and a large percentage of the population lack access to adequate food.

Also, the efficiency with which available resources and technology are used by the farmers becomes a matter of concern for investigation. An underlying premise is that, if farmers are not efficient in the use of the existing technology, then efforts designed to improve efficiency would be more cost effective than introducing new technologies as a way of increasing output (Belbase and Grabowski, 1985; Taphee, 2015). Generally, it is expected that the findings of this studyprovide useful information and technical advice to the maize farmers in the study area and Nigeria at large. The study also helped in identifying these farmer's production constraints and proffer solutions with a view of increasing their productivity, income level and standard of living. The study thus assisted in establishing the efficiency with which maize farmers in the study area allocate their resources in maize production. In addition, the results of this study is expected assist policy makers in designing appropriate policies to increase maize productivity in Kaduna State and indeed Nigeria in general. The results of this studyis a useful to agricultural planners such as Agricultural Development Programmes (ADPs) and Ministry of Agriculture at the state and national level and other relevant bodies including NGOs in their planning activities as regards efficient allocation of available resources for increased productivity. Researchers will also benefit immensely from the results of the study as a good resource base because though there exist many literatures on maize production, there is also the need to update the research and findings on the crop so as to sustain growth and development of the economy.

1.5 Hypotheses of the study

The hypotheses put forward for this study were:

i. There is no significant relationship between the socioeconomic characteristics of the maize farmers and economic efficiency.

ii. Maize production does not have significant effect on food security of the households in the study area.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Conceptual Literature

2.1.1Theconcept of resource productivity

Productivity denotes the efficiency with which various input are converted into output. It signifies the relationship between output and input. Agricultural productivity is the index of the ratio of the value of total farm output to the value of the total input used in farm production (Amaechina and Eboh, 2017).

Productivity measures are sub-divided into partial and total measures. Partial measures are the amount of output per unit of the particular input. Commonly used partial measures are yield (output per unit of land), labour productivity (output per economically active person or per agricultural person - hour). Yield is commonly used to assess the success of new production practices or technology. Labour productivity is often used as a means of comparing the productivity of sectors within or across economies. It is also used as an indicator of rural welfare or living standards since it reflects the ability to acquire income through sale of agricultural goods or agricultural production (The Least Developed Countries Report, 2015). Also partial productivity includes capital and management productivity which is the ratio of total output to inputs of capital and management respectively. The computation of this important productivity statistics can be achieved from analysis of production functions. Such productivity statistics include the Average Product (AP), Marginal Product (MP), Marginal Rate of Substitution (MRS), Elasticity of Production (EP), and Return to Scale (RTS).

2.1.2 Farm profitability

Profitability is the primary goal of all business ventures without which the business will not survive in the long run. This involves estimation of costs and returns of production. If returns are more than cost, profit is made and if cost exceeds returns, loss is made. Two tools for estimating profits and loss in a farm production are Net Farm Income (NFI) and Gross Margin (GM) analysis (Olukosi and Erhabor, 1988; Aduba, Mohammed, Jilasaya and Ozumba, 2013).

2.1.3 Farm production efficiency

Farm production efficiency refers to the ability of a farm to produce a given set of output with the lowest amount of resources (Rahman, 2013; Rukwe and Zubairu, 2019). The efficient method of producing a product is the one which uses the least amount of resources to get a given amount of output. Efficient farms make better use of existing resources to produce maximum output or incur the lowest cost. A farm is said to be efficient when there is maximum output, minimum risk, least cost, zero waste, maximum profit and best quality produce.There are three main types of farm production efficiency namely technical, allocative and economic efficiency.

2.1.3.1 technical efficiency (TE)

Technical efficiency (TE) is used to measure the ability of a farm to achieve maximum output from a given set of inputs under a given technology. Thus, it is the attainment of production goals without wastage (Jandrow*et al*., 1982; Amaza and Olayemi, 1999 and Taphee, 2015). Technical efficiency is defined as the measure of a firm's success in producing maximum output from a given set of inputs (Farrel, 1957; Taru, Lawal and Tizhe, 2011). A technically efficient farm operates on the production frontier while a technically inefficient farm operates below the frontier and could be made efficient by increasing its output with the same input level or using fewer inputs to produce the same level of output. As such, the closer a firm gets to the frontier, the more technically efficient it becomes (Ogunyinka and Ajibefun, 2003 as cited in Rahman, 2013).

2.1.3.2 allocative efficiency (AE)

Allocative efficiency refers to the ability of a farm to use inputs in optimal proportions given their respective prices and the production technology (Chirwa, 2003 as cited in Rahman, 2013). Allocative efficiency has to do with the extent to which farmers make efficient decisions by using inputs up to the level at which their marginal contribution to production value is equal to the factor cost (MVP = MFC) (Ebiowei, Chukwuemeka and Jackson, 2013). Under competitive conditions, a farm is said to be allocatively efficient if it equates the marginal returns of factor input to the market price of output (Fan, 1999; Sibiko, Mwangi, Gido, Ingasia and Mutai, 2013).

2.1.3.3 economic efficiency (EE)

Economic efficiency is derived from the product of the technical and allocative efficiencies. It occurs when a firm chooses resources and enterprises in such a way as to attain economic optimum (Kareem, Dipeolu, Aromolaran and Akegbejo, 2008). It is concerned with the realization of maximum output in monetary terms with the minimum available resources (Rahman, 2013).

2.1.3.4 determinants of farm production efficiency

Determinants of farm production efficiency are grouped into three classes based on the nature of the relationship that exists between a farm and some factors within and outside the farm. The three aspects of the relationship that influence efficiency of farm production are Farm – farmer relationship, farm –institution relationship, farm – production relationship (Rahman, 2013).

Farm – Farmer Relationship

This describes the influence of farmer's socio-economic characteristics on farm production. Age, farm size, income, household size, farming experience, education, cooperative participation and land tenure system have been identified as factors that influence farm production efficiency (Lau and Yotopolous, 1971;Ajani, 2000; Adeoti, 2002; Ajibefun and abdulkadiri, 2004; Ogundari*et al.,* and Idiong*et al*., 2007 as cited in Rahman, 2013. It is expected that as farmers become older, their productivity will decline. Farmers with a higher level of education adopt new technologies easily and use them efficiently to enhance productivity. Farmers with more years of farming experience tend to be more efficient in farm production. The land ownership status is also important because farmers that own parcels of land for farming tend to be more productive.

Farm – Institution Relationship

In most developing countries like Nigeria, improvements in agricultural production, efficiency and sustainability depends on the support given to the farmers which enable them to adopt new technologies and decide wisely in the management of their farms. Some institutions which are established to drive production efficiency by rendering essential services such as agricultural extension, agricultural credit, agricultural research and agricultural marketing (Rahman, 2013).

Farm – Production Relationship

Production of farm produce involves different relationships between inputs and outputs. Production relationship provides tools for analysing problems of production and resource use efficiency. The farm production efficiency maybe analysed under three micro economic relationship (Rahman, 2013).

i. **Factor – Factor Relationship**: This determines the most profitable combination of inputs in producing a given level of output or determines the most profitable level of output to produce at a given combination of resources.

ii. **Factor – Product Relationship**; in this relationship, the economist tries to determine the most profitable amount of resources to use to produce a given level of output or to determine the most profitable amount of output to produce at a given level of input.

iii. **Product – Product Relationship**: This determines the most profitable level of input to use to produce a given combination of products or to determine the most profitable combinations of products at a given level of input.

2.1.4 Concept of food security

Food security is a situation that exists when all people, at all times have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary requirements and food preferences for an active and healthy life (FAO, 2001). Food security is directly related to food consumption, both in quality and quantity (Baliwati*et al*., 2015). Food security is a condition related to the supply of food, and individuals' access to it. Base on supply of food, food security is the availability of adequate supply of basic foodstuffs at all times, to sustain a steady expansion of food consumption and to offset fluctuations in production and prices (FAO, 2003). Based on demand and access to food, the term 'food security' exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (Ramachadran, 2013; FAO, 1996). Household food security exists when all members, at all times, have access to enough food for an active, healthy life. Individuals who are food secure do not live in hunger or fear of starvation (FAO, 2013). On the other hand, food insecurity is a situation of limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire acceptable foods in socially acceptable ways (Gary *et* *al*., 2000). According to Olagunju, *et al*. (2012), household food insecurity mainly originates from lack of wealth. In their study, they ascertained the fact that wealthier households are less prone to food shortages compared with low-income household with meagre resources, and the effect of increasing price of food is relatively severe on poor household. Chronic food insecurity is defined as the long-term, persistent lack of adequate food (Ecker and Breisinger, 2012). Food security incorporates a measure of resilience to future disruption or unavailability of critical food supply due to various risk factors including droughts, shipping disruptions, fuel shortages, economic instability, and wars (Boeing, 2016). In the years 2011–2013, an estimated 842 million people were suffering from chronic hunger (FAO, 2013). Food security can be measured by calorie intake per person per day (Webb *et al*., 2006; Perez-Escamilla and Segall-Correa, 2008). Generally, the objective of food security indicators and measures is to capture some or all of the main components of food security in terms of food availability, access and utilization or adequacy. While availability and utilization seemed much easier to estimate, access to food remains largely elusive (Barrett, 2010). However, factors influencing household food access are often context specific.

2.1.4.1 Pillars of Food Security

The Food and Agriculture Organization (2009) identified the four pillars of food security as availability, access, utilization, and stability.

Food availability: This relates to the supply of food through production, distribution, and exchange (Gregory *et al*., 2005). Food availability is when all people have sufficient quantities of food available on a consistent basis. It is mainly determined by food production and food trade (FAO, 2008). Food production is determined by a variety of factors including land ownership and use; soil management; crop selection, breeding, and management; livestock breeding and management; and harvesting (FAO, 2013). Because food consumers outnumber producers in every country (Tweeten, 1999), food must be distributed to different regions or nations. Food distribution involves the storage, processing, transport, packaging, and marketing of food (FAO, 1997). The exchange of food requires efficient trading systems and market institutions, which can affect food security (Ecker and Breisinger, 2012). Per capita world food supplies are more than adequate to provide food security to all, and thus food accessibility is a greater barrier to achieving food security (Tweeten, 1999).

Food access: This refers to the affordability and allocation of food, as well as the preferences of individuals and households (Gregory *et al*., 2005). Access to food can be direct, in which a household produces food using human and material resources, and/or economic, in which a household purchases food produced elsewhere (FAO, 1997). According to the United States Department of Agriculture (2008), access to food must be available in socially acceptable ways, without resorting to emergency food supplies, scavenging, stealing, or other coping strategies.

Food utilization: refers to the metabolism of food by individuals (Tweeten, 1999). Food utilization is seen as the ability of the human body to ingest and metabolize food through adequate diet, clean water, good sanitation and health care to reach a state of nutritional well-being where all physiological needs are met (Philipine Food Security Information System FSIS, 2018).

Food stability: refers to the ability to obtain food over time. Food insecurity can be transitory, seasonal, or chronic. In transitory food insecurity, food may be unavailable during certain periods of time. At the food production level, natural disasters and drought result in crop failure and decreased food availability. Civil conflicts can also decrease access to food (Ecker and Breisinger, 2012). Instability in markets resulting in food-price spikes can cause transitory food insecurity. Other factors that can temporarily cause food insecurity are loss of employment or productivity, which can be caused by illness. Seasonal food insecurity can result from the regular pattern of growing seasons in food production (FAO, 1997).

2.2.1Maize production and cropping system in Nigeria

Maize is the second most cultivated crop in Nigeria in terms of area harvested 6.5million hectares, second to Cassava's 7.1 million hectares (FAOSTAT, 2018). Nigeria is the second largest maize producer in Africa, after South Africa, with an estimated 10.41 million metric tonnes produced in 2016 (FAOSTAT, 2018). Despite its high production volumes, Nigeria's average maize yield of 1.7 metric tonnes per hectare is one of the lowest among the top 10 maize producers in Africa. It lags behind countries such as Egypt and South Africa where the yields are 7.7 metric tonnes per hectare and 5.3 metric tonnes per hectare respectively (FAOSTAT, 2018). Simply by addressing this low yield issue, Nigeria could become the largest maize producer in Africa and one of the largest producers in the world without increasing the area currently used for its cultivation. In Nigeria, the largest volumes of maize are produced in the Northern region, particularly in Kaduna, Borno, Niger, and Taraba and in the South -Western states including in Ogun, Ondo and Oyo. Cropping systems differ from North to South. Northern farmers typically do not practice intercropping. While, in the South, maize is usually intercropped with yam, cassava, guinea corn, rice, cowpea, groundnut, and soybeans.

The production season of maize differs in the North and South. The main season in the North is May-October while the main season in the South is March-August. There is usually a second season (August-January) which is rain-fed in the South and irrigated in the North. Harvest is usually done three months after planting. However, the cycles have been affected in recent years by changing weather patterns. During the growing season the price of dry maize, locally referred to as "old maize", increases significantly due to growing demand by processors. Grain merchants in Northern Nigeria store the maize during the peak of availability and sell at higher prices in off-season periods to food processors and feed mill operators.

According to FAOSTAT 2020 as shown in figure2.1 below, Production yields and areas harvested trends for the past decade, shows an overall alignment between production and area harvested. In the year 2010 – 2016, the area harvested increased but there was a decrease in maize yield. From the year 2016 – 2017, the area harvested decreased but there was an increase yield of maize (about 495,952 hectares). This might indicate an improvement in production technology, since yields are increasing as well.

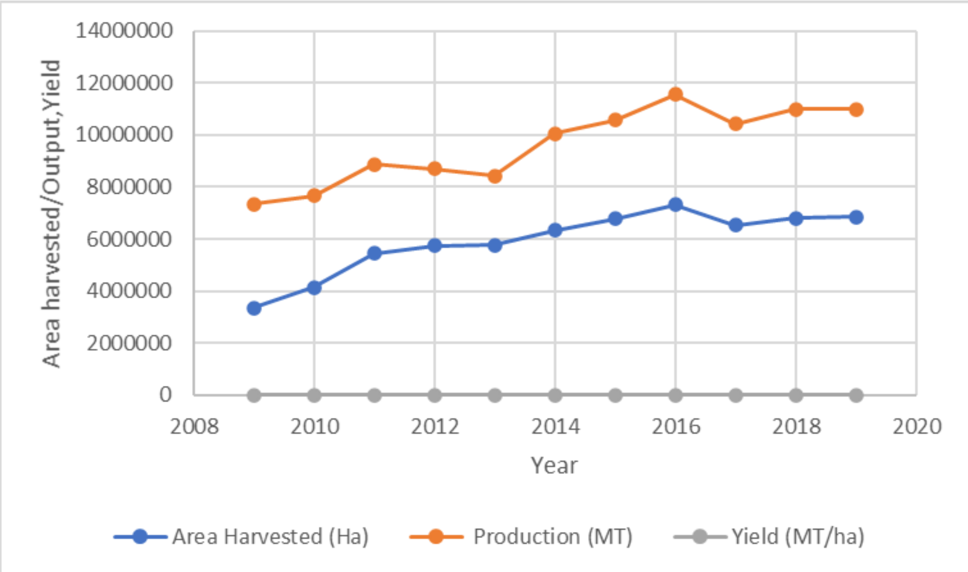

Figure 2.1: Maize production trend in Nigeria from 2009– 2019

2.2.2 Maize Production in Kaduna State

Maize production in Kaduna State shows an increasing trend. From the year 2009 – 2013, there was fluctuations in the yield of maize with some years having a slight increase and some years, a decrease. The average yield of maize in the state for those years was 1.93 MT. This, the ADP complained is the consequence of farmers not using recommended planting material e.g. hybrid seed and fertilizer, rather they depend on seed from market or previous harvest and organic fertilizer. However, from the year 2014 – 2019 there is a great improvement in the average maize yield 5.1 MT. This success can be attributed to the various interventions in the state working at improving the livelihood of smallholder farmers. That also shows that if farmers adopt appropriate technologies and more sustainable approaches, the land under cultivation has the potential to translate into profitable production.

