ANALYSIS OF PRODUCTIVITY AMONG MAIZE FARMERS IN DOGUWA LOCAL GOVERNMENT AREA OF KANO STATE, NIGERIA

BY

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(MSc / AGRIC / 13999 / 2011-12)

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

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JANUARY, 2016

DECLARATION

I hereby declare that this dissertation titled "**Analysis of Productivity among Maize Farmers in Doguwa Local Government Area of Kano State, Nigeria",** has been written by me and it is a record of my research work. No part of this work has been presented in any previous application for another Degree or Diploma in this or any other institution. All borrowed information has been duly acknowledged in the text and a list of references provided.

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CERTIFICATION

This dissertation titled '**Analysis of Productivity among Maize Farmers in Doguwa Local Government Area of Kano State, Nigeria,** by Ado **YAKUBU** meets the regulations governing the award of the Degree of Master of Science, Ahmadu Bello University, Zaria, and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This Dissertation is dedicated to my late father Malam Yakubu Musa (Maigwado), may Allah reward him a paradise as an exalted vision of felicity.

ACKNOWLEDGEMENTS

I glorify the exalted name of Almighty Allah (SWT), the cherisher and sustainer of the universe, for His mercy, assistance and protection especially for seeing me through this programme successfully. My appreciation goes to my Late father, Malam Yakubu Musa (Maigwado) may his soul rest in perfect peace and my mother Umma Salama Yakubu for their moral upbringing, encouragement, advices and for been a source of inspiration all through my life over my academic career.

I owe a lot of appreciation and sincere gratitude to my esteem supervisory team namely; Dr. M. A. Damisa and Prof. S. A. Sanni for their invaluable assistance, close supervision, constructive criticisms, suggestions and pieces of advice that aided the completion of this research work. May Allah bless you all and your families. My appreciation also goes to Dr. O. Yusuf, Mr. O. Oyinbo for their support and guidance.

I sincerely express my gratitude to Head of Department, my lecturers, other staff and students of the Department of Agricultural Economics and Rural Sociology, Faculty of Agriculture, Ahmadu Bello University, Zaria.

I wish to also express my special indebtedness to my Mentors and Guidance; Vice chancellor of the university Prof. Ibrahim Garba, Prof. N. D. G. Ibrahim for their support, encouragement and advices in different capacity, May Almighty Allah bless you and your family. I am highly indebted to my elder brother, Musa B. Yakubu for taking over the parental care, support and encouragement.

Again I would like to appreciate my wife, Hasiya and children: Nana Khadija, Al-mustapha and Ahmad, my younger brother, Abdulrazaq Yakubu Musa, for words of encouragement, prayers, endurance and support. May the Almighty Allah bless you and keep us together.

My appreciation also goes to members of my extended family including Late Rakiya and Habiba may Allah grant them paradise as their final home. Also, Yaya Yar' Yau, Maimuna, Gambo, Zuwaira, Hauwau, Amina, Hafsat, Zubairu and Hindatu for their kind support. Special thanks to my friends; Alhaji Ahmad Ibrahim Maiglass, Abdurrahman Sanni, Ahmad Muazu Mohammad, Amos Ugwu, Nura Isa Zubair, Nuhu Adamu Masinja, Yahuza Lurwanu Gafasa, Akosua Oppong-Yeboah, Lawal Sani Alhaji, Abdulganiyu Biniyu, Mohd Sulaiman, Mallam Bala Mohd, John Ali Kwage, Engr. Mohammed Abdullahi Gele, Abubakar Ishaq, Officer Umar, Dr. Mubarak Ali, Shehu Basawa and all other friends during the M.Sc programme and others who have contributed toward this enviable academic programme. May Almighty Allah reward you all. Finally, may the peace and blessings of Allah be upon His noble Prophet Muhammad (SAW), his household, companion and those on their foot paths till the day of reckoning.

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ABSTRACT

This study examined productivity among maize farmers in Doguwa Local Government Area of Kano State, Nigeria during 2014 production season. A multi-stage sampling technique was employed which follows random election of 179 maize farmers for the study. Primary data was used, the information collected is on a single visit with the aid of structured questionnaire and analyzed using descriptive statistics, Data Envelopment Analysis (DEA) model, multiple regression estimates, net farm income and profit function model. The results of the socio-economic analysis shows that maize farmers fell within the mean age of 42 years, mean household size was 15 persons, while the mean farming experience found was 24 years with an average of 4 years access to extension services. Results from the DEA shows that mean scale efficiency observed was 55%, Out of the maize farms (DMU's) studied; 92.18% were scale inefficient as they operates under IRS and DRS assumptions and therefore, operated at stage I and stage III of the production process, The mean technical efficiency scores from DEA using CRSTE and VRSTE specifications were 62% and 47% respectably, 68.16% of the maize farms were not technically efficient in the use of production inputs due to inability to reach a frontier threshold of 100%. In the same vein; age, education, extension contact and farming experience are positive and statistically significant at different probability levels and were key determinants responsible for the variation in technical efficiency among maize producers in the study area. Finding also revealed that, the net farm income was ₦65,979.75 and return per naira invested is ₦1.99, indicating that for every ₦1 invested a profit of ₦0.99 kobo was made. Thus, it could be concluded that maize production in the study area was economically viable and there exist a positive and significant relationship between inputs used and maize output level. Finally, maize farmers attested to the fact that; high cost of inputs, poor market price, and lack of capital are most severe constrains militating the chances of increasing maize production to achieve sustainable food production. It is therefore recommended that; farmers most shift to a production stage were a proportionate increase in inputs will lead to a proportionate increase in output, efficiency and reduce cost of input utilization of maize productivity, and should be a pivotal component in government programs geared toward empowerment especially the teaming unemployed youths in the country. Immediate effort should be made by maize farmers to form or join cooperative societies, so as to be able to benefit from economy of bulk purchase of input supply, farm advisory services, increased access to micro-credit, and access to modern farming techniques, there is the need for the government at federal, state, local levels and stakeholders to assist farmers beyond input supply, by creating effective marketing system and enabling environment among farming community were by actors will find a place for investment thereby increase productivity level and livelihood standard of farmers.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Agricultural sector in Nigeria is one of the leading sectors in terms of its contributions to income, employment, foreign exchange earnings and domestic food supply (Omojimite, 2012), and accounted for 40.9% of the Gross Domestic Product, GDP in 2010 (Central Bank of Nigeria, 2011). In spite of the predominance of the petroleum sub-sector in Nigeria's economic growth and development, agriculture remains a major source of economic resilience (Ojo and Akanji, 1996). Nigeria has about 79 million hectares of arable land, of which 32 million hectares are cultivated, both crop and livestock production remains below potentials although the average agricultural growth rate was 7% between 2006 and 2008, this growth lies below the 10% necessary for attaining food security and poverty reduction (Nwajiuba *et al.,* 2012).

Nigerian agriculture has many features among which the magnitude of the farm size is most important. The size of the farm is based on the size of land used by the household for crop production. Over the past few decades, the farm size has decreased mainly due to inheritance and transfer, the growing increase in the number of farms might be due to combined effect of institutional, technological and demographic factors. The size distribution of farm holdings in Nigeria are categorized as: Small scale farms, ranges from 0.10 to 5.99 ha, medium scale, 6.0 to 9.99 ha and large scale above 10 ha. These classes constituted 84.49%, 11.28% and 4.23% respectively (Oksana, 2005; Mckenzie, 2005; Dorward, 2005 and National Bureau of Statistics, 2006). When judged by international standards, whereby all farms less than 10.00 ha are classified as small, then 95.77% of all farm holdings in Nigeria (or a total of 46.08 million holdings) must be classified as small scale farms, while the remaining 4.23% of all holdings (or 2.033 million holdings) as medium scale. The demand for agricultural produce is continuously rising due to the geometric rise in population; this has resulted in the intensification of cultivable land in an attempt to increase agricultural productivity (Akinbile, 2008).

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 *et al*., 1997). The measurement of productivity analysis of one firm relative to other firm or to the "best practice" in an industry has long been of interest to agricultural economists. Efficiency measurement has received considerable attention from the theoretical and applied economists, in the productive efficiency arena; researchers are familiar with three types of efficiency, namely; technical, allocative, and economic (Sadiq *et al*., 2009).

Majority of studies on agricultural productivity in developing counties support the view that there is an inverse relationship between farm size and productivity (Barrett, 1996; Berry and Cline, 1997; Heltberg, 1998; Hazarika and Alwang, 2003; Masterson, 2007; GulUnal, 2008; Okoye *et al*., 2007, 2008a, 2008b). It has been recently reviewed by Eastwood and Laszlo, (2008) and particularly in relation to African agriculture, questioned by Collier and Dercon (2009), who maintain that "there are (only) a handful of reasonably careful studies showing the inverse farm size and productivity relationship in African settings, but some showing the reverse (that is positive)". A substantial part of the debate, and increasingly so in recent contributions, has focused on whether the relationship may be a statistical artifact, stemming from problems with the available data sets.

Maize is a cereal crop grown in various agro-ecological zones, as a single crop or in mixed cropping. It is the third most important cereal in the world, next to rice and wheat and with highest production potential among the cereals (Prathyusha *et al.,* 2013). Today the crop is one of the most important sources of the world's food supply, It is the most heavily cultivated cereal crop globally, and one of the main cereals crops of West Africa and the most important cereal food in Nigeria (Onuk *et al.,* 2010). According to Food and Agricultural Organization (2014), statistics, 822.7 million metric tons of maize was produced worldwide in the year 2008. Africa produced 53.2 million metric tons, while Nigeria produced 7.5 million metric tons and decline to 7 million metric tons in 2012. Maize production in Kano State rose to 5 million tons in 2010, as against the only 1.9 million tons in 2003 and has an average maize grain yield of 4.6 ton/ha which shows remarkable increase in productivity as against the national average yield of 3.825 ton/ha in 2012 (Kano State Agricultural and Rural Development Authority, 2011).

The area devoted to maize crop increase from 653,000 hectares in 1984 to its present level 5.1 million hectares, which represent about 4% level of increase and the output for-cast of maize is 9.7 million tons in 2012 compare with outputs for-cast of 9.088 million tonnes production in 2011 representing 6.74% increase, Badu-Akpraku, *et al*. (2012). Despite these however the crop is thus characterized by low yield, low level of inputs and limited area under cultivation, (Abdulrahman *et al.* 2015).

Research shows that Nigeria is the tenth largest producer of maize in the world, and the largest maize producer in Africa, followed by South Africa. While maize is grown in the entirety of the country, the north central region is the main producing area. It is usually intercropped, with yam, cassava, guinea corn, rice, cowpea, groundnut, and soybeans, Oyelade and Awanane, (2013). As a result of competition for maize by both man and animal, the significance of increasing productivity may not be taken too lightly, higher maize productivity will lead to quicker economic growth, rural jobs and resources for industrial progress along with food supply to ever-increasing population. (Binswanger *et al.*, 1995; Deininger, and Feder 1995; Barrett 1996; Townsend *et al.*, 1998; Helfand and Levine 2004; Krasachat, 2003), indicates that the relationship between inputs and productivity is more complex and caution must be used when advocating policies for agricultural development. Therefore, effective economic development strategy depends critically on promoting productivity and output growth in the agricultural sector, particularly among smallholder producers which dominate the sector.

1.2 Problem Statement

Most common characteristic of Nigeria is an agrarian economy with 70% of its people dependent on agriculture (NBS, 2007). Agriculture is dominated by peasant farmers relying mainly on traditional method and crude implements (Njiforti, 2008). The Government of Nigeria has been trying to achieve food security at both household and national level through its mechanized approach. It is however surprising that, with all her potentials for agricultural progress can hardly meet its food requirements. Some of the challenges of food Production in Nigeria according to FMAWR (2008), have been attributed to several factors such as; small land area cultivated by farmer of less than 2 hectares for cropping; sub-optimal supply of agricultural inputs such as fertilizer, limited access to credit. Less than 10% of irrigable land is under irrigation and only 40% of the arable land is under cultivation (Kareem *et al.,* 2008).

The ability of the farmer to perform his role in agricultural development according to Ogunsumi *et al.* (2005), has been on the decline in the last three decades. One of the reasons identified as the causes of the declining performance of the sector is inefficient allocation of available farm resources; Land, labour, seed, and fertilizer, these managerial resources are inefficiently allocated thereby leading to decrease in productivity and reduced agricultural output. Measuring efficiency is important because this is the first step in a process that might lead to substantial resource saving which have economic implication for both policy formulation and firm management (Ajibefun and Abdulkadir, 2004; Usman, 2009).

The trends in yields have been very disappointing and characterized by very unstable and mostly negative growth. For example, between 1998/2000 and 2001/2003, negative growth rate in yield was observed for maize, sorghum, rice, cassava, yam and rubber. It has also placed a serious stress on the marketing systems (Ojo and Imoudu, 2000). Also Nigeria produced 7.5 million metric tons in 2008 and decline to 7 million metric tons in 2012, FAO (2014). The growth in output in the face of declining yields suggests that the bulk of the production increase is accounted for by expansion in cultivated area. Maize is one of the most important cereal crops in Nigeria where over 150 million people consume an average of 43 kilograms per year (Oyelade and Awanane, 2013). Maize consumption is widespread across the country and among households of different wealth (Cadoni and Angelucci, 2013). The widening gap between food demand and supply in the country which necessitated massive food imports continued to swell Nigeria's agricultural import bills despite all remedial measures to assuage the problem. According to Ndaeyo (2007), this lopsided relationship between food demand and supply had earlier compelled the Food and Agricultural organization of United Nations to opine that as the world population is increasing by approximately 1 million every four hours, we may have more than 3000 million people to feed by the year 2025. If they are to be fed adequately, the present food production level will have to be doubled and other strategies/approaches revised and/or encouraged. Youths are therefore, encouraged to go into agriculture to bridge the encroaching generation gap in agriculture (Anyaegbunam *et al.*, 2008).

Problem against some literatures on productivity relationship is that the measure used for land productivity, is inappropriate; it only compares total output to the size of the farm, ignoring other factors of production and inputs (Masterson, 2007). It resulted in commencement of debate among researchers of various regions in the world. Researchers showed that the inverse relationship between farm size and land productivity is positive as agriculture becomes more capital intensive therefore, there is an appeal for larger size of farm to increase agricultural productivity of the farmers (Helfand, 2003; Rios and Gerald, 2005).

For sustainable maize production, research is necessary and whether relationship exists between inputs and maize productivity is an empirical question that can be settled only with recent data sets. Assuncao and Ghatak (2003), indicate that relationship among input and output is systematically related to the level of development and can best explain the dramatic differences in productivity stem from the utilizations of available resources across heterogeneous farms. Based on these, the study will therefore try to answer such questions as:

i. What are the socio-economic characteristics of maize farmers in the study area?

ii. What is the scale efficiency status on maize productivity?

iii. What are the technical efficiency and its determinants in maize production?

iv. What is the profitability of maize production in the study area?

v. What are the constrains faced by maize farmers in the study area?

1.3 Objectives of the Study

The broad objective of this study was to analyze the productivity among maize farmers in Doguwa Local Government Area of Kano State, Nigeria.

The specific objectives were to:

i. describe socio-economic characteristics of maize farmers in the study area;

ii. estimate the scale efficiency in maize productivity level;

iii. estimate the technical efficiency and its determinants in maize production;

iv. determine the profitability of maize production and

v. describe the constrains faced by maize farmers.

1.4 Justification of the Study

In Nigeria, the awareness of the importance of cereal crops in the food economy is on the increase, in terms of agricultural land utilization under major crops; the cereals such as maize, rice, Sourghum and millet accounted for 75% of the land area devoted to food crops in 2005, (FAO, 2010). In terms of the land area cultivated and volume of production, maize more than any other crop offers a promise of meeting African food needs in the current millennium. No other crop is distributed so large an area than maize in the country (Ado *et al.*, 2007). These assertions translate the study area's good potentials for maize production. As a result of competition for maize by both man and animal, there is the need to increase the supply level of the grain. Studies in maize production in different parts of Nigeria have shown an increasing importance of the crop amidst growing utilization by food processing industries and livestock feed mills (Ogunsumi *et al*., 2005; Abdulrahman and Kolawole, 2008).