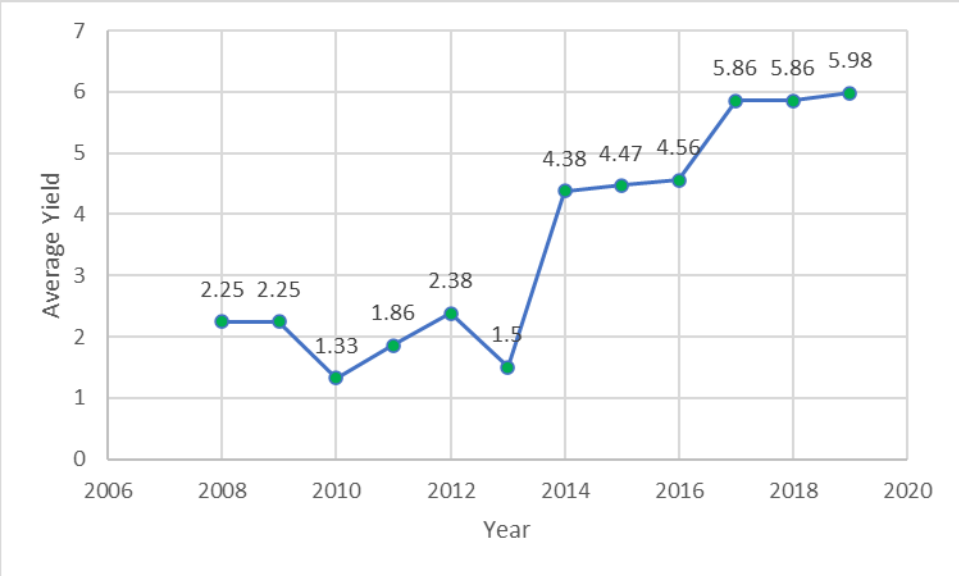

Figure 2.2: Maize production trend in Kaduna State from 2008 – 2019

2.2.3Importance of maize in Nigeria

Maize is one of the most versatile emerging crops having wider adaptability under varied agro climatic conditions. (Srikanth *et al.*, 2017) The importance of the crop lies in its wide industrial applications besides serving as food for human consumption such as Pap, maize flour, thick porridge and boiled grains which are notable food consumed by majority of Nigerians, mostly in the northern part of the country. As the demand for the crop is growing globally due to its multiple uses for food, feed and industrial sectors, new production technologies offer great promise for increasing productivity to meet the growing demands of consumers. Maize is industrially important chiefly for the production of starch and alcohol. The starch can be used as converter dextrin, syrup and sugar; oil obtained from it is used to make soup or refine for cooking and salad dressing (Oyewo, 2011). According to IITA (2009) as cited by Offiah (2015), the nutrients mostly found in the grain include vitamins A, C and E, carbohydrates, and essential minerals, and contain 9 percent protein. They are also rich in dietary fibre and calories which are a good source of energy (IITA, 2009). The importance of maize during the December 2006 Abuja summit on food security in Africa where African head of states and governments identified maize, among other crops, as a strategic commodity for achieving food security and poverty reduction and called on Africa union commission (AUC) and the new partnership for Africa development (NEPAD) to promote maize production, on the continent to achieve self-sufficiency by 2015 (AUC, 2006). Being a remedy for food insecurity, maize has become so important because foods made out of maize is very nutritious as it is an important source of carbohydrate, protein, iron, vitamin B, and minerals (Offiah, 2015), and it is a major ingredient in infant food brewery (Sowunmi and Akintola, 2010). Furthermore, edible oil which is an all-purpose culinary oil is extracted from maize grains (Oladejo and Adetunji, 2012). Maize is also widely used as the main source of calories in animal feeding and feed formulation. More than half of the maize produced is consumed by the animal feed sector, with poultry claiming as much as 98 percent of the total feed produced in Nigeria between 2005 and 2010 (United State Department of Agriculture USDA report, 2005-2010).

2.2.4 Maize cropping system in Nigeria

The term cropping system refers to the crops, crop sequences and the management used on a particular field over a period of years (Emerson, 2010). The various types of cropping system include mono-cropping, Double-cropping, Relay intercropping, strip cropping, inter-cropping (Emerson, 2010). It refers to the crop production activity of a farm, which comprises all cropping patterns on the farm and their interaction with farm resources, other household enterprise and the physical, biological, technological and socio-economic factors or environment.

The cultivation of maize in Nigeria is performed in two major ways depending on the environment and custom of the people concerned. Sole cropping is seldom practised; the great majority of the maize crop is grown as mixed crop with yam, cassava, guinea corn, rice, cowpea, groundnut and soybeans (Raw Material Research and Development Council, 2004). The crop is Africa's most important cereal, and also forms a basic part of the cereal-legume intercropping system common to most developing countries agriculture. Maize-legume intercropping is currently receiving global attention because of its prime importance to world agriculture (Oyelade and Awanane, 2013).

Maize is typically inter-cropped with other food crops, with the predominant combinations varying by production zones. When grown in mixtures, the maize is usually in low density mixed with one or more associated crops including cassava, sorghum, cowpea, groundnut, yam, sweet potato, rice, vegetables et cetera. Mixed cropping lower's maize yields, but it helps farmers increase the overall productivity of the resources invested in agriculture and reduces losses if any of the crop fails. However, some farmers grow a super-impose mixture of the maize with legumes, particularly groundnut, soybeans and cow pea (RMRDC Report, 2004). Ecological zone of production includes; swamp, deep water, irrigated lowland, rain-fed lowland, rain-fed lowland and rain-fed upland. Although the guinea savannah zones provide the best ecological condition for maize cultivation, maize is also grown in the forest zones, the derived savanna zone and the southern savannah. The cropping system of maize in Nigeria is classified based on the ecological zones of Southern guinea, Northern guinea and Derived guinea savanna (Olukosi, 1991; Nansak, 2016).

Southern guinea savanna is predominant with sorghum, maize and millet based cropping system, in which maize seems to be replacing gero (millet), while yam now assume an increasing role for food and cash crop. The major maize crop mixtures include millet/maize/dauro (millet), maize/sorghum and maize /cassava (Olukosi, 1991; Nansak, 2016).

Northern guinea savanna is dominated by millet, sorghum and cowpea, in which maize is now becoming an important crop. The major maize crop mixtures are maize/sorghum, maize/cotton and maize/ rice. Derived guinea savanna is dominated by yam/cassava based system, and other crops include sweet potato, sesame pigeon pea, sorghum, groundnut and rice. The important maize crop mixtures are maize/rice, maize/pigeon peas, maize/groundnut (Olukosi, 1991; Nansak, 2016).

2.3 Analytical Framework

2.3.1 Gross margin analysis

The gross margin (GM) for an enterprise is the difference between the total value of production (total revenue) and the total variable cost of production (Alam, Aboki, Gidado and Buba, 2013). According to Olukosi and Erhabor, 1988; Nandi, Gunn and Yurkushi, 2011, gross margin is important because it easy to compute and interpret, highly applicable to subsistence system of farming involving small fixed capital component, useful where the same capital items are used in many different enterprises in a given farm, serves as a guide to the selection of enterprises by comparing their margins, helps the farm manager to critically examine the variable cost components in production and helps in building partial budgets for the farm.

Gross margin is calculated as:

$$GM = TR - TVC$$

Where,

GM = Gross Margin (N/ha)

TR = Total Revenue (N/ha)

TVC = Total Variable Cost (N/ha)

2.3.2 Net farm income

Net farm income is the difference between gross income (revenue) and total cost of production (Olukosi and Erhabor, 1998; Alam*et al*., 2013). It is used to show the levels of costs, returns and net profit that accrue to farmers. The technique emphasizes the costs (fixed and variable costs) and returns of any production enterprise. According to Alam*et al*., 2013, two major categories of costs are involved in crop production. These are fixed and variable cost. Fixed costs (FC) refer to those costs that do not vary with the level of production or output while variable costs (VC) refer to those costs that vary with output. The total cost (TC) is the sum of total fixed cost (TFC) and total variable cost (TVC).

$$NFI = TR - TC$$

Where:

NFI= net farm income (₦/ha)

TR= total revenue (₦/ha)

TC= total cost of production (₦/ha)

$$TC = TVC + TFC$$

Where:

TVC = Total variable cost (₦/ha)

TFC = Total fixed cost (₦/ha)

2.3.3 Measurement of farm production efficiency

Generally, there are two approaches to measurement of efficiency of a firm, namely the parametric approach and the non-parametric approach. The parametric approach involves the use of stochastic frontier analysis (SFA) while the non-parametric approach involves the use of data envelopment analysis (DEA).

2.3.3.1 The stochastic frontier production function

The stochastic frontier production model was independently proposed by Aigner *et al*., (1977). In the stochastic frontier analysis (SFA), the error term is assumed to have two component parts V_i and U_i. The Vi covers the random effects (random errors on the production which are outside the control of the farmer) while the U_i measures the technical inefficiency effects (behavioural factors that come under the control of the farmer and are controllable errors if efficient management is put in place). The stochastic frontier production function model is generally preferred over the non-parametric approach for the measurement of productivity and estimation of efficiency in this study for the following reasons: the inherent variability of agricultural production due to interplay of weather, soil, pest, diseases and environmental factors and many farms are small family owned enterprises where keeping of accurate records is not always a priority hence, available data on production is subject to measurement errors.

The stochastic frontier production function model is specified as:

$$Y_i = f(X_1, \beta)\ exp\ (V_i - U_i)$$

Where:

Y_i= quantity of maize output of the i^{th} farm

X_i = vector of input by the i^{th} farm

β = vector of parameters to be estimated

V_i= random error outside the farmer's control and

-U_i=technical inefficiency effects

2.3.3.2 data envelopment analysis (DEA)

This non-parametric efficiency measurement method is a mathematical programming approach often referred to as the Data Envelopment Analysis (DEA) (Charnes *et al.*, 1978; Smriti *et al.*, 2018). It uses linear programming methods to estimate a production frontier function (Oum and Chunyan, 1994).The main advantage of this technique in the estimation of technical efficiency is that it does not require prices either for the outputs or for the inputs. Moreover, this technique permits considering the multi-input and multi-output case and the approach is deterministic, that is, it does not admit noise.

Technical efficiency scores can be obtained by running a constant return to scale (CRS) DEA model or variable return to scale (VRS) DEA. Technical efficiency scores obtained from constant return to scale (CRS-DEA) model are called total technical efficiency and from variable return to scale (VRS-DEA) model as pure technical efficiency. Total technical efficiency of a firm can be decomposed into pure technical and scale efficiency. Pure technical efficiency relates to management practices while scale efficiency relates to the residuals of productivity. This would enable better understanding of the nature of technical efficiency of farms and would assess the possibilities of relationship between resource productivity gains by improving the efficiency of farmers. The key construct of a DEA model is the envelopment surface and the efficient projection path to the envelopment surface (Charnes *et al.,* 1978). The envelopment surface will differ depending on the scale assumptions that underline the model. The efficiency projection path to the envelopment will differ depending on whether the model is output-oriented or input oriented. The choice of model depends upon the optimization of production process characterizing the firm. Input oriented DEA determines how much the mix for a firm would have to change to achieve the output level that coincides with the best practice frontier. Output-oriented DEA on the other hand is used to determine a firm's potential output given its inputs mix if operated as efficiently as firms along the best practice frontier.

2.3.4 Measurement of food securitystatus

Several measures had been developed that aim to capture the component of food security (Ballard *et al.,* 2011). Worthy to take note is that no single method has been agreed on by researchers even though they seem to have similar objectives; identifying the food insecure, characterizing the nature of insecurity, monitor changes in their circumstances and assess the impact of interventions. These methods include:

Household Food Insecurity Access Scale (HFIAS): This is a continuous measure of the degree of food insecurity (access) in the household in the previous month.

Household Dietary Diversity Score (HDDS): The Household Dietary Diversity Score (HDDS) was developed in 2006 as part of the FANTA II project as an indicator of household food access. Household dietary diversity can be described as the number of food groups consumed by a household over a given reference period, and is an important indicator of food security for many reasons. A more diversified household diet is correlated with caloric and protein adequacy, percentage of protein from animal sources, and household income (Swindale *et al.* 2006). The HDDS indicator provides a glimpse of a household's ability to access food as well as its socioeconomic status (Kennedy *et al.* 2011).

Majorly, 12 food groups are used to calculate the HDDS indicator:

Each food group is assigned a score of 1 (if consumed) or 0 (if not consumed). The household score will range from 0-12 and is equal to the total number of food groups consumed by the household:

The average household dietary diversity score for the population of study can be calculated as follows: Sum (HDDS)/Total number of households surveyed

Household Hunger Scale (HHS): This is a measure of the experience of household food deprivation based on a set of predictable reactions, captured through a survey and summarized in a scale; and Coping Strategies Index (CSI): This assesses household behaviors and rates them based on a set of varied established behaviors on how households cope with food shortages (Maxwell *et al.*, 2008).

Cost of Calories (COC): This method uses the cost of buying the minimum calories intake to establish a food security line which is used to classify respondents as food secure and insure(Amaza*et al*., 2006; Keku, 2017)

Food Security Index (FSI): This approach uses the identification and aggregation procedures. Identification is the process of defining a minimum level of nutrition necessary to maintain healthy living. This is referred to as the 'Food Security Line", below which people are classified as food insecure and subsisting on inadequate nutrition (Ojeleye, 2015). The following equation is used for estimating the food security index.

$$Food\ security\ index = \frac{Household\ per\ capita\ calorie\ avaailable}{Household\ daily\ per\ capita\ calorie\ required}$$

2.4Constraints Associated with Maize Production

The most important constraints farmers face in maize farming as pointed out by research include lack of farm tools, low soil fertility, lack of financial resources to purchase inputs and high prices of the inputs (especially fertilizers and seed, and low technical know-how. Others are pests and diseases, vagaries of weather, unavailability of inputs, inadequate access to credit facilities and agricultural extension services, and poor marketing of both inputs and outputs.

Nuhu (2016) reported that the major constraint to maize production in Soba Local Government Area, Kaduna State is the high cost of acquiring inputs (24 percent) such as seeds, fertilizer, herbicide and pesticide. Other constraints militating against maize production is inadequate capital (23 percent), poor selling market price (15 percent), poor climate condition (11 percent), and inadequate extension contact (18 percent). The report also revealed that farmers face incidence pest and diseases attack (9 percent) all of which inhibit increases in maize yields and production.

Ado (2016) in his research on analysis of productivity among maize farmers in Doguwa local government area of kano state, identified farmers major constraints to increase maize production to include high cost of inputs (34.1 percent), low output price (27.9), lack of access to credit (16.2 percent), non-availability of tractor hire implement (8.38 percent), drought (5.57 percent), pest and diseases (4.5 percent), lack of access to road network (3.35 percent).

Oyelade and Awanane (2013) indicated that a major limitation to maize production in Nigeria is the declining soil fertility which is exacerbated by the high cost and/or unavailability of chemical fertilizer. Low soil fertility, especially of Nitrogen and Phosphorus, is the prime factor limiting maize growth which subsequently affects grain yield. The production constraints associated with maize production include drought, shortage of rainfall, and pest and diseases (Oyelade and Awanane, 2013). Other constraints relate to crop management, the non-availability of good seed, as well as soil fertility depletion (Badu-Aprakuet al., 2012). Research by scholars have shown low capitalization, price fluctuation, diseases and pests, poor storage facilities, and inefficiency of resource utilization as the identified problems in maize production in Nigeria.