Among different income generating crops, maize is an important cash crop to small holder farmers which constitute a major source of calories for the poorer proportion of consumers, who cannot afford more expensive foods such as bread, milk or meat. 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 (Oyelade and Awanane, 2013). Given the importance of maize to individual household, industries and the economy as a whole, the grain yields have increased only marginally over the last two decades, where most of the increase in production has come from expansion in the area harvested rather than from increases in yield (FARA, 2009).

The analysis of productivity is generally associated with the possibility of farms producing certain optimum level of output from a given bundle of resources or certain level of output at least cost. Therefore, it is important to note that in order to increase maize productivity, maize farmers must shift for increasing productivity through more efficient utilization of available scarce resources as its more reasonable and cost effective than introducing new technologies (Bravo–Ureta and Pinheiro, 1997). This research will therefore provide an avenue of contribution to the field of knowledge, the relationship between scale efficiency (be it small size, medium size or large size) and productivity among maize farmers, as well as intervention avenue to maize producing farmers on increasing technical efficiency while revealing profitability status and constrains of maize farming. The research interest in this area is emphasized by the fact that farmers from the study area produced overwhelming total maize output at the time of the survey. It is hoped that this will serve as a source of reference to researchers who will identify other areas and variables for further studies on maize production.

1.5 Hypotheses of the Study

i. Maize farmers in the study area are technically not efficient.

ii. Maize production is not profitable in the study are.

CHAPTER TWO

LITERATURE REVIEW

2.1 Maize Production and its Trend in Nigeria

Maize (*Zea Mays*) is an important crop in the world, it ranks second followed by wheat in the world production of cereals. A report has it that it was introduced to Europe in 1942 from Southern and Central America by Christopher Columbus and later spread to Africa (Okoruwa and Ogundele, 2003). Today, maize has become Africa's most important staple food crop and is grown by both large and small scale farmers. Currently, maize is produced in most countries of the world and is the third most planted field crop after wheat and rice. The bulk of maize production occurs in the United States and the People's Republic of China (456.2 million tons). Mexico, the world's fourth largest producer of maize currently produces approximately 14 million tons of grain annually on 6.5 million hectares (Ricardo, 2007). The world total area devoted to maize in 1948 and 1989 was 88 and 129 million hectare respectively. Thus, indicating an increase of about 47% (Onwueme and Sinha, 1991).

In Nigeria, maize was introduced in the fifteenth century and is one of the most important crops for food and cash. There has been dramatic shift of dry grain production to the savanna, especially the Northern Guinea savanna. This can now be regarded as the maize belt of Nigeria; in this zone farmers tend to prefer maize cultivation to other grain species. This trend may have been brought about by several reasons including availability of streak resistant varieties, high-yielding hybrid varieties, increase in maize demand coupled with the federal government imposed ban on importation of rice, maize and wheat (Iken and Amusa, 2004).

However, maize production in Nigeria has been on the increase both in terms of hectarage and production in nineteenth centenary (Ajala and Kling, 1999). The ability of the Nigerian agriculture to perform its role in agricultural development according to Ogunsumi and Ogbosuka (2009), has been on the decline in the last three decades. Recent statistics by FAO 2014, shows an overall alignment between production and area harvested trends for the past two decades, in other word; for the past five years (1999 –2004) have been on the increase except for the year 2005 – 2007 which had a slight decline from the previous years while the production increased between 2008 and 2009, again in 2010 – 2011 such a decline was observed from the previous years but as of 2012 production rise-up. This might indicate an inconsistency in production technology and inefficiency in inputs used since yields are increasing and decreasing as well. Indeed, from 2000 the area harvested remains lower than the nineteenth centenary (between 3 and 4 million from 1998 to 2010) and increased till date, the area devoted to maize crop increased from 5.1 million hectares in 2012 which represent a 6.74% increase compared to previous years (Badu-Akpraku *et al*, 2012). Table 2.1 shows maize production trend in Nigeria from 1998-2012 adopted form FAO, (2014).

Apart from maize being a major food item in many parts of the country. Abalu (1984), in his study found that small scale farmers in Nigeria constitute the most significant population of those engaged in farm production. He also identified small-scale peasant farmers as the most effective means of meeting the food needs of the country. Onucheyo (1998), asserted that the small-scale farmers hold the key to increased food production in Nigeria. It is therefore the responsibility of research scientists, government and extension agents to improve the status of maize production in country.

Table 2.1: Maize Production Trend in Nigeria from 1998-2012

Year	Area Planted (ha)	Output (ha)	Yield
1998	15.66724	363657.00	23211.30
1999	17.175487	387441.00	22558.97
2000	16.498883	383504.00	23244.24
2001	14.832926	366153.00	24685.15
2002	4.5001733	161000.00	35776.40
2003	4.3869676	163963.00	37375.02
2004	3.4391562	150170.00	43664.78
2005	4.5242417	161500.00	35696.59
2006	4.5483541	162000.00	35617.28
2007	4.5606648	162500.00	35630.77
2008	3.7449868	159248.00	42522.98
2009	3.0480904	128112.00	42030.25
2010	4.9711340	187300.00	37677.52
2011	5.4054054	200000.00	37000.00
2012	5.2287582	200000.00	38250.00

Source: FAO, 2014.

2.2 Importance of Maize Crop

Maize is one of the most crucial and strategic cereal crops in Africa and developing world in general. It is produced in different parts of the continent under diverse climate and ecological conditions. Maize is important in the cropping system of the small scale Nigerian farmer where it is frequently grown in sole and mixture with other crops such as legumes or even cereals under traditional practice. Due to its increasing importance, maize has become a major staple and cash crop for small holder farmers (IITA, 2000). Apart from early millet, it is the earliest grain that is harvested in any given season, hence giving relieve to the usual food scarcity being experienced at such periods of the year. Surplus early harvested maize is sold off by farmers and the revenue realized is used for buying other farm input for example, fertilizer for application on other crops or even late planted maize, or for hiring additional labour outside the family source.

In Nigeria, the awareness of the importance of cereal crops in the food economy is on the increase, in terms of agricultural land utilization under major crops; the cereals such as maize, rice, guinea corn and millet accounted for 75% of the land area devoted to food crops in 2005 (FAO, 2010). In terms of the land area cultivated and volume of production, maize more than any other crop offers a promise of meeting African food needs in the current millennium and no other crop is distributed so large an area and none occupies a large hectare than maize in the country (Ado *et al*., 2007). Maize is the preferred staple for about 900 million poor consumers and about one third of all malnourished children in Africa (FARA, 2009). It is one of the most important commodities used for food aid to the deadly war and hunger areas of the world. Since maize is cheaper than other cereals such as rice and wheat, it is more affordable to the vast majority of the population, and therefore occupies a prominent position in the agricultural development agenda of several countries in Africa (FARA, 2009). It is a multipurpose crop because every part of its plant has an economic value (Oladejo and Adetunji, 2012). The grain, leaves, stalk, tassel and cob can all be used to produce a large variety of food and non-food products (IITA, 2001).

In industrialized countries, maize is largely used as livestock feed and as a raw materials product, while in low-income countries, it is mainly used for human consumption

(IITA, 2001). Maize also serves as food for human consumption. Pap, popcorn, thick porridge boiled grains is notable food consumed by majority of Nigerians, mostly in the southern part of the country (Oyewo, 2011). 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). The importance of maize have during the December 2006 Abuja summit on food security in Africa, Africa 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). Oyelade and Awanane (2013), also shows that among different income groups, maize is a relatively more important source of calories for the poorer proportion of consumers. With more than 50% of all households assigning over 50% of their cereal area to maize, maize production dominates the farming system in Nigeria and hence it is of strategic importance for food security and the socio-economic stability of the country (Oyelade and Awanane, 2013).

The grains is used as food for humans; feed for livestock and as an industrial material in the manufacturing of several commodities. As a result of competition for maize by both man and animal, there is the need to increase the supply level of the grain. Studies in maize production in different parts of Nigeria have shown an increasing importance of the crop amidst decline and growing utilization by food processing industries and livestock feed mills (Ogunsumi *et al*., 2005; Khawar *et al*., 2007 and Abdulrahman and Kolawole, 2008). The local production of maize had to be geared up to meet the demand for direct human consumption, breweries, baby cereals, livestock feeds and other industries, (Iken and Amusa, 2004). Being one of the strategic crops in Nigeria, In face of the scarcity of farmland and constraints of extensive maize farming, the significance of increasing productivity may not be taken too lightly. Higher maize productivity will lead to quicker economic growth, rural jobs and resources for industrial progress along with food supply to ever-increasing population of about 170 million Nigerian.

2.3 Trends in Farm Size Holdings

The common indicators of farm size all indicate that during a period, average farm size increased and the rate of growth for the different size measures differs, this is because, while the total land in farms has decreased slowly, the number of farms has decreased at a somewhat higher rate. For examining trends in Nigeria, where land quality and/or commodity mix vary greatly across space, majority of output is increasingly produced on very large farms. Not surprisingly, the measures based on output show considerable annual variation, but they are generally increasing over the full period. According to 1990 World Agricultural Census (FAO, 2011), average farm size was 1.6 hectares in both Africa and Asia, which showed the dominance of small scale farms in the region. In China, the average size of land holdings decreased from 0.56 hectares in 1980 to 0.4 hectares in 1999 (Fan and Chan-Kang, 2003); in Pakistan, it steadily declined from 5.3 hectares in 1971-73 to 3.1 hectares in 2000, consequently, the number of small farms rose to more than triple during the period. In Africa, the average size of land holdings decreased from 1.5 hectares in 1970 to 0.5 hectares in 1990 Sial (2012). Nigerian agriculture has many features among which the magnitude of the farm size is most important in productive efficiency arena. Over the past few decades, the farm size has decreased mainly due to inheritance and transfer. The growing increase in the number of farms might be due to combined effect of institutional, technological and demographic factors.

2.4 Concept of Productivity and Efficiency

2.4.1 Definition of productivity

Broadly defined, productivity is the relationship between output produced and one or more of associated inputs used in the production process (National Research Council, 2009). The divergence in opinion among researchers centres on the choice of concept for a specific measurement purpose, and how to measure output and inputs. In essence, the section of an appropriate concept of productivity depends on the objective of measurement, availability of data and preference of research (Ogundari, 2006). Productivity can also be defined as an index that measures output (goods and services) relative to the inputs (land, labour, materials, etc,) used to produce the output. As such it can be expressed as Output/Input ratio, (Coelli *et al*., 1998). There are two major ways to increase productivity; either by increasing the output or decreasing the input.

The measurement of productivity analysis of one firm relative to other firm or to the “best practice” in an industry has long been of interest to agricultural economists Productivity can be measured in terms of level and rates of change. Generally, productivity can be studied at four levels: site/project, firm/organization, industry and entire economy. Because productivity measures exist largely to be compared, people are more interested in productivity change. Hence, it is more meaningful to use productivity measures as indices of performance (NRC, 2009). Productivity is usually expressed in one of the three forms: partial factor productivity, multi factor productivity and total productivity (Encyclopedia, 2006: Hughes, 2001).

2.4.1.1 Partial Productivity

The standard definition of productivity is actually what is known as partial factor measure of productivity, in the sense that it only considers a single input in the ratio (Fakayode, 2009). The formular then for partial-factor productivity would be the ratio of total output to a single input. The partial factor measure options could appear as output/labour, output/machine, output/capital, or output/energy (Fakoyode, 2009). Terms applied to some other partial factor measures include capital productivity (using machine hours or dollars invested), energy productivity (using kilowatt hours) and materials productivity using inventory dollars (Encylopedia, 2006: Hughes, 2001).

2.4.1.2 Multifactor Productivity

A multifactor productivity measures utilizes more than a single factor, for example, both labour and capital. Hence, multifactor productivity is the ratio of total output to a subset of inputs: a sub set of inputs might consist of only labour and materials or it could include capital. Obviously, the different factors must be measured in the same units, for example dollars or standard hours (Fakayode, 2009).

2.4.1.3 Total Factor Productivity

A broader gauge of productivity: total factor productivity is measured by combining the effect of all the resources used in the production of goods and services (labour, capital, raw material, energy) and dividing it into the output (NRC, 2009). As such the formular could appear as: a ratio computed by adding standard hours of labour actually produced, plus the standard machine hours actually produced in a given time period divided by the actual hours available for both labour and machines in the time period. Total output must be expressed in the same unit of measure and total input must be expressed in the same unit of measure. However, total output and total input need not be expressed in the same unit of measure (Fakayode, 2009).

2.4.2 Definition and concept of efficiency

Efficiency measurement has received considerable attention from the theoretical and applied economists. From theoretical point of view, there has been a spirited exchange about the relative importance of various components of firm efficiency. From an applied perspective, measuring efficiency is important because this is the first step in an agricultural production process that might lead to substantial resource saving. These resource saving has important implication for both policy formulation and firm management (Sadiq *et al*., 2009).

The concept of efficiency goes back to the pioneering work of Farell (1957) who distinguishes between three types of efficiencies: Technical efficiency (TE), Allocative or price efficiency (AE) and Economic efficiency (EE). In the productive efficiency arena, researchers are familiar with three types of efficiency, namely, technical, allocative, and economic. Technical efficiency refer to the ability of firm to obtain maximal output from a given set of inputs under certain production technology while the allocative efficiency reflects the ability of firm to use the inputs in optimal proportions, given their respective prices. Economic efficiency, a combination of technical and allocative efficiencies, reflects the ability of production unit to produce a well specified output at the minimum cost. Efficient firms are more likely to generate higher income and thus stand a better chance of surviving and prospering (Sadiq *et al*., 2009).

However, some authors distinguish other dimensions of efficiency beyond these three (Gonzalez-Vega, 1998; Alpízar, 2007; León, 2011), for example, considers five additional categories, describing them in terms of the actions on which production units should embark in order to achieve the greatest possible efficiency; Technological efficiency: to choose the best available technology (production function) to produce each output, Dynamic efficiency: to promptly absorb innovations in products and processes, Approach efficiency: to select appropriate technologies according to the nature and magnitude of any challenge faced in the market, Pure technical efficiency: not to use more inputs than necessary to produce a given amount of output given the technology, Scale efficiency: to find the correct level of production with the aim of taking advantage of economies of scale, and joint production efficiency: to determine the most attractive combination of output given the opportunity to generate economies of scope or size.

The technical efficiency has been defined as the ratio of actual output to potential output given by the frontier production function as defined by Leibenstein (1966) for a given set of inputs and technology. Taking into account that not all the firms are efficient and the efficient ones have varying levels of efficiency, there arises then the need to measure efficiency as a proxy for firm's performance. Technical efficiency of a producer is a comparison between observed and optimal values of its outputs and inputs (Fried *et al*., 2008). This can be done either from the output side or input side. On the output side observed output is compared to potential output obtainable from the inputs while from the input angle observed input levels are compared to minimum potential input required to produce the output. In either perspective, the optimum is defined in terms of production possibilities (Kirsten *et al*., 1998). It is also possible to define the optimum in terms of the behavioral goal of the producer. In this case, efficiency is measured by comparing observed and optimum cost, subject to any appropriate constraints on quantities and prices.

It is important to note that the measurement of technical efficiency assumes that the factors of production used are homogeneous. It is not much of a problem if all firms use heterogeneous inputs in fixed proportions. However, if firms are different in the composition of their inputs, according to their quality, then a firm's technical efficiency will reflect both the quality of its inputs and the efficiency in their management. As a result, if technical efficiency is defined with respect to a given set of firms and a given set of factors of production, measured in a specific way, any differences across firms in the quality of the inputs will affect the measure of efficiency (Liebenberg, *et al*., 2010). Since this concept resembles that of Friedman theory of 1967 that a production function can reflect the entrepreneurial ability to produce maximum output under given circumstances, thus the technical efficiency of a firm tends to reflect the entrepreneurial efficiency of keeping other things constant.

The terms productivity and efficiency are often used interchangeably but these are not precisely the same things; Productivity and efficiency are two different concepts except under the assumption of constant returns to scale. According to Fried *et al.* (2008), Productivity is an absolute concept and is measured by the ratio of outputs to inputs of a producer. This measure is easy to calculate if a producer uses a single input to produce a single output. But when multiple inputs are used to produce several outputs, the outputs in the numerator and inputs in the denominator have to be combined in some economically sensible fashion, so that productivity remains the ratio of two scalars.