2.5 Empirical Studies on Production Efficiency

Udoh and Etim (2007) used the stochastic frontier production function in estimating farm level technical efficiency of fluted pumpkin production in Uyo, Nigeria. The result showed that land, labour, inorganic fertilizer and planting material were significantly related with output of fluted pumkin at 1 percent, 5 percent and 10 percent levels of probability, respectively. The technical efficiencies ranged between 0.01 and 0.96 with a mean technical efficiency of 0.86. The determinants of technical inefficiency in fluted pumpkin production result showed that extension contact and farming experience were the significant determinants of technical inefficiency at 5 percent and 1 percent levels of probability respectively.

Tanko and Opara (2010) used stochastic frontier production function in the measurement of technical efficiency in maize production in Bosso Local Government Area of Niger State of Nigeria. Farm size, labour and fertilizer were found to be significantly related with maize output at 1 percent levels of probability. The mean technical efficiency is 0.873 which implies that on the average the respondents are able to obtain a little over 87.3 percent of potential output from a given mix of production inputs, suggesting a wider scope for the farmers to increase their level of technical efficiency by allocating existing resources more optimally. The summary of the results indicated that the best farm has technical efficiency of 0.983 (98.3 percent) while the worst farm has a technical efficiency of 0.434 (43.3 percent) implying that some of the farmers are operating far away from the frontier region. The results of the determinants of technical inefficiency in maize production showed that education, farming experience, and credit were significantly related with technical efficiency at 1 percent levels.

Rahman *et al*. (2005) used the stochastic frontier production function in estimating the technical efficiency in sorghum-based cropping systems in Soba area of Kaduna state of Nigeria. For sole sorghum production, land, fertilizer and labour were significantly related with output at 5 percent level of probability, with an average technical efficiency of 0.62. For sorghum-cowpea production, land and labour were reported to be statistically significant at 5 percent level with an average technical efficiency of 0.74. For sorghum-groundnut production, land and labour were statistically significant at 5 percent level with an average technical efficiency of 0.64. For sorghum-soya bean production, land and labour were statistically significant at 5 percent with an average technical efficiency of 0.71 (71 percent). For sorghum- millet production, land and labour were statistically significant at 5 percent level with an average technical efficiency of 0.58 (58 percent). The overall technical efficiencies achieved in the sorghum-based cropping system ranged between 58 to 74 percent.

Kadurumba*et al*., (2009) used translog stochastic frontier production function to measure the level of technical efficiency and its determinants in traditional palm oil processing in Imo State of Nigeria. From the result, oil palm fruit (kg), water used, amount of loan borrowed, petrol/diesel energy were statistically significant at 5 percent and 10 percent levels respectively and were positively related with technical efficiency. While labour and water usedwere statistically significant at 1 percentand 10 percent levels respectively and negatively related with technical efficiency. Result of the determinants of technical efficiency in traditional palm oil processing showed that age, educational level and net processing income were negatively related with palm oil processing but significant at 5 percent, 1 percent and 10 percent level respectively.

Depreciation on fixed assets, litre of petrol/diesel energy, cooperative membership, credit availability, interest on loan, mill membership and mechanization energy were statistically significant at 1 percent, 5 percent and 10 percent level respectively. The frequency distribution of technical efficiency indices showed the maximum technical efficiency (0.97), minimum technical efficiency (0.16) and the mean technical efficiency (0.86).

Muhammad-Lawal *et al.*, (2009) used Cobb-Douglas frontier production function model to estimate technical efficiency of youths participating in agricultural programs in Ondo State, South-Western Nigeria. The estimated individual technical efficiencies ranges between 32.62 percent and 96.25 percent, with a mean technical efficiency of 85.23 percent. The result showed that 86 percent of the respondents were operating at 80 percent level of technical efficiency. The determinants of technical efficiency were years of participation in agricultural programme, household size, usage of extension service and education.

Chukwuji (2010) studied the technical efficiency in cassava-based food crop production systems in Delta State by using stochastic frontier function. The result showed that 71 percent and 67 percent of the variations in output is attributable to difference in technical inefficiencies. Mean technical efficiencies for mixed crop and mono-crop farmers were 80 and 71 percent respectively. The determinants of technical inefficiency are Level of formal education, contact with extension agents, farming experience and capital to labour ratio and credit to total cost ratio.

Nuhu (2016) used the stochastic frontier production function to study the economic analysis of maize production in Soba Local Government Area of Kaduna State, Nigeria. The result showed that seed, herbicide and fertilizer were significantly related with output of maize at 1 percent, 10 percent and 1 percent levels of probability, respectively. Maize production had mean technical efficiency of 0.86. The determinants of technical inefficiency in maize production result showed that household size, level of education and extension contact were the significant determinants of technical inefficiency at 1 percent, 1 percent and 1 percent levels of probability respectively.

Amos (2007) carried out an analysis of productivity and technical efficiency of smallholder cocoa farmers in Nigeria using stochastic frontier production function model. The estimated individual technical efficiencies ranges between 11 percent and 91 percent, with a mean technical efficiency of 72 percent. The result showed that many of the respondents were operating between 51 percent - 80 percent level of technical efficiency. The determinants of technical inefficiency are age of farms and age of farmers.

Hussaini *et al*. (2016) used the stochastic frontier production function to study the economics of irrigated rice production on farmer’s productivity in Kogi State, Nigeria. The result showed that seed, fertilizer and labour were significantly related with output of maize at 1 percent level of probability. Irrigated rice production had mean technical efficiency of 0.59. The determinants of technical inefficiency in irrigated rice production result showed that household size, farming experience and farm size were the significant determinants of technical inefficiency at 1 percent levels of probability.

CHAPTER THREE

METHODOLOGY

3.1 Description of the Study Area

The study was conducted in Kaduna State, Nigeria. The state is located between latitudes 9° $00^{'-}$N and 11^{0} $30^{'-}$ N and longitudes 6° $00^{'-}$E and 9° $10^{'-}$E of the prime meridian (Kaduna Agricultural Development Agency, KADA, 2018). There are twenty-three (23) Local Government Areas (LGAs) and four (4) agricultural zones in Kaduna state. The zones include Maigana zone, Lere zone, Samaru and Birnin Gwari zones (KADA, 2018). The state occupies an area of about of 46,053 square kilometres, with a projected population of 8,789,003 in 2019 at an annual growth rate of 3.2 percent (National Population Commission, NPC and National Bureau of Statistics, NBS, 2016).

The climate is the tropical wet and dry type. The wet season last from April through to mid-October of one calendar year to April the next calendar year (Abaje, Sawa, Iguisi, and Ibrahim, 2016) weather is characterized by dry and wet seasons. The average annual rainfall is about 1,323 mm (Abaji*et al.*, 2015). The spatial and temporal distribution varies, decreasing from an average of about 1,733 mm in the southern part of the state (Kafanchan) to about 1,203 mm in the central part (Kaduna) and about 1,032 in the northern part (Zaria) (Abaji*et al*., 2016). The state has a mean annual temperature of 25.2 ℃, April being the warmest month (28.6 ℃)and December the lowest (22.9 ℃) through January (23.1 ℃) (Abaji*et al*., 2016).

Kaduna state lies within the Guines Savanna Ecological Zone. About 80 percent of the population in Kaduna state takes farming as their main occupation (Kaduna Agricultural Development Project, KADP, 2014), with emphasis on the cultivation of cereal crops like maize, sorghum, rice, millet, and legumes like cowpea, soybean and groundnut which are mainly rain-fed. The cropping pattern in the area is dominated by mixed cropping although sole cropping is also practiced. Also, livestock such as cattle, sheep, goat, swine, rabbits and poultry are kept.

The major ethnic group of the state includes Hausa, Fulani, Gbagyi, Jaba, Bajju, Koro, Atyab, Kaninkon, Kadara, Chawai, Atakai, Gure, Kahugu, Kulu, Kurama, Kagoro, Kagoma, Ninzo and Morwa (KADA, 2018).

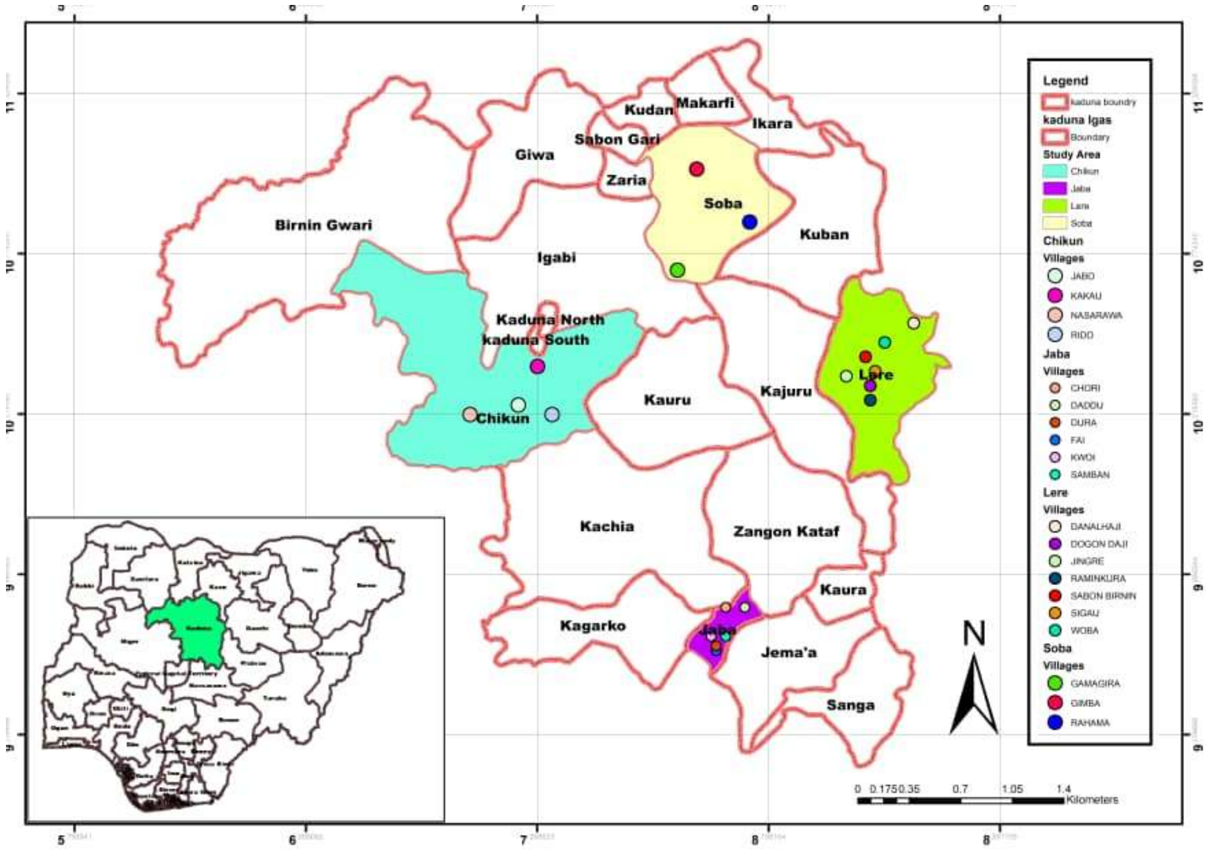

Figure 3.1: Map of Kaduna State showing the twenty-three LGAsand the study area

3.2 Sampling Procedure and Sample Size

A multistage sampling procedure was used to generate data for this study. The first stage involved the selection of the four agricultural zones (Maigana, Samaru Kataf, Lere and Birnin Gwari zones) in the state. The second stage involvedthe random selection of one LGAeach in three of the agricultural zones selected using a simple balloting system of selection. The fourth LGA was purposively selected from the last zone (Birnin Gwari) because of the security challenges in the area. This gives a total of four (4) LGAs. Ten (10) percent of villages were randomly selected and this translates into 3, 7, 6 and 4 villages for Soba, Lere, Jaba and Chikunrespectively as shown in the Table 3.1. The last stage involved the random selection of 10 percent of the sample frame from each village to get the sample size. Therefore, a total of two hundred and fifty-eight (258) maize farmers out of two thousand, five hundred and eighty (2580) were randomly selected for the study, using the same balloting system for selecting villages.

Table 3.1: Population and sample size of maize farmers in the study area

Zones	LGA	Villages	10% of villages	Name of villages	Sample frame	Sample size
Maigana	Soba	33	3	Gamagira	212	21
				Rahama	174	17
				Gimba	122	12
Lere	Lere	68	7	Raminkura	226	23
				Sabon Birnin	271	27
				Sigau	147	15
				GogonJeji	109	11
				Danlahaji	58	6
				Jingre	77	8
				Woba	41	4
Samaru Kataf	Jaba	61	6	Kwoi	181	18
				Sambam	111	11
				Chori	87	9
				Fai	89	9
				Dura	92	9
				Daddu	49	5
Birnin Gwari	Chikun	43	4	Nasarawa	153	15
				Kakau	151	15
				Rido	133	13
				Jabo	97	10
Total		**205**	**20**		**2580**	**258**

Source: Reconnaissance survey; Kaduna State Agricultural Development Agency KADA 2018

3.3 Data Collection

Primary data wereused for this study. The data were obtained through the use of structured questionnaire which was administered to the selected maize farmers in the study area. Data that wereobtained from the maize farmers are: (a) farmers' socio-economic characteristics which are age, household size, level of education, amount of credit received, number of extension contact, and years spent in cooperative. (b) Production information; inputs used and output of maize production. (c) Food security information: calorie consumed (d) Constraints faced by the farmers in maize production.

3.4 Analytical Techniques

Data collected for this research were analysed using the following:

i. Descriptive statistics
ii. Net farm income model
iii. Stochastic frontier model
iv. Food security index
v. Tobit regression model

3.4.1. Descriptive statistics

Descriptive statistics was used to achieve objectives (i) and (vi) of the study. It involved the use of measures of central tendencies such as the mean, frequency distribution, standard deviation, coefficient of variation and percentages to describe the socioeconomic characteristics and use of frequency and percentage to describe the constraints faced by maize farmers in the study area.

3.4.2 Net farm income model

The Net Farm Income (NFI) was used to achieve objective (ii). It was used to determine the profitability of maize production in the study area. The formula for the net farm income model is stated as:

$NFI = TR - TC$ ………………………………………………………………… (1)

Where:

NFI= net farm income (₦)

TR = total revenue (₦)

TC= total cost of production (₦)

$TC = TVC + TFC$ ………………………………………………………………… (2)

Where:

TVC = Total variable cost (₦)

TFC = Total fixed cost (₦)

The fixed inputs which include knapsack sprayer and machineries such as tractor were not used up in the maize production process. They were estimated using the straight line depreciation method given by:

$D = \frac{P-S}{N}$ ……………………………………………………………….3

Where:

D = depreciation (₦),

P = Purchase value (₦),

S = salvage value (₦) and

N= life span of asset (years).

Return per naira invested (RNI) is obtained by dividing the gross income (GI) by the total cost (TC).

Therefore,

$RNI = \frac{GI}{TC}$ ……………………………………………………………………… (4)

Where,

RNI = return per naira invested (₦)

GI = gross income (₦)

TC = total cost (₦).

The decision rule holds that:

If RNI > 1, it implies there is profit in production.

If RNI = 1, the farmeris breaking even.

If RNI < 1, the farmer is at loss.

The gross ratio (GR) is obtained by dividing the total cost (TC) by the gross income (GI)

Therefore,

$$GR = \frac{TC}{GI}$$

Where,

GR = gross ratio

TC = total cost

GI = gross income

3.4.3. The stochastic frontier production model

The stochastic frontier production function was used to achieve objective (iii). It was used to determine the economic efficiency of maize production in the study area. It is specified implicitly as:

$Y_i = f(X_1, \beta)\ exp\ (V_i - U_i)$ ……………………………………………………5

Where:

Y_i= quantity of maize output (Kg) of the i^{th} farm

X_i = vector of input by the i^{th}farm

β = vector of parameters to be estimated

V_i = random error outside the farmer's control and

-U_i= technical inefficiency effects

The Stochastic Frontier Production Function (SFPF) specifying the technical efficiency in maize production in the study area is expressed explicitly as:

$InY = \beta_0 + \beta_1 InX_1 + \beta_2 InX_2 + \beta_3 InX_3 + \beta_4 InX_4 + \beta_5 InX_5 + (V_i - U_i)$ ……………7

where:

In = natural logarithm

Y = output of maize (Kg)

β_0 = constant term

β_1- β_5 = regression coefficients

X_1 = farm size (hectares)

X_2= quantity of seed used (kg)

X_3= total labour used in production (man-days)

X_4 = quantity of agrochemicals used (litres)

X_5 = quantity of fertilizer used (kg)

V_i = random error term in the production that cannot be influenced by the farmer

-U_i = inefficiency effect.