Differences in production technology scale of operation, operating efficiency and the operating environment in which production occurs are the most common causes of variations in productivity either across producers or through time (Thirtle and Piesse, 2003). Mine while efficiency is a relative concept and is measured by comparing the actual ratio of outputs to inputs with the optimal ratio of outputs to inputs. Production efficiency is the relative performance of the process used in transforming inputs into output. In economic analysis, much is concerned with the technical, allocative and economic efficiencies or resource transformation and scale efficiencies. These are the major components of the measure of productivity, (Coelli, 1996).

2.5 Analytical Framework

The discussion in this section is confine to the econometric approach to estimation of technical efficiency and scale efficiency under the assumption that the producer produces only single output. The data underlying the study would consist of observation on the quantities of inputs employed and outputs produced by each farmer.

2.5.1 Measurement of productivity and efficiency

Generally, there are two approaches to measurement of efficiency of a firm which are parametric approach and non-parametric approach. Parametric approach involves the use of stochastic frontier analysis (SFA) while non-parametric approach involves the use of data envelopment analysis (DEA). Louisa, Sean and Simon, (1998) found out that overall distribution of the technical efficiency scores for the stochastic production frontier (SPF) and VRS DEA models were similar while the efficiency scores for individual boat varied considerably for these two approaches. Also, Sharma *et al*. (2003) found the result from the DEA to be more robust than those from the parametric.

2.5.1.1 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). It uses linear programming methods to estimate a production frontier function by fitting pieces of hyper planes to envelope an observed set of data formed by the inputs and outputs (Oum and Chunyan, 1994).

DEA model was preferred over parametric approach for the measurement of productivity across farm sizes and estimation of efficiency in this study because it provide means of testing sensitivity of a relationship and decomposing total technical efficiency into pure technical and scale efficiency. The main advantage of this technique in the estimation of technical efficiency is that it does not require prices neither for the outputs nor 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) Data Envelopment Analysis model or variable return to scale (VRS) Data Envelopment Analysis model. 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/surface will differ depending on if 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 is used to determine a firm's potential output given its inputs mix if operated as efficiently as firms along the best practice frontier. Measurement of technical efficiency is important because it is a success indicator of performance measure by which production units are evaluated (Ajibefun and Abdulkadir, 2004).

DEA model specification

The DEA model is a relative measure of efficiency where the general problem is stated. Given the CRS assumption, the best way to introduce DEA is via the ratio form. For each decision-making unit (DMU); one would like to obtain a measure of the ratio of all outputs over all inputs, such as $u'y_i/v'x_i$, where u is an Mx1 vector of output weights and v is a Kx1 vector of input weights. To select optimal weights one specifies the mathematical programming problem:

Max u,v $(u'y_i/v'x_i)$,

st $u'y_j/v'x_j \leq 1$, j=1,2,…, N,

u, v ≥ 0 .... (1)

This involves finding values for u and v, such that the efficiency measure of the i-th DMU is maximized, subject to the constraint that all efficiency measures must be less than or equal to one. One problem with this particular ratio formulation is that it has an infinite number of solutions. To avoid this one can impose the constraint $v'x_i = 1$, which provides:

Max x_i,v($i'y_i$),

st $v'x_i = 1$,

$\mu'y_j - v'x_j \leq 0$, j =1,2, …,N,

μ, v ≥ 0.. (2)

Where: The notation change from u and v to μ and v reflects the transformation relationship. This form is known as the multiplier form of the linear programming problem. Using the duality in linear programming, one can derive an equivalent envelopment form of this problem:

$\text{Min}_{\theta,\lambda}\, \theta$,

St $-y_i + Y\lambda \geq 0$,

$\theta x_i - X\lambda \geq 0$,

$\lambda \geq 0$, ... (3)

Where θ is a scalar and λ is a N x1 vector of constants. This envelopment form involves fewer constraints than the multiplier form (K + M < N+ 1), and hence is generally the preferred from to solve. The value of θ obtained will be the efficiency score of the i-th DMU. It will satisfy $\theta \leq 1$, with a value of 1 indicating a point on the frontier and hence a technically efficient DMU. An implicit assumption of the model described is the return to scales and thus farms are operating at an optimal scale (Fraser and Cordina, 1999). Note that the linear programming problem must be solved N times, once for each DMU in the sample. A value of é is then obtained for each DMU.

The CRS linear programming problem can be easily modified to account for VRS by adding the convexity constraint: $N1'\lambda=1$ to (3) to provide:

$Min\theta,ë^{\theta},$

st $-y_i + Y\lambda \geq 0,$

$\theta x_i - X\lambda \geq 0,$

$N1'\lambda=1$

$\lambda \geq 0,$ .... (4)

where: θ is a scalar and λ is a N x1 vector of The value of θ obtained will be the efficiency score of the i-th Decision Making Unit (DMU).

It will satisfy $\theta \leq 1$, with a value of 1 indicating a point on the frontier and hence a technically efficient DMU, according to (Banker *et al*., 1984) definition.

One would then run the following cost minimization Data Envelopment Analysis:

$Min_{\lambda,xi}* \ W_{i2}X_i*$

st $-y_i + Y\lambda \geq 0,$

$x_i* - Xë \geq 0,$

$N1'\lambda=1$

$\lambda \geq 0,$ .... (5)

Where: w_i is a vector of input prices for the i-th DMU and x_i* (which is calculated by the LP) is the cost minimizing vector of input quantities for the i-th DMU, given the input prices w_i and the output levels y_i. The total cost efficiency (CE) or economic efficiency of the i-th DMU would be calculated as:

$CE = w_{i2}\, x_i{}^*/\, w_{i2}\, x_i$.. (6)

That is, the ratio of minimum cost to observed cost. One can then calculate the allocative efficiency residually as:

AE = CE/TE.. (7)

Note that the product of technical efficiency and allocative efficiency provides the overall economic efficiency. Note that all three measures are bound by zero and one. The technical efficiency measure under CRS, also called the "overall" technical efficiency measure, is obtained by solving N linear programs of the form. The output and input oriented models will estimate exactly the same frontier surface and therefore, by definition, identify the same set of firms as being efficient.

Scale inefficiencies arise due to the presence of either increasing return to scale or decreasing return to scale.

Where;

Max TE *

Subject to :

n j Xβ Yα m r iji s r rjr ,..,1=,

1≤ ∑ ∑ 1= 1=αr, βi ≥ 0; r = 1, -----, s; i = 1, …, m... (8)

Where Xij and Yij respectively are quantities of the ith input and rth output of the jth firm and αr, βi ≥ 0 are the variable weights to be determined by the solution to this problem Scale efficiency can be obtained residually from CRS and VRS technical efficiency scores as follow:

SE= TECRS/TEVRS..(9)

SE= 1 indicates scale efficiency or constant return to scale (CRS) and SE <1 indicates scale inefficiency.

2.5.1.2 Multiple Regression Analysis

Multiple regression is a statistical measure that attempts to determine the strength of the relationship between one dependent variable (usually denoted by Y) and a series of other changing variables (known as independent variables). The two basic types of regression are linear regression and multiple regression. Linear regression uses one independent variable to explain and/or predict the outcome of Y, while multiple regression uses two or more independent variables to predict the outcome.

The explicit form of the regression model is written as:

$Y = \beta o + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + u$……………………10

Where,

Y = Production efficiency indices of the mean efficiency scores from VRSTE

$X_1 - X_7$ = independent variables

βo = constant term,

$\beta_1 - \beta_7$ = regression coefficients of independent variables, and

u = Error term.

2.5.2 Farm profitability analysis

This involves estimation of costs and returns of production. Adeleke, *et al*. (2008) developed a farm level model to evaluate alternative cropping mixtures and patterns. These involves; profitability: which is measured as the differences between value of yield and cost of production, Net return: this involves the difference between value of yield and cost of inputs, including hired labour. In choosing economic indicators on the basis of production factors affected by potentials innovation, Abedullah and Mushtaq (2007) suggested the use of gross margin and returns to variable cost where only capital is affected, Yield/labour ratio, where only labour is affected, and Gross margin, return to variable costs and monetary return to labour, where capital and labour are affected. The major problems associated with cost-return analysis as basis for profitability assessment are; It does not indicate the relative importance of each of the resources in production, It is location bound and specific in applicability due to use of money as the common unit of measurement and the prevailing price for estimates. Gomez (1975) asserted that despite of the limitations, Cost and return analysis is a useful tool for enterprises comparison and indicating a profitability pattern of aggregate input use.