The -U_i is expressed as:

-$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \delta_7 Z_7$ …………………8

Where:

-U_i = technical inefficiency of the i^{th} farmer

δ_0 = constant

δ_1-δ_6 = parameters to be estimated

Z_1 = age of farmer (years)

Z_2 = level of education ((nil = 0, primary = 1, secondary = 2, Tertiary = 3)

Z_3 = household size (number of persons)

Z_4= Farming experience (years)

Z_5= Membership of association (years)

Z_6 = access to credit (₦)

Z_7 = access to off-farm income (₦)

3.4.3.1 The stochastic frontier allocative efficiency model

The allocative efficiency model used in the study is specified as:

$C = F(P, Y; \alpha)\ exp\ e_i\ i = 1,2 \ldots n$ ………………………………………9

Where:

C = cost associated with maize production (₦),

P= vector of input prices (₦),

Y = maize output (Kg),

α = vector of parameters and

e_i = composite error term.

The stochastic frontier cost function is explicitly expressed as:

$$InC_i = \beta_0 + \beta_1 InF_1 + \beta_2 InF_2 + \beta_3 InF_3 + \beta_4 InF_4 + \beta_5 InF_5 + \beta_6 InF_6 + (V_i + U_i) \ldots 9$$

Where:

In = natural logarithm

C_i = total cost of maize output (₦)

β_0 = constant term

β_1 - β_6 = regression coefficients

F_1 = depreciation value of land (₦)

F_2 = depreciation of machinery (₦)

F_3= cost of maize seed (₦)

F_4 = cost of fertilizer (₦)

F_5= cost of other agro-chemicals (₦)

F_6 = cost of labour used in production (₦/man-days)

V_i = random error term in the production that cannot be influenced by the farmer

U_i = inefficiency effect which are non-negative.

The inefficiency model is defined by:

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 9$$

Where:

U_i = Cost of inefficiency effect

δ_0 = constant

δ_1 - δ_6 = parameters to be estimated

Z_1 = age of farmer (years)

Z_2 = level of education ((nil = 0, primary = 1, secondary = 2, Tertiary = 3)

Z_3 = household size (number of persons)

Z_4 = Membership of association (years)

Z_5 = access to credit (₦)

Z_6 = access to off-farm income (₦)

3.4.3.2 Economic efficiency model

The product of technical efficiency (TE) and allocative efficiency (AE) provides the index of economic efficiency (EE). The model to be used in the study is specified as:

$EE = TE * AE$ ……………………………………10

Where:

EE= economic efficiency,

TE= technical efficiency and

AE= allocative efficiency

3.4.4. Food security index (FSI)

Food security index was used to achieve objective (iv) of this study which is to determine the food security status of maize farming household. To measure household food security, a food security index was constructed which involves two steps: identification and aggregation procedures. Identification is the process of defining a minimum level of calorie consumed necessary to maintain healthy living. This is referred to as the ‘Food Security Line”, below which households are classified as food insecure while aggregation was used to derive food security statistics for the households. The food security line used in this study is based on the calorie consumed daily. It was estimated using the formula:

$Z_i = \frac{X}{Y}$...11

Where:

Z_i = Food Security Index

X = Per capita calorie available to a household per day

Y = Recommended per capita calorie intake per day

For a household to be food secure, Z_i must be greater than or equal to 1 ($Z_i \geq 1$). If Z_i is less than 1 ($Z_i < 1$), the household is food insecure. Thus, a household is food secure if its calorie food intake is more than or equal to Z_i and food insecure ifotherwise. For the purpose of this study a farm household is a group of individuals who live together and eat from the same pot.

3.4.5 Tobit regression

Tobit model was used to achieve objective (v). To determine the effect of maize production on food security of maize-farming household.Two stages of analyses were involved; firstly, a food security index (FSI) was constructed and secondly, the tobit regression model was used as a lead model to estimate the effects of maize production on food security status of the maize farmers.

$Y_i = X_i\beta + \varepsilon_i$ ....

Where:

Y_i = Food security index for i^{th} farming household

Where:

X_i = independent variables which are the factors influencing food security status

ε_i = the error term

β = vector of the parameter estimates

The Tobit model is stated explicitly as:

$$Y_i = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + \beta_{10}X_{10} + \beta_{11}X_{11} + U_i$$

Where:

Y_i = Index of food security for the i^{th} farming household

X_1 = Output of maize (Kg)

X_2 = Age of household head (years)

X_3 = Marital status of household head

X_4 = Education level of household head (years)

X_5 = Adjusted household size (number of person)

X_6 = Farm size (Ha)

X_7 = Years of farming experience (years)

X_8 = Membership of association (years)

X_9 = Access to credit (₦)

X_{10} = Access to off-farm income (₦)

X_{11} = Number of contacts with extension agent

3.5 Variable Definition and Measurement

Three dependent variables and thirteenindependent variables were measured as determinants in the specified models.

3.5.1 Dependent variable

i. **Output:** This was measured in Kilograms. It is the quantity of maize produced. This was used to determine the technical efficiency.

ii. **Cost of Production:** This was measured in naira. It refers to the total cost of maize output. This was used to determine the allocative efficiency.

iii. **Food security index:** This refers to food security status of the households whereby if Y = 1, the household is considered food secure and Y = 0, the household is considered food insecure. The quantity of crops produced and purchased for consumption was converted to kilogram and then to calorie and then divided by the adult equivalent household size, using FAO adult equivalent scale. To estimate the calorie consumed per day per household, the result was further divided by 365 days and then compared with the FAO standard (2260 Kcal) for food secured individual. This was used for Tobit regression.

3.5.2 Independent variables

i. **Age:** This refers to farmer's years attained from birth. It is a continuous variable which is measured in years. Age is assumed to be positively related to economic efficiency and food security as the older a farmer, the more experienced he will be; this may lead to increased production and income (Ojeleye, 2015).

ii. **Household size (number of persons):** This refers to the total number of people in the house and eat from the same pot. Household size is expected to have a negative relationship with food security as food requirements increases with the number of person in the household (Omonona and Agoi, 2007)

iii. **Education level:** It refers to respondents' level of formal or informal education. This was measured in years. The role of education is considered very important in the perception of new farm practice/technologies. Therefore, level of education is expected to have a positive relationship with economicefficiency and food security status (Oluyole and Taiwo, 2015; Onasanya and Obayelu, 2016).

iv. **Amount of credit obtained**: This was measured as amount received in naira. It refers to amount of money received from both formal and informal sources. Credit is a very important factor that is needed to acquire or develop farm enterprise. Its availability could determine the extent of production capacity. The *a priori* expectation for amount of money received is expected to be positively related to efficiency and food security status. (Onasanya and Obayelu, 2016)

v. **Farm size**: It is the size of the respondents' farm measured in hectares. The *a priori* expectation is positive. It is expected that a household with more land will produce more crops and more marketable surplus thereby being food secured (Natayi and Robert, 2018).

vi. **Extension visits:** This was measured in terms of number of visits made by an extension agent per season. The relationship between agricultural extension agent and the farmer is important in improving the yield of maize as well as in ensuring food security. The more number of visits of an extension agent to a farmer, the greater the chance of that farmer adopting new technologies. Number ofextension contact is expected to have negative sign on the technical inefficiency (Adebayo, 2012).

vii. **Co-operative membership:** This was measured in years. Co-operative groups are organized for the promotion of special interest or to meet certain needs that cannot be achieved by individual efforts. The *a priori* expectation for cooperative society is expected to be positive, this implies that the cooperative membership of the farmer is reducing inefficiency and increasing food security.

viii. **Quantity of seed:** This was measured in kilograms (Kg). It was included in the model to examine the actual kilograms of the maize seed used in a production cycle. The *a priori* expectation for quantity of seed is expected to be positive; this implies that, a unit increase in quantity of seed will bring about increase in output (Taru *et al.,* 2012).

ix. **Quantity of labour:** Labour was measured in man-days. This consist of both family and hired labour, it was included in the model to examine how variability in labour used will affect output. The *a priori* expectation for quantity of labour is expected to be positive; this implies that, a unit increase in quantity of labour will bring about increase in output (Shehu *et al.,* 2017).

x. **Quantity of agro chemicals:** This was measured in litres (L). It was included in the model to examine the actual amount of chemicals used in production. It is expected to have a positive effect on maize output; a unit increase in quantity of chemicals used will bring about increase in output (Franklin *et al.,* 2017).

xi. **Quantity of fertilizer:** This was measured in kilograms (Kg). It is included in the model to examine the actual amount of fertilizer used in production. The *a priori* expectation for fertilizer is positive meaning that, a unit increase in quantity of fertilizer used will bring about increase in output (Habtamu *et al.,* 2015).

xii. **Adjusted household size:** This measurement is adopted from Appendix 6. It is expected to have a negative relationship with the food security status of maize farming households.

xiii. **Household farm income**: This was measured in naira (₦). This is the total income accruing to the household from farming activities (crop and livestock production). The *a priori* expectation is that there is a positive relationship between farm income, economic efficiency and food security (Ojeleye, 2015).

xiv. **Household non-farm income:** Household non-farm income was measured in naira (₦). This refers to the total income from other sources apart from farming. The *a priori* expectation is that with increasing non-farm income, the farmer is more empowered with a higher purchasing power therefore directly increases the economic efficiency and food security status (Ojeleye, 2015).

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Socioeconomic characteristics of farmers

The socioeconomic characteristics of the respondents that were analysed using descriptive statistics include age of respondents, marital status of respondents, levels of education, household size, years of farming experience, cooperative membership, access to extension, access to credit, sources of credit, amount of credit obtained and membership of association.

4.1.1 Age of farmers

The result of the age distribution of maize farmers is presented in Figure 4.1 It showed that majority of maize farmers (59.30%) were within the age range of 31-50 years, while only a few (8.14%)were above 60 years. The mean age of the maize farming household head was 46 years. About 37% of the respondents had their age below the mean age, while about 63% had their age above the mean age. Hence, there are older household heads than younger counterparts in the study area. This portrays that most of the maize farmers are on average still within the productive and economically active age group hence, they are more likely to make positive contribution to agricultural production, and may be more receptive to improved agricultural technologies and management practices. This in turn leads to optimum productivity and food security as they earn some income from farming and non-farming activities. The age distribution is expected to have positive influence on the farmer's participation in maize production, which invariably means better efficiency in maize production and food security. This agrees with the findings of Oladejo and Adetunji, 2012 who had a mean age of 45.8 yearsthus leading to better productivity of maize. This result also conforms to the result obtained by Mequanent*et al.* (2014) who found out that the older the household head, the lower the probability that the household would be food insecure because they have richer experience and better access to land.

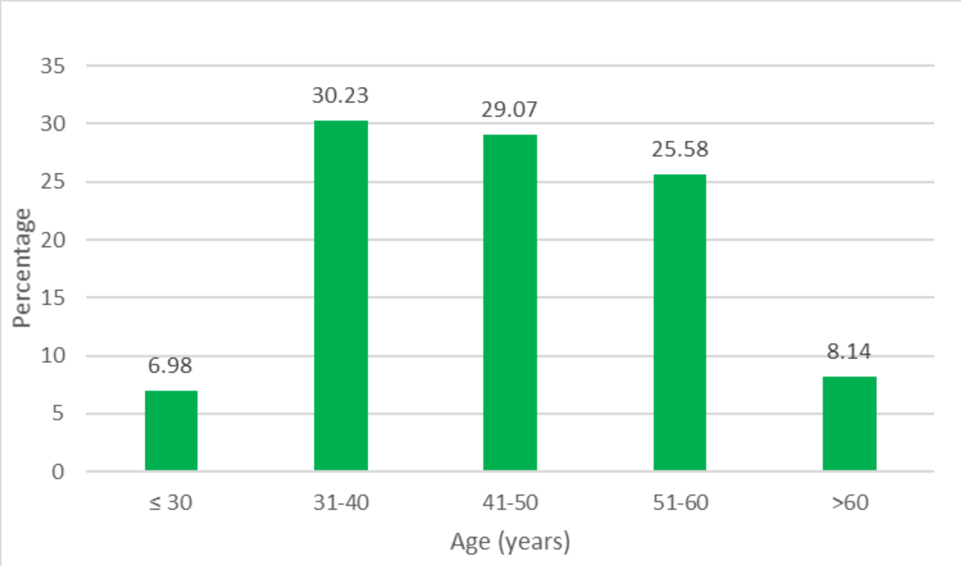

Figure 4.1: Distribution of household heads based on age

4.1.2 Marital Status of Household Heads

Among the sampled maize farmers, majority of the respondents (92.64%) were found to be married. A few of the farmers (3.88%) were found to be widowed, while 2.33% were single. The significance of high number of married farmers is that there could be more family labour available to farming householdsto accomplish different farm operations in order to increase their income and standard of living. This finding is in agreement with Amaza*et al. (2009*); Oluyole and Taiwo, 2015 who posited that it is expected that family labour would be more available where the household heads are married. The widowhood status may have some economic implications in cultures where little or no regards is accorded to women when it comes to the acquisition of land which is a factor of production. This negatively affects food production, thus affecting food security especially if the household is large (Ojeleye, 2015).

Table 4.1: Distribution of marital status of household heads

Marital status	Frequency	Percentage
Single	6	2.33
Married	239	92.64
Divorced	3	1.16
Widow/widower	10	3.88
Total	258	100

4.1.3 Education levels of maize farmers

Education is an important socio-economic factor that influence farmer's decision making as it influences farmer's awareness, perception and adoption of innovations that can bring about increase in productivity. The result in Table 4.2 revealed that only a few of the respondents (23.26%)had no formal education while majority of the maize farmers (76.75%) in the study area had one form of formal education or the other implying that there is potential for increased maize production since literate farmers have better ability to access and absorb new information to enhance their productivity. Muhammed-Lawal *et al.*, (2009) noted that level of education is expected to influence farmers' adoption of agricultural innovations and decision on various aspects of farming. He maintained that education is highly important for sustainable agricultural growth and development. This finding is in agreement with Fakayode*et al.* (2015) who in his research work on food security found that most of the farmers were literate and this probably increased their perception and adoption of innovations as it enables farmers make accurate decisions in the management of farms, thus leading to higher productivity and subsequently food security of the households. Also, Babatunde, (2007) postulated that education is a socio-economic tool which positively affects food security and alleviate poverty status of rural farm households.

Table 4.2: Distribution of education levels of farmers

Level of education	Frequency	Percentage
Non-formal	60	23.26
Primary	56	21.71
Secondary	90	34.88
Tertiary	52	20.16
Total	258	100

4.1.4 Household size of farmers

The result of distribution of household size presented in Table 4.3 showed that majority (41.86%) of the farmers have household size of 6-10 persons, while very few (0.78%) had household size above 30 persons. The mean household size of 10 persons suggests that more mouths are available to be fed and depend on the income from maize production to be food secured. The significance of household size in agriculture that there is likelihood of reduced cost of labour, as adequate family labour may be available for farming operations. However, the implication of household size for food security is that small households are less prone to food insecurity than large household sizes because large household sizes have low per capita (Oluwatayo, 2008). The result agrees with Awotide*et al*. (2013) and Oluyole and Taiwo, 2015 who found out that larger household sizes may provide the needed labour on the farm thus, increasing their productivity.