As with any economic analysis, the profitability of an investment is based on a comparison of the return and cost of the investment. Another way to add value on the production side would be to reduce processing costs by increasing the efficiency (and thus the profitability) of production (Masters *et al*., 2005). The profitability of crop production depends on reducing the farming cost as much as possible, and at the same time maximizing the income from the sale of crop. Profitability in some farm business exists because they are managed more efficiently than others. The reward for doing the job better is usually profit. The prospect of earning and maintaining profitability serves as the incentives for creativity and efficiency among farmers. Profitability stimulates risky ventures and drives farmers to develop ways of cutting cost and improving technology always in an effort to satisfy consumer interest (Troke, 2008). Profitable agriculture is dependent to productive soil and maize production is not an exceptional.

Net farm income is the difference between gross income (revenue) and total cost of production (Olukosi and Erhabor, 2008). It is used to show the levels of costs, returns and net profit that accrue to farmers involved in production. The technique emphasizes the costs (fixed and variable cost) and returns of any production enterprise. Olukosi and Ogungbile (2006) have examined two major categories of costs 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 cost (VC) refers to those costs that vary with output. The total cost (TC) is the sum of total fixed cost (TFC) and total variable cost (TVC).

2.6 Review of Empirical Studies

2.6.1 Data envelopment analysis

Farm size is usually considered as the physical size of land held in operation. It has been proved that a regression equation leads to biased estimates and mistakenly leads to an inference that there had been diseconomies of scale in land use, when conventional definition of size of a farm is used as measure of form size (Sampath, 1992). It happens, when the total operational area is dichotomized in the analysis into irrigated and no irrigated land, because of implicit assumption that a unit of irrigated piece of land had the identical cropping intensity potential than a unit of no irrigated piece of land.

Using the similar type of dataset, Fan and Chan-Kang (2003), demonstrated that there were no diseconomies of scale in use of land when the operational holding is dichotomized into irrigated and non-irrigated land in the econometric model. Therefore, this led to further examining the relationship between various structure of land size and various variables on the soybean productivity among owner-operated and share cropper-operated farms. Primary data for Madhya Pradesh for the 1999 rainy season crop was used and productivity of owner-operated and trial farms was found higher than sharecropped farms. The celebrated inverse-relationship was found again for both owner-operated (r = 0.27) and share cropper-operated (r = 0.30) farms (Wani *et al.*, 2006). In order to investigate the relationship between efficiency estimates and farm size results are consistent with the finding of Javed *et al*. (2008), that small farms are pure technically more efficient than large farms.

The recent literature focused on agricultural economics in developing countries (Binswanger *et al.,* 1995; Barrett 1996; Townsend *et al*., 1998; Helfand and Levine, 2004), indicates that the inputs and productivity relation is more complex and caution must be used when advocating policies for agricultural development, also for all farms there exists a threshold size over which efficiency growth is observed with increasing farm size. Recently, the Data Envelopment Analysis (DEA) also used by (Sang, 2001; Krasachat, 2003; Dhungana *et al*., 2004), with focus on the evaluation of rice farms' efficiency, because of the policy interest in the size distribution of farms, there is need to understand the causes of changing farm sizes. The causes of changes in farm size are complex and interrelated and include; inheritance and transfer, government policies, technological change, and changes in farm and nonfarm markets, (Mary and Jet, 2004).

Earlier studies have identified an inverse relationship between farm size and productivity in several underdeveloped regions, including Paraguay (Masterson, 2007), India (Dyer, 1991; Sen, 1962), and Rwanda (Byiringiro and Reardon, 1996). Numerous theories have emerged to justify this observed trend, with most suggesting that smaller farms use labor and physical inputs more intensively than larger farms. Among the most common rationales for this behavior are underdeveloped labor and input markets, and desperation to meet consumption requirements. Researchers have suggested numerous channels through which underdeveloped markets may interact with farm size to impact input intensity.

Finding an inverse relationship between intensity of input use and productivity, Byiringiro and Reardon, (1996) propose that, the presence of imperfect labor markets implies that family laborers may not be able to secure off-farm employment, small farms cultivated by large families are likely to have an abundance of labor. Mine while they are more able to meet their agricultural input demands without utilizing local markets, which may be inefficient or non-existent, small farmers possess an input advantage relative to farmers of larger plots (Masterson, 2007). These advantages in input access allow smaller farms to use resources more intensively.

Other researchers have suggested that small farms will employ higher input intensities out of desperation to meet consumption needs (Masterson, 2007). If a household must meet consumption requirements using a small amount of land, it will have very high incentives to maximize the plot’s productivity. As the amount of land is fixed, productivity might be boosted through increased labor or input use. There is some evidence to support this theory; land pressure, defined as the number of cultivated acres divided by the number of household members, this has shown to lead to higher rates of fertilizer and improved seed use (Freeman and John 2003).

Observations reveal, however, that larger farms do not consistently have higher input or capital-to-land ratios than smaller farms (Masterson, 2007). Thus, while larger farmers may have greater access to credit in absolute terms, the difference may not fully account for disparities in land ownership. If this is the case, and larger farmers had lower credit access on a per-cultivated-acre basis, insufficient financing might be offered as an additional explanatory factor for larger farms' underinvestment in inputs. In-kind loans might therefore go further in reducing credit constraints for larger farmers. Meanwhile, providing in-kind loans to smaller farmers who already use inputs intensively is expected to produce minimal gains in productivity, while in kind loans may not significantly improve farm productivity on average, the effect of credit use on productivity gains will be moderated by farm size, with larger farms enjoying greater benefits due to higher reductions in input and capital access constraints.

While an inverse relationship between land size and productivity has been observed in many contexts, researchers have indicated channels through which this association might be weakened. In particular, the literature has emphasized the advantages that larger farms have on smaller farmers and may invest away from agricultural inputs in order to mitigate the risk inherent in farming, particularly given the absence of crop insurance. Barrett (1996), assumes that larger farmers have more investment options than do small farmers, and thus suggests that large farmers attempting to diversify their revenue streams may underutilize land holdings, terms of credit access and costs. These cost benefits are due in part to the dualistic nature of underdeveloped financial markets, wherein wealthier farmers, it is argued, maintain exclusive access to lower interest, institutional loans. Presumably, the improved credit access for larger farms should increase their input and capital investments and thereby improve their productivity (Dyer, 1991).

The measurement of efficiency (technical, allocative, economic and scale) has remained an area of important research both in the developing and developed countries, where resources are not sufficient and opportunities for developing and adopting better technologies are dwindling. Efficiency measures are important because it is a factor for productivity growth. Such studies benefit these economies by determining the extent to which it is possible to raise productivity by improving the neglected sources of growth with the existing resources base and availability of technology.

2.6.2 Factors influencing efficiency in production

Literature suggests many factors which affect the efficiency of farmers. These are classified into conventional and non-conventional factors. Non-conventional factors capture the impacts of macroeconomic variables such as public investment and agro-ecological variables. Conventional factors are traditional choice variables in the farmer's production decision process. According to Pender *et al*. (2004), the conventional inputs include tractor use intensity, fertilizer usage, labour use intensity and stock of livestock. On the other hand, non-convectional inputs include calorie availability, irrigation, agricultural research, agricultural export, instability and land quality. Deininger and Olinto (2000) and Pender *et al.* (2004) also identified fertilizer, cattle ownership, access to credit, supply of extension, human capital (education, age, and gender of house head), family size and proportions of dependents as explanatory variables to efficiency. The plot level factors such as the size of the farm, tenure, distance of the field from the residence in one way or another affects productivity (Xu *et al.*, 2009). Ownership of livestock especially oxen is likely to help famers prepare their fields early and also allows them to increase the area of land cultivated. Furthermore livestock acts as buffer zone and improves farmer's access to credit and fertilizer markets.