Table 4.3: Distribution of maize farmers' household size

Household size	Frequency	Percentage
≤5	54	20.93
6-10	108	41.86
11-15	62	24.03
16-20	16	6.20
21-25	12	4.65
26-30	4	1.55
> 30	2	0.78
Total	258	100
Mean	10.3	
SD	6.1	
CoV	9.2	

4.1.5 Farming experience of maize farmers

The distribution of maize farmers by years of farming experience presented in Figure 4.2 showed that majority of maize farmers (73.25%) had farming experience within the range of 11-30 years whereas only a few(6.98%)each of which constitute the minority had farming experience below 10 years and above 40 years. The mean years of farming experience found was 25 years. This result shows that majority of the farmers are experienced in maize production. High number of years of experience shows that farmers will be able to make sound decisions that are technically feasible as regards to resources allocation and management of their farm operations that is economically worthwhile as the more the number of years of production by maize farmer, the more knowledge and skills gained which in turn brings about efficiency thus increasing food security status. This result conforms to the result obtained by Oyewole, (2012) who found that years of farming experience increases agricultural productivity and food security among farming households in Nigeria.

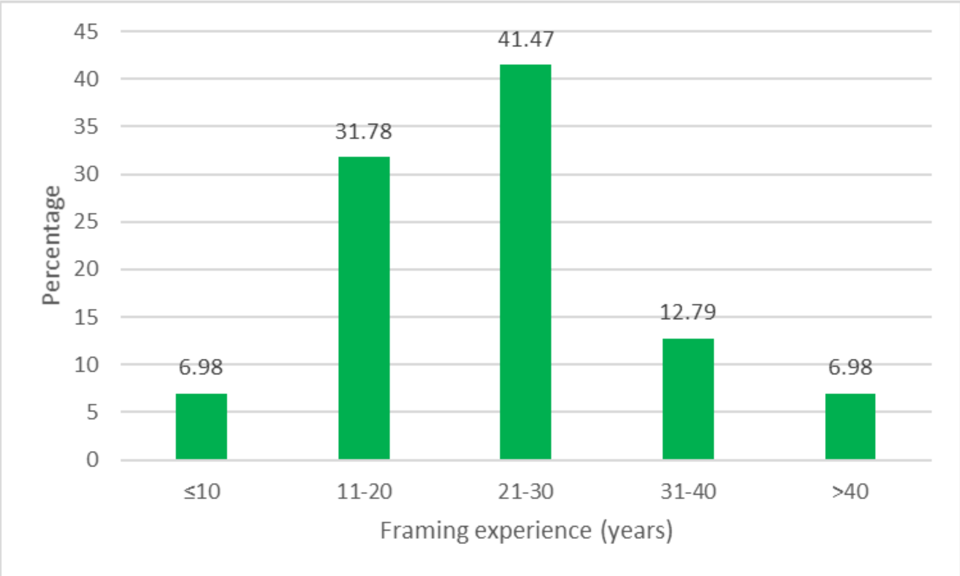

Figure 4.2: Distribution of farmers by years of farming experience

4.1.6 Maize farmers' access to extension services

The distribution of maize farmers based on number of extension visit is presented in Table 4.4. The result showed that majority (75.19%) of the respondents had no contact with an extension agent during the season, while other farmers had at least one extension contact. This could be attributed to low extension agent - farmer ratio in the study area. This result is in contrast to Adeola (2010) who reported that the average number of extension contacts was

0.78 as the access level to extension agents in the study area is low. The inability of majority of farmers to have access to extension services through extension agents may result in low level adoption of improved maize farming practices especially if farmers do not have other sources of information on the benefits of such practices and how they implement the practices.

Table 4.4: Distribution of farmers' access to extension contact

No of extension contacts	Frequency	Percentage
0	194	75.19
1	1	0.39
2	3	1.16
3	10	3.88
4	14	5.43
5	13	5.04
≥6	23	8.91
Total	258	100
Mean	4.7	
Std. Dev.	1.5	
CoV	31	

4.1.7 Maize farmers' access to credit

In agricultural production, adequate funding is required by farmers to finance their production activities. However, a large number of farmers face serious shortage of funds to finance their maize production activities, which in turn limits their level of productivity. The result of the distribution of maize farmers' access to credit presented in Figure 4.3 showed that majority (98.45%) of the farmers in the study area had no access to credit, while 1.55% had access to credit from different sources. The implication is that the size of maize production will be smaller and other inputs may be affected since capital is not available to enhance production. The low accessibility to credit services have been reported in many parts of Sub-Saharan Africa as well as other developing countries as the limiting factor for increased agricultural productivity (Eze*et al.*, 2006; Junge *et al.*, 2009; Okoedo-Okojie and

Onemolease, 2009). Ekong (2003), who asserts that credit, is a very strong factor that is needed to acquire or develop any enterprise; its availability could determine the extent of production capacity.

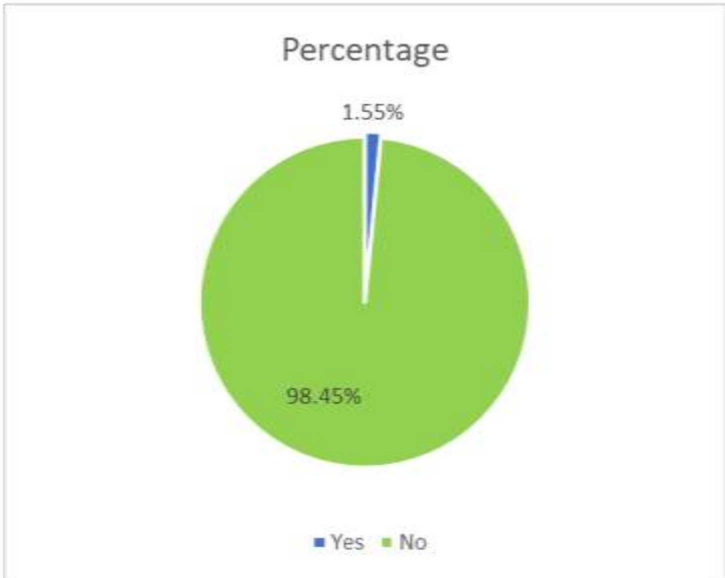

Figure 4.3: Distribution of maize farmers according to access to credit

4.1.8 Membership of Cooperative of Society of Maize Farmers

The result in Figure 4.4 shows the number of years spent as members of Cooperative. About 89.92% of maize farmers did not participate in any Cooperative Association while 10.08% participated in cooperatives. The result indicates low membership of cooperatives by a significant proportion of maize farmers in the study area, which implies that farmers had less access to resources and information that will improve their production practices. This finding is in contrast to Ekong (2003) and Oyewole (2012), who observed that most of the respondents were members of cooperative societies and through this, they were able to access micro-credit, input subsidy and an avenue to share ideas and information that could help them in pooling resources together in order to expand their production efficientlyforprofit maximization. Membership of cooperatives affords farmers the opportunity of sharing information on modern practices. However, most of these associations are grossly underdeveloped and inactive (Keku, 2016).

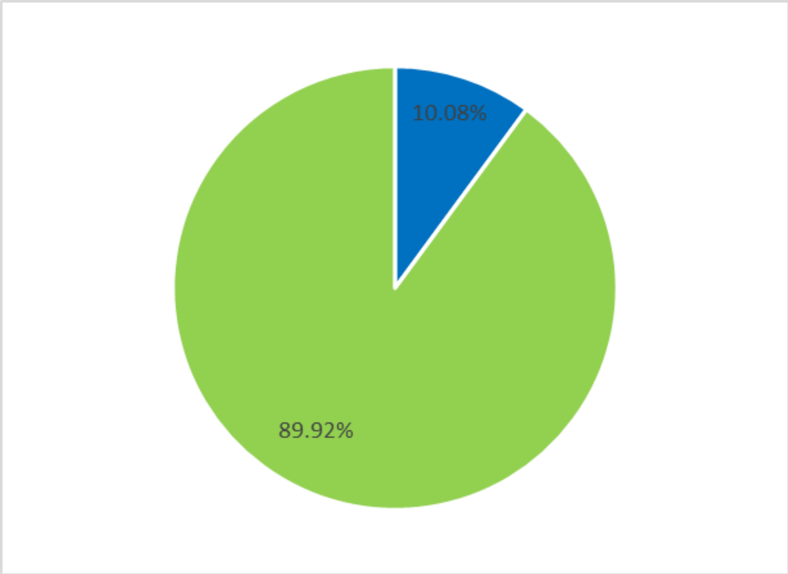

Figure 4.4 Distribution of maize farmers according to cooperative membership

4.1.9 Farm Income of Household Heads

The income from farming is a major determinant of per capita household expenditure and food security status. The result shows that majority of the respondents had farm income greater than ₦400,000 per year. This shows that farm households have enough to satisfy their food needs before selling the excess in the market. The result also shows that average farm income of the rural households in the study area was ₦514,303 per annum. This translates to a monthly farm income of ₦42,858 which is far above the national minimum wage of ₦30,000 per month. The study revealed that most of the respondents had enough money to meet their food need. This is in agreement with Babatunde *et al.* (2007) who found out that households with higher farm income had a higherchance of being food secure.

Table 4.5: Distribution of farm income of households

Farm income	Frequency	Percentage
≤ 50000	22	8.53
50001-100000	37	14.34
100001-150000	13	5.04
150001-200000	10	3.88
200001-250000	2	0.78
250001-300000	8	3.10
300001-350000	4	1.55
350001-400000	6	2.33
> 400000	156	60.47
Total	258	100
Mean	514303.6	
Std. Dev.	723746.2	
CoV	140	

4.1.10 Non - Farm Income of Households

Household non-farm income is an important factor in household access to food. Non-farm income in the study area comes from formal and informal jobs such as education, commercial motor cycling, transportation, trading. The study revealed that all respondents have non-farm income. A great number of the respondents (72.48) have non- farm income greater than or equal to ₦50,000. The mean non-farm income for rural households in the study area was ₦67,490 per year which translates to a monthly non-farm income of ₦5,624 and a daily non-farm income of ₦185.The non-farm income of maize households will have a direct effect on food security status as farmers are well disposed to economic power to buy food (Babatunde and Qaim (2009) as cited in Ojeleye, 2015). Babatunde and Qaim (2009) illustrated this when they found that high-value food such as fruits, vegetables and animal protein are positively linked to non-farm income. Therefore, higher income causes a better access to more nutritious food.

Table 4.6: Distribution of non-farm income of households

Non-farm income	Frequency	Percentage
≤ 50000	187	72.48
50001-100000	7	2.71
100001-150000	7	2.71
150001-200000	16	6.20
200001-250000	18	6.98
250001-300000	8	3.10
> 300000	15	5.81
Total	258	100
Mean	67490.31	
Std. Dev.	119053.6	
CoV	176	

4.2 Profitability of Maize Production in the Study Area

Results presented in Table 4.7 indicated that the average gross income (GI) per hectare cultivated was ₦367,083.10while the total cost (TVC + TFC) was ₦122,633.30. The net farm income was therefore ₦244,449.30. The cost of labour was found to be the highest variable cost accounting for 26.6 percent and 42 percent of the TVC and TC respectively while the cost of renting of farm land (28.8%) was found to be highest fixed cost of maize production in the study area.

The average rate of returns on investment (return per naira invested) was 2.99, indicating that for every ₦1 invested in maize production in the study area; a profit of ₦2.99 was made. The result agrees with the findings of Girei *et al.* (2018) in their research where it was observed that maize production is profitable by returning ₦1.40 to every ₦1.00 spent. The operating ratio of 0.21 indicates that 21 percent of the gross revenue is expended on operating costs of variable resources. This means that maize farmers can sustain production and survive for a longer time. The fixed ratio of 0.12 showed that 12 percent of the gross income is accrued to the fixed resources. This relates to maize farmers fully utilizing all fixed resources during production. The gross ratio which measures the solvency and success of maize farming was found to be 0.33, showing that 33 percent of the gross income is accrued to the total cost. Thus, it can be concluded that maize production in the study area is economically viable.

Table 4.7: Average costs and returns per hectare of maize production

Items of cost	Average value (N/ha)	Percentage
Variable cost		
Seed/seedlings	12,621.29	10.3
Labour (land preparation, planting, weeding, spraying, harvesting, threshing)	32,579.02	26.6
Fertilizers	11,159.00	9.1
Agro chemicals	8,351.00	6.8
Transportation	12,651.16	10.3
Total variable cost	77,361.47	
Fixed cost		
Land	35,289.51	28.8
Machineries	9,982.34	8.1
Total Fixed cost	45,271.85	
Total Cost	122,633.3	100
Returns		
Sales	305,910.5	83.3
Consumption	38,692.1	10.5
Gifts	22,480.42	6.2
Gross income (GI)	367,083.1	100.0
Gross Margin	289721.6	
Net Farm Income	244,449.8	
Return per naira invested	2.99	
Operating Ratio OR= TVC/GI	0.21	
Fixed ratio= TFC/GI	0.12	
Gross ratio = TC/GI	0.33	

4.3 Estimation of the Factors Affecting Efficiencies of Maize Farmers

The stochastic frontier model was used to estimate the technical efficiency (TE), allocative efficiency (AE), and economic efficiency (EE) of maize farmers in the study area.

4.3.1 Estimation of the Technical Efficiency of Maize Farmers

The maximum likelihood estimate (MLE) of the parameters of the technical efficiency model is presented in Table 4.8. The estimated sigma squared (σ^2) for maize farmer was significantly different from zero at 1 percent level. This indicates a good fit and correctness of the specified distributional assumptions of the composite error terms. In addition, the estimated gamma parameters (γ) of 0.98 was also significant at 1 percent level of significance, indicating that about 98 percent of the total variation in output was as a result of factors within the control of the farmer and that variation in maize output could be attributed to inefficiency. This could also be interpreted to mean that the differences between actual (observed) and frontier output were dominated by technical inefficiency (i.e., factors within the control of the farmers rather than outside their control). The remaining 2 percentwas due to factors outside the control of the farmers. Result resonates with the findings of Abdulai *et al.* (2017) who found 96.1percent variation in output of maize in a studyassessing the economic efficiency of maize production.

The MLE result of technical efficiency model as presented in Table 4.8showed thatefficiency variables farm size (0.476, $p < 0.10$), quantity of seed (0.228, $p < 0.10$), labour (0.663, $p < 0.01$), and quantity of agro chemicals (0.206, $p < 0.05$)were positive and significant at their respective levels. However, among the inefficiency variables, age (-1.148, $p<0.01$), level of education (12.483, $p<0.01$), farming experience (1.41, $p<0.01$), membership of association (-14.541 $p<0.01$), and access to credit (-27.828, $p <0.01$) were found to be significant.

Specifically, farm size was positive and statistically significant at 10 percent. The result showed that a hectare increase in farm size will lead to 0.476 units increase in output of maize, *ceteris paribus*.The result supports *a priori* expectation that as area cultivated increases, output of maize increase also. The result is in tandem with the findings of Girie *et* *al*. (2018) who found out that farm size significantlydetermines maize output at 1 percent level of significance.

The coefficient ofquantity of seed was positive and statistically significant at 10 percent. This implies that a unit increase in quantity of seed used for planting leads to a corresponding increase in maize output by 0.228 units. This is in line with *a priori* expectation thatunit increase in quantity of seed brings about an increase in output. The significance of seed quantity is that seed determines to a large extent the output obtained. If correct seed rates and quality seeds are used, output will be high given other inputs are adequate. This agrees with the findings of Ayinde *et al.* (2015) who observed that the estimated coefficient of seed is positive as expected and significant at 10 percent level which implies that the more seed is applied and the more labour employed the better the output of maize.

From the result, the coefficient of labour was positively correlated and statistically significant at 1 percent. This implies that a unit increase in labour on the farm will lead to a corresponding increase in maize output by 0.663 units. This agrees with *a priori* expectation that unit increase in labour will bring about increase in output. This is in agreement with the findings of Ayinde *et al.* (2015) who observed that the estimated coefficient of labour is positive and significant at 1 percent level which implies that the more labour employed, the better the output of maize.