In an effort to identify strategies to increase agricultural productivity and reduce land degradation, Pender *et al*. (2004), used econometric analysis on cross sectional data in Uganda. The study findings showed that ownership of livestock (especially oxen), agro-climatic zones, primary sources of income, age of house head, ownership of land and participation in agricultural extension activities positively affected productivity. The study also shows that investments such as irrigation facilities are more likely to improve productivity. The Population density has a bearing on the way farmers employ their inputs. Studies show that farmers in high density populated areas tend to use intensive methods of crop production. For example Pender *et al*. (2004) show that household in more densely populated areas were found to adopt some labor intensive land management practices which enabled them to increase crop production per hectare.

Farm size also affects the productivity. Pender *et al.* (2004) showed that farm size was negatively related to productivity in Uganda. In Zambia, Brambilla and Guido (2009) used cross-sectional postharvest survey data to investigate the dynamic impacts of cotton marketing reforms on farm output. This study showed that small farms are more efficient. Liebenberg *et al*. (2010), agrees that for small scale the production is normally small but in terms of productivity or production per hectare they perform better than larger plots.

Again, Farm size also have impact on maize productivity and efficiency as shown by Sadiq *et al*. (2009), which found that technical efficiency was calculated for maize crop in AJK using stochastic frontier approach. The estimates reveal that the farmers of the area are inefficient and there is enough scope to increase their productivity. However, about 10 percent of the farmers are near to the frontier. Farm size and close contact with the extension agents have shown negative impact on inefficiency effect, indicating that farmers with large farm size with more contact with extension agents are technically more efficient than their counterparts (Sadiq *et al*., 2009).

Trade performance has some impact on the agricultural productivity. If farmers can access local and export markets, literature shows that productivity can go up because whatever is produced would be bought on the market. Using cross section time series data for 28 Sub-Sahara African countries, Ajao (2008), estimated an agricultural production function in an attempt to examine sources of agricultural specific crop productivity growth and stagnation. The results showed that the coefficient on agricultural export was positive and statistically significant. However, Pender *et al.* (2004) found little evidence on the impact of access to markets on agricultural intensification and crop productivity.

Although education as human capital is important for increasing household income, it was not found to be a solution to the problem of low productivity in Uganda (Pender *et al.*, 2004). Similar results were reported by Deininger and Olinto (2000) using panel data of the postharvest survey. However the study which aimed at examining the relatively lackluster performance of the country's agricultural sector following liberalization concluded that education enables farmers to overcome market imperfections as reflected in the fact that more educated farmers demand higher amounts of fertilizer and credit per hectare. Results for Mexico indicate that lowering transactions costs through improved transportation and the promotion of organizations for marketing would increase output by both increasing market participation and increasing production for market participants (Key *et al.*, 2000). They found that the net effect of an increase in the selling price is an increase in output by 0.49%. Abebe (2005) also measures supply response with respect to own price and cross price of cereals in Ethiopia.

2.6.3 Farm profitability

As with any economic analysis, the profitability of an investment is based on a comparison of the return and cost of the investment. Another way to add value on the production side would be to reduce processing costs by increasing the efficiency (and thus the profitability) of production (Masters *et al.*, 2005). Profitability in some farm business exists because they are managed more efficiently than others. The reward for doing the job better is usually profit. The prospect of earning and maintaining profitability serves as the incentive for creativity and efficiency among farmers.

CHAPTER THREE

METHODOLOGY

3.1 The Study Area

This study was conducted in Doguwa local government area in the extreme south of Kano State, Nigeria. Its headquarters is in the town of Riruwai, it shares common boundries with Lere, Kubau and Ikara local government areas of Kaduna State and Toro local government area of Bauchi State across north-west and south-east respectively. The total land area of Kano State is about 20,760sq km^2 with 1,754,200ha of agricultural land and 75,000ha of forest vegetation and grazing land (Daniel, 2010). "There are 86,000 hectares of Fadama land in the State put under dry season cultivation" (KNARDA, 2011). Doguwa local government has land area of 1,473 km^2 about 3,849 hectares are put under irrigation scheme and has estimated population of 151,181 people with projected population of 257,479 people as at 2015 at 3.2% growth rate (NPC 2006), the people of the community are predominantly farmers.

The study area was endowed with natural Falgore Game Reserve and available mineral resources deposits. The common crops grown in the area include: maize, sorghum, rice, millet, cowpea, groundnut, soybeans and pepper under rain fed conditions. In the area, the people are also involved in dry season farming; the common crop grown is tomatoes, vegetables, sugarcanes and onion crops under micro- irrigation. The area has two main seasons, wet and dry, the wet season starts at the end of May and ends in September-October and the dry season starts in October and ends in April. The mean annual rainfall is between 400-1,200 mm/annum, and The mean maximum temperature is $32.03^{\circ c}$, while the mean minimum temperature is $14.02^{\circ c}$. Dry cold and dust wind (Harmattan) is experienced between November and February weather is always cold. Heat is more severe in March and April. The climatic condition is Guinea savannah with grassland vegetation and scattered trees (KNARDA, 2011).

Communities and parts of neighboring states apart from sole maize production, practice mixed farming with cattle and goats being significant components in the farming system reared predominantly by Fulani. Cattle are used for traction and land preparation, but tremendous use of tractors is intensively involved in all farming activities of the area.

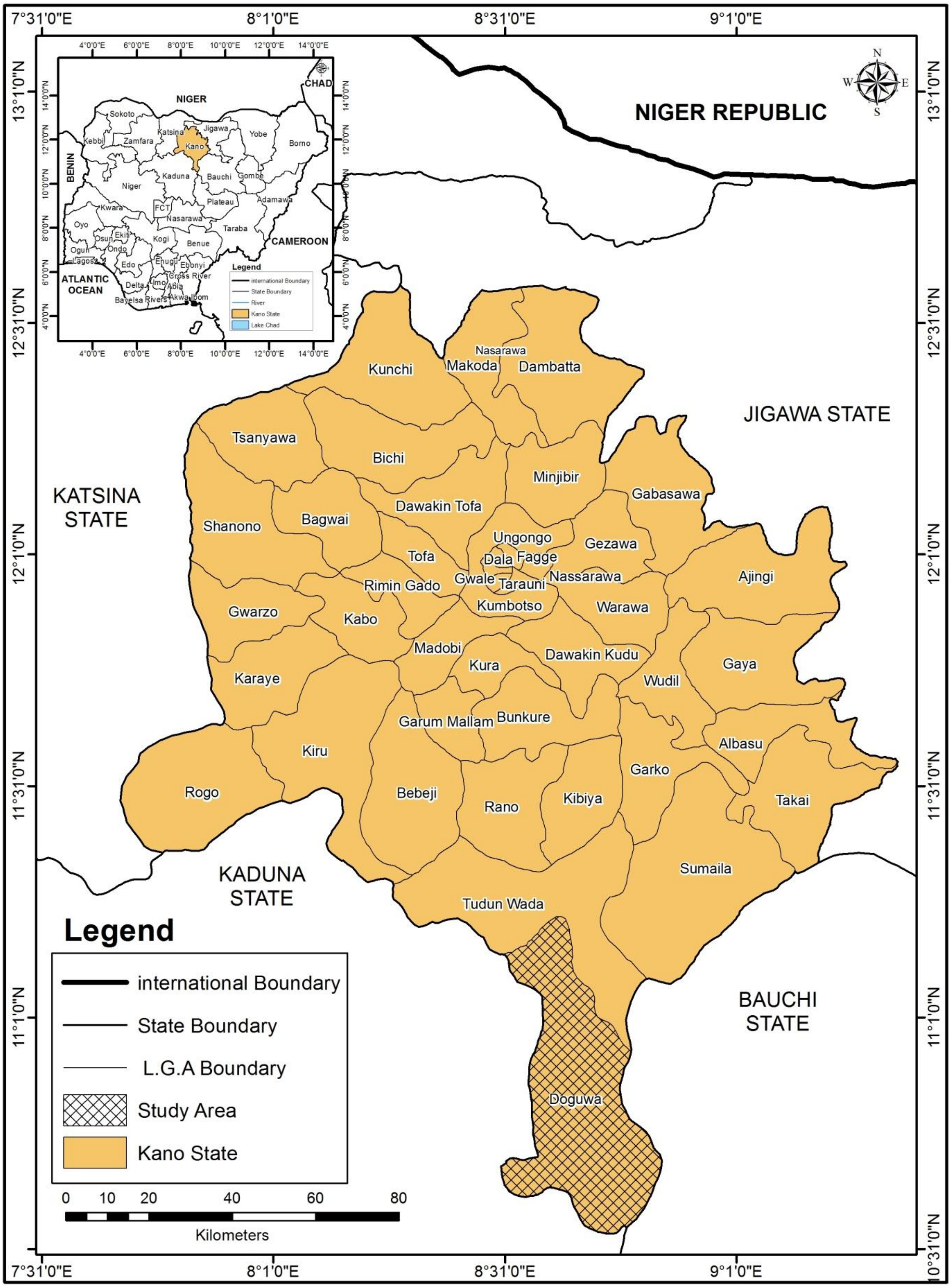

Figure 1: Map of Kano State showing Study Area (Doguwa L.G.A.)