The estimated coefficient of herbicide was 0.206 which is positive and significant at 5 percent level of significance. This implies that with a unit increase in herbicide, output of maize will increase by 0.206 units. This finding is in line with the findings of Abdul *et al.* (2016) who observed that the estimated coefficient of agrochemical input was positive as expected and significant at 5 percent level implies that the more agrochemical is applied and the more labour employed the better the output of maize.

The result of the inefficiency modelshowed that age of farmer was significant at 1 percent but had a negative relationship (-1.148) with technical inefficiency. The result showed that a year increase in the age of farmers reduce inefficiency in maize production by 1.148 unit. This further indicates that older farmers who had been in maize farming due to their increasing farming experience are more technically efficient than younger ones. This is in agreement with *a priori* expectation. This is in conflict to the findings of Ayinde *et al.* (2015) who found age to be positive but not significant.

Level of education, which is a fundamental variable that reduces inefficiency in production, was significant at 1 percent. Result showed that an increase in level of education will lead to a 12.483 units increase in technical inefficiency. This is in opposition to *a priori* expectation where education is supposed to reduce inefficiency in production. This indicates that maize farmers without formal education were more technically efficient than those with formal education. This could be attributed to more educated farmers having other jobs and do not give all attention to farming thereby, reducing their efficiency.This result agrees with that of Ayinde *et al.* (2015) that showed a positive relationship between education and technical inefficiency in maize production.

Contrary to*a priori* expectation, farming experience was found to be positive and statistically significant at 1 percent. The coefficient of farming experience indicates that a unit increase in farm experience will lead to 1.41 units increase in technical inefficiency, thereby reducing technical efficiency. This suggest that maize farmers with more years of experience are less technically efficient than those with less years of experience. This result corroborates Oyewo (2009) who found maize farmers with many years of experience to be less technically efficient. Result also contradicts Donkoh*et al.* (2013) and Abdulai *et al.* (2017) who found experience to be significant in determining the efficiencyof production.

The coefficient of membership of association a proxy to social capital, was found to be negative and significant at 1 percent.The result shows that an increase in membership association would lead to a decrease in inefficiency by 14.541 units thereby increasing technical efficiency. This agrees with the *a priori* expectationwhere maize farmers who are members of farmers' group or association are more likely to be technically efficient. This could be as a result of the benefits derived from the group they belong to. Such benefit includes information on supplies, market for inputs, easy contact with extension personnel and many more. The result does not agree with the findings of Abdul *et al*. (2016) who in his work on cost efficiency of rainfed maize production found cooperative membership to be negative but insignificant.

Table 4.8 Results of maximum likelihood estimates of stochastic frontier production function of maize production

Variables	Parameters	Coefficients	Std. error	T – ratio
Constant	β_0	11.777	0.566	20.80***
Farm size	β_1	0.476	0.288	1.65*
Quantity of seed	β_2	0.228	0.134	1.69*
Labour	B_3	0.663	0.204	3.25***
Quantity of agro chemicals	β_4	0.206	0.091	2.27**
Quantity of fertilizer	β_5	-0.006	0.063	-0.10
Inefficiency variable				
Constant	Z_0	-69.259	23.72	-2.92***
Age	Z_1	-1.148	0.089	-12.78***
Level of education	Z_2	12.483	2.194	5.69***
Household size	Z_3	-0.137	0.225	-0.61
Experience	Z_4	1.41	0.172	8.22***
Membership of association	Z_5	-14.541	5.751	-2.53***
Access to credit	Z_6	-27.828	7.897	3.52***
Off-farm income	Z_7	5.109	5.989	0.85
Diagnostic statistics				
Sigma square	σ^2	187.99	47.287	3.98***
Gamma	γ	0.982	0.005	188.83***
Log likelihood function	L/f	-679.648***		
LR test		0.163		
Total observation		258		
Mean efficiency		0.732		

Note: Level of Significance; *= 10%, ** = 5% and *** = 1%

The estimated coefficient of credit access was negative and statistically significant at 1 percent level. This shows that an increase in access to credit will lead to 27.828 units decrease in technical inefficiency of the farmers. This is in line with *a priori* expectation where farmers who had access to credit are more technically efficient than those with no credit access in the study area. Credit increases farmers' level of investment in maize production, thereby causing him to be more technically efficient. The result agrees with the findings of Usman (2017)) who found the coefficient of access to credit to be negative and significant.

4.3.2Estimation of theAllocative Efficiency of Maize Farmers

The MLE of the stochastic cost parameters for maize farmers is presented in Table 4.9.The high value of the sigma squared indicates the goodness of fit and correctness of the specified assumption of the composite error terms distribution. The gamma (γ= 0.974) shows that 97.4 percent variability in the total costs of maize production of maize farming households results in the existence of allocative inefficiency.

The estimated parameter of the cost function showed that the coefficients of cost of farmland, cost of machinery, cost of fertilizer, cost of agro-chemical, and cost of labour were all positive and significant at 1 percent level, indicating that these variables are major determinants of the total cost of maize production. This also could mean that a marginal increase in their unit prices has sizeable effect on the production cost of maize.

The coefficient of cost of land was positive and statistically significant at 1 percent levels of probability. From the result, a unit increase in cost of land, while holding other costs constant will lead to an increase in the total cost of production by 0.275 units. In other words, for a given level of output, maize farmers will exceed the minimum feasible cost of production by

27.5 %.The coefficient of cost of machinerywas also positive. It is a clear indication that a unit increase in cost of purchasing farm machinery will increase the total cost of maize production by 0.332 units.Cost of fertilizer also had a positive coefficient of 0.368and significant at 1 percent level probability. It therefore means that a unit increase in cost of fertilizer will increase the cost ofmaize production by 0.368 units.Result resonates with the findings of Zalkuwi*et al.* (2010)who stated that increasing cost of fertilizer significantly increased total cost of maize production.

The coefficient of cost of agro-chemicals was also positive and statistically significant 1 percent. This implies that an increase in cost of agro-chemical will lead to an increase in total production cost by 0.073 units.The estimated coefficient of cost of labour was also positive and significant at 1 percent level probability. This simply suggests that an increase labour cost will lead to an increase in total cost of production by 0.142 units.

The positive and significance cost of farmland, cost of machinery, cost of fertilizer, cost of agro-chemical, and cost of labour agrees with what was found by Abdulai *et al*. (2017) where these variables significantly and positively increased the total cost of maize production.

The estimated coefficient in the explanatory variables for the cost inefficiency is of interest and has important implication. The positive coefficient of level of education indicates that farmers' level of cost efficiency tend to decline with education. This is in contradiction with the assumption that educational level of the farmers will have positive effect on the level of efficiency as the embody skill that can improve their overall efficiency. Result conforms to the findings of Zalkuwi*et al*. (2010) where level of education was positive and significantly increased cost of maize production.

The significant and positive coefficient of household size also suggests that efficiency in the total cost of maize production decreases with family size. This negates the assumption that household size – a proxy for labour availability can supply paid/hired labour thereby reducing cost of labour and bringing about increase in the efficiencies in overall cost of maize production.

The negative coefficient of years of farming experience and membership of association implies that experienced farmersand farmers who belong to association are more cost efficient than the inexperienced ones. This could also mean that as the years of farming experience and membership of farmer's association increases in the study area, the cost inefficiencies of maizefarmer decreases. This is in conformity with the assumption that farmers' years of experience affect production efficiency.

Table 4.9: Results of maximum likelihood estimates of stochastic frontier cost function of maize production

Variables	Parameters	Coefficients	Std. error	T – ratio
Constant	β_0	1.018	0.703	1.45
ln cost of land	β_1	0.275	0.062	4.46***
ln depreciation of machinery	β_2	0.332	0.023	14.65***
ln cost of seed	β_3	0.006	0.035	0.18
ln cost of fertilizer	β_4	0.368	0.015	24.50***
ln cost of agro-chemical	β_5	0.073	0.020	3.59***
ln cost of labour	β_6	0.142	0.055	2.56***
Inefficiency variable				
Constant	Z_0	-23.867	1.416	16.86***
Age	Z_1	0.040	0.033	1.22
Level of education	Z_2	0.988	0.177	5.59***
Household size	Z_3	0.336	0.051	6.55***
Experience	Z_4	-0.089	0.048	-1.85*
Membership of association	Z_5	-1.172	0.330	-3.55***
Access to credit	Z_6	0.360	0.786	0.46
Off-farm income	Z_7	0.659	0.611	1.08
Diagnostic statistics				
Sigma square	σ^2	6.989	0.349	20.01***
Gamma	γ	0.974	0.019	52.06***
Log likelihood function	L/f	-202.704***		
LR test		422.509***		

Total observation	258

Note: Level of significance *= 10%, ** = 5% and *** = 1%

4.3.3 Distribution of Efficiency Estimates

The result in Table 4.10showed the distribution of maize farmers according to their technical, allocative, and economic efficiencies. Specifically, the mean technical efficiency of maize production in the study area was 0.73. The mean technical efficiency value of 73 percent means that maize farmers only attained an output equal to 73 percent of potential output and they could get an additional output of 27 percent if the technical inefficiency in production is eliminated. The result also showed the minimum and maximum values to be 41 and 99 percent respectively. This indicates a high variation between the least technically efficient maize farmer and the best technically efficient farmer in the study area.

The mean allocative efficiency was 70 percent with minimum and maximum allocative efficiency level of 5 percent and 100 percent respectively. However, the mean allocative efficiency suggests that farmers were 70 percent efficient in input use relative to input prices.

Table 4.10: Technical, Allocative and Economic Efficiencies of maize farmers

Efficiency levels	Technical Efficiency		Allocative Efficiency		Economic Efficiency	
	Frequency	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
≤ 0.50	11	4.26	22	8.53	115	44.57
0.51 - 0.60	44	17.05	15	5.81	77	29.85
0.61 - 0.70	42	16.28	59	22.87	42	16.28
0.71 - 0.80	71	27.52	109	42.25	22	8.53
0.81 - 0.90	55	21.32	52	20.16	2	0.78
0.91 – 1.00	35	13.57	1	0.39	0	0
Total	258	100	258	100	258	100
Mean	0.73		0.70		0.51	
Min	0.41		0.05		0.04	
Max	0.99		1.00		0.80	
Std. Dev.	0.18		0.15		0.12	
CoV	25.0 %		22.1%		24.2%	

Economic efficiency had a mean of 51 percent. This measures the extent to which farmers make efficient decisions by using inputs up to the level at which their marginal value products equal their marginal factor costs while obtaining maximum output from a given set of inputs under the given production technology. As regards the distribution of efficiency estimates across the various efficiency types, majority (27.5 percent) of the maize farmers had technical efficiency within the 0.71 and 0.80 (Table 4.10). Likewise, a larger proportion (42.3 percent) had allocative efficiency within the 0.71 and 0.80. However, economic efficiency was higher with more than half (about 55.5 percent) of maize farmers recording efficiency level within 0.51 to 0.90 as presented in the efficiency distribution table.

4.3.4 Disaggregation of the farmer's efficiency in relation to the significant variable input

4.3.4.1 Average efficiency and farm size of maize farmers

Table 4.11 shows the average efficiency distribution of maize farmers based on farm size. From the results, farmers who had moderate farms size between 2.1 – 4 hectares had the highest technical efficiency (0.77) than those who had smaller or bigger farm sizes. The average allocative and economic efficiency varies based on the farm size. The implication of this result is that with increase in farm size, TE of the farmers decreases. This contradicts the finding of Abdulaleem *et al.,* (2019)who found out that that farmers who had bigger farm size had greater efficiency than those who had smaller farms.

Table 4.11: Average efficiency distribution and farm size of maize farmers

Farm size (ha)	Average TE	Average AE	Average EE
0.1 – 2	0.72	0.69	0.49
2.1 – 4	0.77	0.71	0.54
4.1 – 6	0.75	0.68	0.53
> 6	0.74	0.74	0.57

4.3.4.2 Average efficiency and quantity of seed used by maize farmers

Table 4.12 shows the average efficiency distribution of maize farmers based on quantity of seed used by the farmers. From the results, farmers who had higher quantity of seed >50 had the least technical efficiency (0.68) than those who had smaller quantity. The average allocative and economic efficiency varies based on the quantity of seed used. The implication of this result is that with too much increase in quantity of seed, TE will also decrease.

Table 4.12: Average efficiency distribution and quantity of seeds used by maize farmers

Quantity of seeds (kg)	Average TE	Average AE	Average EE
≤ 25	0.73	0.69	0.50
26 – 50	0.75	0.71	0.53
> 50	0.68	0.73	0.48

4.3.4.3 Average efficiency and quantity of herbicides used by maize farmers

Table 4.13 shows the average efficiency distribution of maize farmers based on quantity of herbicides used by the farmers. From the results, farmers who used between 11-15 L had the highest TE (0.76). This shows that under application and over application of herbicide may affect yield negatively. The average allocative and economic efficiency varies based on the quantity used. The implication of this result is that too little or too much herbicide should not be used on the farm as this will affect the TE of the farmers.

Table 4.13: Average efficiency distribution and quantity of herbicides used by maize farmers

Herbicides (litres)	Average TE	Average AE	Average EE
≤ 5	0.74	0.70	0.51
6 – 10	0.75	0.66	0.47
11 – 15	0.76	0.72	0.56
16 – 20	0.59	0.67	0.40
> 20	0.73	0.70	0.51

4.3.4.4 Average efficiency and labour used by maize farmers

Table 4.14 shows how labour affects the efficiency of the farmers. Farmers with relatively high number of people working (21 – 30) had the highest technical efficiency (0.77). Farmers with very high number of people (31 – 40) had a very low TE. This could be due to the fact that there will be too many people on the farm doing nothing.

Table 4.14: Average efficiency distribution and labor used by maize farmers

Quantity of labour	Average TE	Average AE	Average EE
1 – 10	0.75	0.70	0.52
11 – 20	0.65	0.69	0.45
21 – 30	0.77	0.70	0.52
31 – 40	0.24	0.80	0.19

4.4 Household Food Security Status

The quantity of crops produced and purchased for consumption was converted to kilogram and then to calorie and then divided by the adult equivalent household size, using FAO adult equivalent scale. To estimate the calorie consumed per day per household, the result was further divided by 365 days and then compared with the FAO standard (2260Kcal) for food secured individual. The households whose daily per capita calorie was up to 2260Kcal were regarded as food secure, while those below the food security line of 2260Kcal were regarded as food insecure.

The result presented in Table 4.15showed that approximately 62 percent of the sampled households were food secure while 38 percent were not food secure. The larger proportion of the food secured household could mean that the level of production was high and this could afford them the ability to consume what they produced and sell surplus to buy other things. It may also be that the food secured households engaged in secondary activities which enables them to generate additional income to supplement revenue from maize production. This is in agreement with the findings of Onasanya and Obayelu (2016) in their study of determinants of food security status of maize based farming households in southern guinea savannah area of Oyo state, Nigeria.

The average food security indices for the food secure and insecure households were estimated to be 1.84 and 0.47 respectively, while the food security index for the pooled data was 2.10. The value of 1.84 index for the foodsecure household indicates a surplus index of 0.84 among the food secured households. The shortfall/surplus index measures the extent of deviation from the food security line. The average total crop output of 8550.68 Kg for the food secure household suggests that these households are more technically efficient in maize production for them to attain a FSI of 1.84.The average daily calorie consumption for the food secure household was 4165.63Kcal, and this suggests an excess in calorie consumption of the recommended by 1905.63Kcal.

On the other hand, the food insecure household with FSI of 0.47 indicates that these households have shortage index of 0.53 (1 – 0.47) for them to be food secured. The average daily calorie consumption of 1069.38Kcal shows a shortage in calorie consumption of the FAO recommended by 1163.62Kcal. Analysis further revealed that the average farm and non-farm income which is a key determinant of households' food security status was estimated to be ₦230,654.90 and ₦685,197.50 for food insecure and food secure household respectively.

The result corroborates the findings of Oyewole (2012) in a study on "Food security measurement and income diversification strategies in Oyo state" where 66.4 percent and 33.6 percent of the sampled households were found to be food secure and food insecure respectively. Result is also in tandem with findings of Keku (2017), where he found majority (66 percent) of sample farm households to be food secure. Interestingly, the result negates the findings of Babatunde (2007) where majority (62.8 percent) of the sampled household were found to be food insecure in a study on socioeconomic characteristics and food security status of farming households in kwara state.

Table 4.15: Summary of households' food security analysis

Variable in Average	Value
Food secured households (No)	161
Food security index	1.84
Surplus index	0.84
Average household daily calorie consumption (Kcal) for food secured household	4165.63
Average calorie consumption in excess of recommended (2260Kcal)	1905.63
Average total crop output for food secured households(kg)	8550.68
Average total income of food secured household (₦)	685197.5
Percentage of food secured household	62.40%
Food insecure households (No)	97
Food insecurity index	0.47
Shortage index	0.53
Average household daily calorie consumption (Kcal) for food insecure household	1069.38
Average calorie consumption in shortage of recommended (2260Kcal)	1163.62
Average total crop output for food insecure households(kg)	1560.77
Average total income of food insecure household (₦)	230654.9
Percentage of food insecure household	37.60%

4.4.1Level of food security among maize farmers

The result presented in Table 4.16 below further showed the different levels or categories of food security status among maize farmers in Kaduna state. The calorie intake shortfalls are estimated based on the nutritional food security line of 2260Kcal. According to Devereux (2006) and Meseret (2012), the level of food insecurity measures the calorie consumption according to the degree of severity of food insecurity. The result in Table 4.16 shows that a proportion (62.4 percent) of the maize farming households were found to be food secured suggesting that these households show zero evidence of food insecurity, whereas the other 37.6 percent were found to be food insecure with different severity levels. The result showed that about 28.7 percent were severely food insecure, while 4.3 percent and 4.7 percent were marginally and moderately food insecure respectively. The result supports the findings of Ojeleye (2015),where larger proportion (66.4 percent) of the sampled households was found to be food secured.

Table 4.16: Distribution of maize farmers based on level of food security

Food security levels	Calorie consumption per person per day	Frequency	Percentage
Food secure	Above 2260 Kcals	161	62.4
Marginally food insecure	Between 1800 and 2260Kcals	11	4.3
Moderately food insecure	Between 1500 and 1800Kcals	12	4.7
Severely food insecure	Below 1500Kcals	74	28.7
Total		258	100

4.5 Effect of maize farming on food security status

The result presented in Table 4.17showed the marginal effects of the Tobit regression estimates of the effects of maize production on households' food security status. The estimated F-value (F was 102.44 and Prob. > F = 0.000) rejects the null hypothesis that the explanatory variables do not have significant effect on maize farming households' food security.

From the result, out of the eleven independent variables used in the model, five variables were found to be significant in affecting the food security status of the maize farming households.The variables are output of maize (p<0.01), age of household head (p<0.01), household size (p<0.01), farming experience (p<0.01), and off-farm income (p<0.10).

Maize output was found to have a positive significant effect on food security status of the maize farming households. Specifically, maize output marginally increased the probability of the household's food security status by0.02%. This can be attributed to the increase in calorie produced when output increases as households consume what they produce and may sell the surplus. This is in agreement with the findings of Onasanya and Obayelu (2016) and Sani *et al*. (2017) who found that maize output had a positive relationship with food security status of the maize farming households.

Table 4.17: Tobit regression of the effects of maize production on food security status

Variables	Marginal effect	Std. error	Z	P > Z
Maize yield	2.01E-4	1.6E-5	12.83***	0.000
Age	-0.034	0.006	-5.52***	0.000
Marital status	0.071	0.065	-1.090	0.276
Level of education	-0.031	0.044	-0.700	0.482
Adjusted Household size	-0.106	0.013	-8.320***	0.000
Farm size	0.003	0.015	0.200	0.839
Experience	0.015	0.006	2.64***	0.008
Association	-0.083	0.201	-0.420	0.678
Access to credit	0.393	0.375	1.050	0.296
Off-farm income	1.25E-06	5.85E-07	2.140**	0.032
Extension contacts	0.006	0.036	0.160	0.872
F(12, 246)	102.44***			
Prob > F	0.000			
Number of observations	258			

Note: Level of significance: *** = 1%, ** = 5% and * = 10%

The age of household head was negative and has significant effect on food security status of the households. Result showed that there is approximately 3.4% reduced probability of the maize farming households to be food secure as household head grows older. This could be due to the fact that households with younger heads were more likely to be innovative, engaged in multidimensional livelihood strategies and consequently more food secure than their elderly counterparts (Tekle and Berhanu, 2015). Also, with increase in age, the productivity of household heads will thereby be impacting on their food security status (Oluyole and Taiwo, 2016). This result is in consonance with Babatunde et al. (2007), Maksuda and Taj Uddin (2012) and Onasanya and Obayelu (2016) who claimed that increase in age decreases food security This result disagrees with the findings of Tshedisco (2017) who found age to have a positive effect on food security.

The result also showed that there is a 10 % reduced probability that the maize farming households will be food secure with larger households. This result is in line with the *a priori* because increase in the member of households translates to more people feeding from the same resource base and this may lead to household members not being able to assess enough food when compared to situations of smaller household sizes thereby reducing the probability of the household to be food secure. This finding is consistent with the studies of Oluyole and Taiwo (2016) and Tshedisco (2017)who found age to besignificant and havea negative relationship food security status of the households.

Farming experience was found to increase the probability that the maize farming households will be food secure by 1.5%. This agrees with the *a priori* expectation because over the years of farming, farmers gain more experience, improve their level of expertise and productivity, thus leading to production of more food for their households.This resonates with the findings of Obasanya and Obayelu (2016) and Oluyole and Taiwo (2016) who stated that farming experience was positive and increases productivity, thus leading to food security.

Income from off-farm activities though really low, had significant effect on food security status of the households. This is possible as farmers with off-farm income channel some of their off-farm resources to provide for their families.This showed that additional income though having a low value, significantly increased households' probability of being food secured. This is in line with *a priori* expectation as income generated from non-farm sources can be used to improve the purchasing power of households. This result disagrees with the findings of Maksuda and Taj Uddin (2012) who found off-farm income to be insignificant in affecting household food security.

4.6 Constraints to Maize Production in the Study Area

The constraints faced by maize farmers in the study area were ranked according to their severity as indicated by the farmers (Table 4.18). Specifically, about 57 percent of maize farmers reported that inadequate access to credit was a serious constraint to expanding maize production in the study area. This implies that difficulty in securing loans due to high interest rates, inadequate loan amounts and collateral requirements by the banks are some of the major reasons to low access to credit in the area. Credit is a very strong factor that is needed in an agricultural production enterprise and its availability could determine the extent of production capacity. It agrees with the findings of Nasiru (2010), who noted that access to micro-credit could have a prospect in improving the productivity of farmers and contributes to improving the livelihood of rural farming communities. Also, food insecurity exists when people have inadequate access to capital to produce food which leads to insufficient amount of safe and nutritious food required for normal growth and development of healthy life (Keku,2017).

Inadequate storage facility was ranked second and accounted for about 40 percent of identified constraints of maize production in the study area. The provision of storage and processing facilities is very important for sustainable maize production as the method of storage in the study area was observed to be traditional in nature. Pest and disease attack accounted for 25 percent of the constraints to maize production in the study area. Crops are susceptible to attack by numerous insects and diseases throughout the life cycle which were responsible for pre-harvest and postharvest losses. Therefore, effective control of these is necessary if reasonable yield is expected as pest and disease automatically causes a serious decline in quality thereby leading to areduction in product price. Also, about 27.90% of the respondent's ranked inadequate extension contact as third constraint and this greatly limits their access to new and improved technology.

Poor seed variety accounted for about 23 percent of identified constraints to maize production. Seeds of high quality are scarce in the study area therefore, farmers use local and unimproved varieties of seeds for production. This finding agrees with Ekong (2003), who opined that most farmers have little or no access to improved seeds and continues to recycle seeds that have become exhausted after generations of cultivation. Also, about 19 percent of the maize farmers ranked inadequate capital as sixth constraint. High cost of labour ranked seventhwith about 17 percent of the farmers, while low market value and high cost of input were ranked 14 and 13.60 percent respectively as eighth and ninth constraints identified by farmers in the study area. Other constraints like inadequate transportation facility, inadequate rainfall and non-availability of tractor hire purchase were ranked 10^{th}.This finding agrees with that of Tekana and Oladele(2011) and Onuk*et al,* (2010) who observed that high cost of farm inputs, inadequate capital and government interference, inadequate transportation facility inadequate storage/processing facilities and inadequate rainfall were among the constraints faced by farmers.

Table 4.18 Constraints to maize production in the study area

Constraints	Frequency*	Percentage	Remarks
Poor seed variety	58	22.5	5^{th}
Low market value	36	14.0	8^{th}
Inadequate access to credit facilities	148	57.4	1^{st}
Low info on improved tech/extension service	72	27.9	3^{rd}
High cost of labour	44	17.1	7^{th}
Inadequate capital	50	19.4	6^{th}
High cost of inputs	35	13.6	9^{th}

Pest and insect attack	64	24.8	4th
Inadequate storage facility	104	40.3	2nd
Others	31	12.0	10th

*** Multiple responses**

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

The broad objective of this study was to analyze the economics of maize production and its effect on household food security status in Kaduna State, Nigeria. A multistage sampling technique was used in selectingthe farming households.Primary data of 258 maize farming households was collected with the aid of well-structured questionnaire and data collected wereanalyzed using descriptive statistics, stochastic frontier production function model, net farm income, food security index and Tobit regression model.

The results of the socio-economic analysis showed that the mean age of farmers was approximately 42 years, Majority (92.64 percent) of the farmers were married. A larger proportion (77 percent) had one form of formal education or the other. The mean household size was 10 persons, and the mean farming experience was 25 years. Findings showed thatlarger proportion (75 percent) had no access to extension services, and 98 percent had no access to credits. Approximately 83 percent of the farmers were not members of any cooperative society. The mean farm income and non-farm income were ₦514,303.60 and ₦67,490.31 respectively.

Moreover, results also showed that the average total costs incurred, and average total revenue obtained per hectare for maize were ₦122,633.3and ₦367,083.1respectively, while the net farm income was estimated to be ₦244,449.8. The average rate of return on investment (return per naira invested) was 2.99, indicating that for every ₦1 invested in maize production in study area; a profit of ₦2.99 was made, and this therefore ascertain the economic viability of maize production in the study area.

The result of the stochastic frontier production function showed that the mean TE was 73 percent, of which the best technically efficient farmer attaining efficiency level of 99 percent, while the least efficient farmer had efficiency level of 41 percent. The mean allocative efficiency was 70 percent, while the mean economic efficiency was 51 percent. The best efficient farmer had an economic efficiency levelof 80 percent, while the least efficient farmer attained an economic efficiency level of 4 percent.

The food security status of the maize farming households was estimated. The study revealed that approximately 62 percent of the maize farmers were food securewith FSI of 1.84 and surplus index of 0.84, whereas about 38 percent were found to be food insecure having FSI of 0.47 and with shortage index of 0.53.

The Tobit regression result of the effects of maize farming on food security status simply showed that output of maize ($p<0.01$), age of household head ($p<0.01$), household size ($p<0.01$), farm size ($p<0.10$), years of farming experience ($p<0.01$),off-farm income ($p<0.05$) and extension contact ($p<0.01$) were major factors significantly determining farming household food security status.Poor access to credit facilities, inadequate storage facility, low information on improved technology/extension service, pest and insect attack and poor seed variety among other constraints, were the major constraints to maize farming in the study area.

5.2 Conclusion

From the findings in this study, it can be concluded that maize production among farmers in the study area is profitable. However, these farmers did not achieve absolute efficiency in terms of input-output relationship and cost thereby, leading to majority not attaining efficiency level of 50%. The findings further showed that majority of the maize farming households are food secure (62.4%). One significant outcome of this research is that maize production has significant, positive effect on the food security status of the maize farming households in Kaduna state.

5.3 Contribution to Knowledge

i. The study revealed that approximately 28 percent of the maize farmers in the study area had TE level between 71 – 80 percent with a mean efficiency of 73 percent.

ii. The study revealed that maize production in the study area is profitable with net farm income of ₦244,449.8. Also for every ₦1 invested in maize production, return of ₦1.99 is realised despite the constraints identified.

iii. Findings revealed that approximately 62 percent of the maize farming households in Kaduna State were food secure while 38 percent were not food secure.

iv. Approximately 29 percent, 5 percent and 4 percent of the maize farming households in the study area were severely food insecure, moderately food insecure and marginally food insecure respectively.

v. Maize output has a positive and significant effect on food security of status of the households

vi. Age of the farmers, adjusted household size, farming experience and off farm income significantly affects the farmer's food security status.

vii. The study indicates that majority (57 percent) of respondents identified poor access to credit facilities as a major constraint to maize production.

5.4 Recommendation

Consequent to the findings of this study, the following recommendations are made:

i. Cooperative association significantly influences efficiency, and a significant proportion of the respondents do not belong to cooperative society. Farmers should be encouraged to join cooperatives as this will enable the farmers to enjoy economies of scale on input and output as they can buy in large quantities at wholesale price.

ii. Poor access to credit, inadequate storage facilities and inadequate extension contact were identified as the major constraints to maize production. Therefore, cooperative societies should be encouraged among maize farmers. This will enable the farmers' group to have increased access to micro-credit, access to modern farming techniques and access to extension agents. Also, subsidies on storage equipment should be provided by both government and private organizations to avoid post-harvest losses in maize production. These are essential indicators for increased productivity and efficiency.

iii. The result of the technical efficiency showed that age is significant but has a negative relationship. Older farmers are less productive in maize production; youths should thereforebe encouraged by both the government and private organisation by providing them with necessary farming incentives,to go back to farming to minimizeinefficiency associated with older aged farmers.

iv. Farmers should be encouraged to embrace improved food production technologies in line with complementary practices like use of farm inputs such as fertilizer, pesticides, hybrid seeds and better farm management practices which will raise their current level of production and of course their access to food for family consumption. This is because a large part of food consumption of farm household is own production, therefore any attempt to improve production will directly and positively affect the amount of food available to farmers, increasing their chances of food security.

v. The higher the household size, the higher the number of mouths to be fed and this directly affects food security status of faming household, sensitization programs on family planning should be conducted with the sole aim of controlling birth to numbers they can cater for. This helps particularly in reducing malnourishment among farming households.

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APPENDIX

Appendix 1: Results of Stochastic frontier production function

the final mle estimates are :

	coefficient	standard-error	t-ratio
beta 0	0.11776993E+02	0.56606600E+00	0.20804982E+02
FARM SIZE	0.47641662E+00	0.28832462E+00	0.16523619E+01
QTTY SEED	0.22768654E+00	0.13437870E+00	0.16943648E+01
LABOR(MAN-DAYS)	0.66257769E+00	0.20391199E+00	0.32493316E+01
QTTY HERBICIDES	0.20565406E+00	0.90758878E-01	0.22659387E+01
QTTY FERTIL	-0.63364013E-02	0.62586876E-01	-0.10124169E+00
delta 0	-0.69258881E+02	0.23720339E+02	-0.29198099E+01
AGE	-0.11477720E+01	0.89838520E-01	-0.12775945E+02
EDUCATION	0.12483052E+02	0.21943203E+01	0.56888014E+01
HOUSEHOLD SIZE	-0.13737458E+00	0.22491225E+00	-0.61079189E+00
EXPERIENCE	0.14100411E+01	0.17147801E+00	0.82228681E+01
ASSOCIATION	0.14541394E+02	0.57511024E+01	0.25284534E+01
ACCESS CREDIT	0.27828398E+02	0.78966782E+01	0.35240638E+01
OFF-FARM INCOME	0.51086090E+01	0.59886437E+01	0.85304942E+00
sigma-squared	0.18799637E+03	0.47287367E+02	0.39756151E+01
gamma	0.98221088E+00	0.52014495E-02	0.18883407E+03

log likelihood function = -0.67964775E+03

LR test of the one-sided error = 0.16256183E+03

MEAN TECHNICAL EFFICIENCY: 0.7316166E+00

Appendix 2: Results of allocative efficiency of maize production

ALLOCATIVE EFFICIENCY

the final mle estimates are :

```
                  coefficient     standard-error    t-ratio

  beta 0           0.10184048E+01  0.70274499E+00  0.14491811E+01
  LAND             0.27547853E+00  0.61796197E-01  0.44578557E+01
  MACHINERY        0.33218592E+00  0.22675967E-01  0.14649250E+02
  SEED             0.63638438E-02  0.34996243E-01  0.18184363E+00
  FERTILIZER       0.36830651E+00  0.15030511E-01  0.24503925E+02
  AGROCHEMICAL     0.72717244E-01  0.20255545E-01  0.35899920E+01
  LABOUR           0.14202553E+00  0.55399368E-01  0.25636669E+01
  delta 0         -0.23867297E+02  0.14159710E+01 -0.16855781E+02
  AGE              0.40070908E-01  0.32884388E-01  0.12185390E+01
  EDUCATION        0.98832270E+00  0.17667333E+00  0.55940684E+01
  HOUSEHOLD SIZE   0.33579765E+00  0.51251647E-01  0.65519388E+01
  EXPERIENCE      -0.88933510E-01  0.48111724E-01 -0.18484790E+01
  ASSOCIATION     -0.11721392E+01  0.33031820E+00 -0.35485154E+01
  ACCESS CREDIT    0.36031843E+00  0.78633123E+00  0.45822729E+00
  OFF-FARM INC    0.65921936E+00  0.61136259E+00  0.10782789E+01
  sigma-squared   0.69899999E+01  0.34933472E+00  0.20009462E+02
  gamma           0.97356071E+00  0.18701291E-02  0.52058475E+03

log likelihood function =  -0.20270408E+03

LR test of the one-sided error =   0.42250996E+03
```

MEAN ALLOCATIVE EFFICIENCY = 0.142857143E+01

Appendix 3: Results Technical, Allocative and Economic Efficiencies of maize farmers

Efficiency levels	Technical Efficiency		Allocative Efficiency		Economic Efficiency	
	Frequency	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
≥ 0.50	11	4.26	22	8.53	115	44.57
0.51 - 0.60	44	17.05	15	5.81	77	29.85
0.61 - 0.70	42	16.28	59	22.87	42	16.28
0.71 - 0.80	71	27.52	109	42.25	22	8.53
0.81 - 0.90	55	21.32	52	20.16	2	0.78
0.91 – 1.00	35	13.57	1	0.39	0	0
Total	**258**	**100**	**258**	**100**	**258**	**100**
Mean Efficiency	**0.73**		**0.70**		**0.51**	
Min	**0.41**		**0.05**		**0.04**	

Max	0.99	1.00	0.80

Appendix 4: Tobit regression result

```
tobit fsical2260 fsistatusyieldkg age sex maritalstatuslevelofeducationhhs
>izeadultequivalentfarmsizeha experience membership creditaccessofffarmempl
>oymentofffarmincomenumbofextensncontacts, llvce(robust)

Tobit regression                                Number of obs     =        258
F(  15,    243)   =      89.04
                                                Prob > F          =     0.0000
Log pseudolikelihood =   -273.851               Pseudo R2         =     0.4646

------------------------------------------------------------------------------
             |               Robust
  fsical2260 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
outputkg |   .0002056   .0000159    12.90   0.000     .0001742     .000237
         age |  -.0311019   .0055011    -5.65   0.000    -.0419377    -.020266
maritalsta~s|  -.1368089   .1025569     1.33   0.183     -.065205    .3388229
levelofedu~n|  -.0453713   .0428478    -1.06   0.291    -.1297717    .0390292
hhsize|  -.1303381   .0228891    -5.69   0.000    -.1754245   -.0852517
adultequiv~t |   .0394252   .0230241     1.71   0.088     -.005927    .0847774
farmsizeha |   .0060895   .0134424     0.45   0.651    -.0203891     .032568
  experience |   .0126697   .0057752     2.19   0.029     .0012938    .0240456
  membership |  -.0289697   .2045521    -0.14   0.887    -.4318912    .3739518
creditaccess |   .3978246   .3874648     1.03   0.306    -.3653938    1.161043
offfarmemp~t |   .3420425   .1487311     2.30   0.022     .0490757    .6350092
offfarminc~e |   3.90e-07   6.43e-07     0.61   0.544    -8.76e-07    1.66e-06
numbofexte~s|  -.0028935   .0353452    -0.08   0.935    -.0725156    .0667286
       _cons |   2.977804   .3444294     8.65   0.000     2.299355    3.656252
-------------+----------------------------------------------------------------
      /sigma |   .7042266   .0387247                      .6279477    .7805054
```

Appendix 5: Nutrient Composition of Commonly Eaten Foods in Nigerian—Raw, Processed and Prepared.

Food items	Kcal/Kg	Food items	Kcal/Kg
Staple Foods		Mango	590
Cassava Tuber	1500	Pawpaw	300
Cassava Flour	3870	Pineapple	320
Cassava Chips	3000	Apple	570
Garri	3840	Coconut	580
Yam Tuber	1100	Guava	730
Yam Flour	3810	Sugarcane	360
Yam Ships	3000	**Meat and Animal products**	
Sweet Potato Tuber	1100	Cow meat	2370
Sweet Potato Chips	900	Goat meat	2370
Irish Potato	1200	Sheep Meat	2370
Cocoyam Tuber	3830	Pork	2370
Maize Green	3100	Bush meat	2370

Maize Grain	4120	Chicken	2380
Maize Flour	4120	Turkey	2380
Sorghum Grain	3500	Fish	2230
Sorghum Flour	3500	Snail	2245
Millet Grain	3500	Shrimps	2230
Millet Flour	3500	Crayfish	2200
Rice	1230	Crabs	2200
Wheat Grain	3400	Eggs (pieces)	1400
Wheat Flour	3300	**Dairy Products**	
Cowpea (Beans)	5920	Milk	4900
Ground Nut	5950	Cheese	4000
Soybeans	4050	Yoghurt	4100
Soybean Flour	2600	Ice cream	4100
Melon (Shelled)	5670	Beverages	
Plantain	770	Cocoa	1200
Banana	960	Tea (Leaves)	1200
Vegetables		Tea (liquid)	1200
Okra	4550	Coffee (Powder)	1340
Tomato	880	Coffee (Liquid)	1340
Pepper	3930	**Drinks**	
Onion	440	Soft drinks	620
Carrot	400	Orange juice	400
Egg Plant	440	Apple Juice	550
Cucumber	270	Pineapple Juice	560
Cochorus/Ewedu	500	Local Beer	740
Spinach	220	Bottled Beer	460
Bitter Leaf	220	Wine	330
Water Leaf	180	**Condiments and Spices**	
Cabbage	230	Maggi	220
Pumpkin	440	Salt	180

Source: Babatudeet *al*., (2007)

Appendix 6: Equivalent Male Adult Weight to Determine Adjusted Household **Size**

Age Category(Years)	Male	Female
Under 1	0.00	0.00
1—4	0.25	0.20
5—9.9	0.60	0.60
10—14.9	0.75	0.75
15—59.9	1.00	0.90
60 and above	0.80	0.65

Source: Falusi, (1985)

Appendix 7: Farmer'sQuestionnaire

DEPARTMENT OF AGRICULTURAL ECONOMICS,
AHMADU BELLO UNIVERSITY, ZARIA.
QUESTIONNAIRE

Dear Sir/Madam,

I am a postgraduate student of the above named institution conducting an M.Sc. research on the **Economic Analysis of Maize Production and its Effect on Household Food Security in Kaduna State, Nigeria.** Kindly answer the under listed questions with utmost sincerity. You are assured of absolute confidentiality with regards to the information given, as this exercise is carried out purely for research purpose.

Thank you.

Background Information

1. Name of the farmer: ……..............…………………………………………………….
2. Phone Number …………………………………………………………………
3. Village: ……………………………....……………………………………..
4. LGA: ……………………………………………….……………………….

Section A: Socioeconomic Characteristics of the Maize Farmer

5. Age: …………………years,
6. Sex: Male ( ) Female ( )
7. Occupation: Major ………………………….. Minor …………………………. …..
8. Marital status: a) Married ( ) b) Single ( ) c) Divorced ( ) d) Widow or Widower ( )
9. Highest level of Education: (a) No Formal ( ) (b) Primary school ( ) (c) Secondary School ( ) (d) Tertiary ( )

10. Are you the head of your household? Yes ( ) No ( )
11. Household size ……………………………..

Categories	Males (No)	Females (No)
Children (Not capable of farm work, 1-15 years)		
Children (Capable of Farm work, 16-49)		
Dependents (Not capable of Farm work, > 50 years)		

12. Years of farming experience: ……………………………………………………years

13. Do you belong to any cooperative society/farmers' associations? Yes ( ) No ( )
14. If yes, for how long? ....years
15. What benefit did you derive as a member? ....
16. Do you have access to loan? Yes ( ) No ( )
17. If yes, what are your sources of loan?

    a) Informal sources (e.g. friends, neighbours, family members) ( )
    b) Private Commercial Banks ( )
    c) Government Loan scheme ( )
    d) Non-Governmental organizations ( )
    e) Remittance
    f) Others (Please specify) ……………………………………………….................
18. How much did you obtain from your source of loan in the last maize production period (2018)? ₦ ....……………………………………………………………………
19. Do you have access to credit? Yes ( ) No ( )
20. If yes, what is/are your source(s) of credit (farm inputs)?
    a) Informal sources (e.g. friends, neighbours, family members) ( )
    b) Private Commercial Banks ( )
    c) Government Loan scheme ( )
    d) Non-Governmental organizations ( )
    e) Others (Please specify): ……………………………………………………………
21. Do you have any off - farm employment? Yes ( ) No ( )
22. If yes, mention it

Source	Amount (₦)
Civil service	
Trading	
Others	

23. Do you have extension contacts? Yes ( ) No ( )
24. If yes, how many times were you visited by an extension agent in the last season (2018)?
    ……..
25. How many times did you visit an extension agent/agency last season?
    ……………………..
26. What activities did the agent teach you? ....
27. Was the training beneficial to you?

    a. Not beneficial ( ) b. somehow beneficial ( ) c. beneficial ( ) d. very beneficial ( )

28. Did you obtain any intervention or aid to improve your level of production? Yes ( ) No ( )
29. If yes, from who?
    a) Federal government ( )

b) State government ( )
c) Local government ( )
d) Others (please specify): ……………………………………………..................................

30. What is the nature of the intervention or aid?
a) Loan (money) ( )
b) Credit (farm inputs) ( )
c) Capacity building ( )
d) Others (please specify): ....

31. If loan, how much? ₦ ……………………………………………………….........................

If credit (farm inputs), name them: ....………………………

Section B: Information on Inputs

(I) Fixed Factor

32. How many maize farm plots do you have? ....

Please indicate the size in the table

Plot No	Plot size (hectare)
1	
2	
3	

33. How did you acquire your land? *(Tick below)*

Plot	Mode of Acquisition				
	(a) Inheritance	(b) Lease	(c) Borrowed	(d) Gift	(e) Purchased
1					
2					
3					

34. How much does it cost to rent one hectare of land per season in your village? ....……........... Naira

35. Did you use any machinery/equipment last season? Yes ( ) No ( )

36. If yes, please tick

Item	Source (own/rented)	Amount (₦)
Knapsack sprayer		
Tractor		
Others (Please specify)		

(II) Variable inputs (Last production Cycle)

37. What quantity (kg) of seed did you use in maize production last year?

Plot No	Quantity of Seed(Kg)	Cost (₦)
1		
2		
3		

38. What quantity (kg) of organic fertilizer did you use in maize production last year?

Plot No	Fertilizer type	Quantity(Kg)	Cost(₦)
1			
2			
3			

39. What quantity (kg) of inorganic fertilizer did you use in maize production last year?

Plot No	Fertilizer type	Quantity(Kg)	Cost(₦)
1			
2			
3			

40. What quantity (litres) of agrochemical did you use in maize production last year?

Plot No	Agrochemical type	Quantity(litres)	Cost(₦)
1			
2			
3			

41. How many people did you engage for land preparation?

Plot No	Hire Labour			Family Labour		
	No of	No of	Cost (₦)	No of	No of	Cost (₦)

	people	Hours		people	Hours	
1						
2						
3						

42. How many people did you engage for planting?

Plot No	Hire Labour			Family Labour		
	No of people	No of Hours	Cost (₦)	No of people	No of Hours	Cost (₦)
1						
2						
3						

43. How many people did you engage for fertilizer application?

Plot No	Hire Labour			Family Labour		
	No of people	No of Hours	Cost (₦)	No of people	No of Hours	Cost (₦)
1						
2						
3						

44. How many people did you engage for first weeding?

Plot No	Hire Labour			Family Labour		
	No of people	No of Hours	Cost (₦)	No of people	No of Hours	Cost (₦)
1						
2						
3						

45. How many people did you engage for second weeding?

Plot No	Hire Labour			Family Labour		
	No of people	No of Hours	Cost (₦)	No of people	No of Hours	Cost (₦)
1						
2						
3						

46. How many people did you engage harvesting?

Plot No	Hire Labour			Family Labour		
	No of people	No of Hours	Cost (₦)	No of people	No of Hours	Cost (₦)
1						
2						
3						

Information on maize output.

What quantity (kg) of output did you realize from maize production per ha/plot last season? …………………………

How many bags were consumed? ……………………………………..

What quantity did you give out as gift? ………………………………

How many bags were sold? …………………………………………..

What is the price per unit? ………………………………………………

Where do you sell your produce?

a. Farm gate ( ) b. Rural market ( ) c. Urban market ( )

When do you sell your produce?

a. immediately after harvesting ( ) b. Few months after harvest ( ) c. Off season ( )

Food Security Status of Households

16. In the last 12 months, were there months in which you did not have enough food to meet your family's need? Yes [ ] No [ ]

17. If yes, which were the months in the last 12 months that you did not have enough to meet your family's needs? ………………………………………………….

18. Do you think that your household is currently food secure? Yes [ ] No [ ].

19. How much did you spend on food purchase for the last season? ………………………………

Information on Expenditure

20. Household expenses last season

Item	Amount (₦)/Week	Amount (₦)/Month
1. Maize		
2. Rice		
3. Sorghum		
4. Schooling		
5. Other food items		
6. Housing Maintenance		
7. Clothing		
8. Hospital care		
9. Fuel/Light		
10. Travels		
11. Community levy		

12. **Others (please, specify)**

21. Wealth and asset: Livestock

	Number owned last year	**Quantity sold last year**	**Amount realized (₦)**	**Amount consumed**
Cattle				
Sheep and goat				
Chicken				
Others				

Constraints to Maize Production

1. What serious constraints did you encounter in maize production?
   i.…………………………………………………………………………………………
   ii…………………………………………………………………………………………
   iii………………………………………………………………………………………...
   iv………………………………………………………………………………………...
   v…………………………………………………………………………………………
   vi………………………………………………………………………………………...
   vii………………………………………………………………………………………..
   viii………………………………………………………………………………………
   ix………………………………………………………………………………………...
   x…………………………………………………………………………………………

2. Suggest ways to overcome the constraints listed above
   i…………………………………………………………………………………………
   ii.…………………………………………………………………………………………
   iii………………………………………………………………………………………..
   iv………………………………………………………………………………………...
   v…………………………………………………………………………………………

THANK YOU.