Source: Adapted from the Administrative Map of Kano State

3.2 Sampling Size and Sampling Technique

In order to select respondents, multi-stage sampling technique was followed for this study. In the first stage, it involves purposive selection of Doguwa local government area based on predominance of sole maize production among the farmers. In the second stage, five districts were selected randomly in form of rumple drown from ten districts based on the discussion with agricultural development programme officers of the local government area and 1524 sample frame was obtained thereof from each of the five districts. Finally, 12% of the sample frame (1524) of maize farmers were randomly selected also in form of rumple drown to select a total of 179 maize farmers as sample size for the study, as shown in Table 3.1.

Table 3.1: population and sample size of farmers

LGA	Districts	*Sample frame	Sample size (12%)
Doguwa	Doguwa	450	54
	Falgore	278	33
	Maraku/Ragada	320	38
	Dogon kawo	213	25
	Tagwaye	245	29
Total		**1524**	**179**

Source: Kano State Agricultural and Rural Development Authority (KNARDA), 2014

3.3 Data Collection

Primary data was used for this study. These were collected with the aid of structured questionnaire. The information collected is based on 2014 cropping season on a single visit and information on input and output data was collected such as; Farm size, seed, fertilizer, labour, herbicide and output of maize respectably. Also farmer’s socio-economic characteristics such as age, Household size, educational level, farming experience, access to credit, numbers of extension contact and cooperative membership was collected.

3.4 Analytical Techniques

3.4.1 Descriptive statistics

Descriptive statistics was used to achieve objective (i) of the study. It involves the use of measures of central tendency: mean, minimum, maximum, standard error, standard deviation, frequency distribution, percentages and coefficient of variation to describe the socio-economic characteristics of maize farmers in the study area.

3.4.2 Data envelopment analysis (DEA)

In this study, the Data Envelopment Analysis (DEA) method is a nonparametric mathematical programming technique that was employed to achieved objective (ii) and (iii), DEA approach was preferred over parametric approach (Stochastic Frontier Production Function model, SFPF) for the measurement of scale efficiency across all farms and estimation of technical efficiency in this study, because it provides means of decomposing total technical efficiency into pure technical efficiency, therefore facilitates the examination of sensitivity of relationship in economies of size. The DEA technique does not require a specific functional or distributional form, and can accommodate size issues. A large number of studies have extended and applied the DEA technology in the study of productivity and efficiency worldwide.

DEA models can be either output or input oriented. The input-oriented model measures the quantities of inputs that can be reduced without any reduction in the output quantity produced. On the other hand, output oriented model measures the degree to which output quantity can be increased without any change in the quantities of inputs used. However, the relative range of the efficiency scores remains the same whether input-oriented or output-oriented method is employed. The input oriented models can be either constant returns to scale (CRS) or variable returns to scale (VRS) assumptions. This study used both CRS and VRS models with input orientation.

3.4.2.1 The DEA Model Specification

Given the CRS assumption, the best way to introduce DEA is via the ratio form. For each decision-making unit (DMU) which in the context of our empirical application is maize farmers; one would like to obtain a measure of the ratio of all outputs over all inputs, such as $u'y_i/v'x_i$, where u is an Mx1 vector of output weights and v is a Kx1 vector of input weights. To select optimal weights one specifies the mathematical programming problem:

Max u,v $(u'y_i/v'x_i)$,

st $u'y_j/v'x_j \leq 1$, j=1,2,…, N,

u, v ≥0 .... (1)

This involves finding values for u and v, such that the efficiency measure of the i-th DMU is maximized, subject to the constraint that all efficiency measures must be less than or equal to one. One problem with this particular ratio formulation is that it has an infinite number of solutions. To avoid this one can impose the constraint $v'x_i = 1$, which provides:

Max x_i,v$(\mathrm{i}'y_i)$,

st $v'x_i = 1$,

$\mu'y_j - v'x_j \leq 0$, j =1,2, …,N,

μ, v ≥0... (2)

Where: The notation change from u and v to μ and v reflects the transformation relationship. This form is known as the multiplier form of the linear programming problem. Using the duality in linear programming, one can derive an equivalent envelopment form of this problem:

$Min_{\theta,\lambda}\, \theta,$

St $-y_i + Y\lambda \geq 0,$

$\theta x_i - X\lambda \geq 0,$

$\lambda \geq 0,$ .... (3)

Where: θ is a scalar and λ is a N x1 vector of constants. This envelopment form involves fewer constraints than the multiplier form (K + M < N+ 1), and hence is generally the preferred from to solve. The value of θ obtained will be the efficiency score of the i-th DMU. It will satisfy $\theta \leq 1$, with a value of 1 indicating a point on the frontier and hence a technically efficient DMU. An implicit assumption of the model described is the return to scales and thus farms are operating at an optimal scale (Fraser and Cordina, 1999). Note that the linear programming problem must be solved N times, once for each DMU in the sample. A value of é is then obtained for each DMU.

The CRS linear programming problem can be easily modified to account for VRS by adding the convexity constraint: $N1'\lambda=1$ to (3) to provide:

$Min\theta,ë^{\theta},$

st $-y_i + Y\lambda \geq 0,$

$\theta x_i - X\lambda \geq 0,$

$N1'\lambda=1$

$\lambda \geq 0,$ .... (4)

where: θ is a scalar and λ is a N x1 vector of The value of θ obtained will be the efficiency score of the i-th Decision Making Unit (DMU).

It will satisfy $\theta \leq 1$, with a value of 1 indicating a point on the frontier and hence a technically efficient of DMU, according to (Banker *et al.*, 1984) definition.

One would then run the following cost minimization Data Envelopment Analysis:

$Min_{\lambda,xi}$* $W_{i2}X_i$*

st $-y_i + Y\lambda \geq 0$,

x_i* - Xë ≥0,

N1'λ=1

$\lambda \geq 0$, ... (5)

Where: w_i is a vector of input prices for the i-th DMU and x_i* (which is calculated by the LP) is the cost minimizing vector of input quantities for the i-th DMU, given the input prices w_i and the output levels y_i. The total cost efficiency (CE) or economic efficiency of the i-th DMU would be calculated as:

CE = w_{i2} x_i */ w_{i2} x_i.. (6)

That is, the ratio of minimum cost to observed cost. One can then calculate the allocative efficiency residually as:

AE = CE/TE... (7)

Note that the product of technical efficiency and allocative efficiency provides the overall economic efficiency. Note that all three measures are bound by zero and one. The technical efficiency measure under CRS, also called the "overall" technical efficiency measure, is obtained by solving N linear programs of the form. The output and input oriented models will estimate exactly the same frontier surface and therefore, by definition, identify the same set of firms as being efficient. The efficiency measures may, however, differ between the input and output orientations. Under the assumption of CRS, the estimated frontier and the efficiency measures remain unaffected by the choice of orientation. For this study, one output and five inputs were used in the model; the only output is the maize output per hectare, the inputs are land, seed, fertilizer, labour and herbicide. Technical efficiency was used to estimate the resource productivity of the maize farmers in the study area. Measurement of technical efficiency is important because it is a success indicator of performance measure by which production units are evaluated (Ajibefun and Abdulkadir, 2004).

DEA approach was preferred over parametric approach for the measurement of productivity relationship across all farm sizes in this study because it provides means of testing sensitivity of a relationship and decomposing total technical efficiency into pure technical. Where the general problem is given as:

Max TE *

Subject to: n_j Xβ Yα m r_{ij} st r r_jr ,..,1,

1≤ ∑ ∑ 1= 1=αr, βi ≥ 0; r = 1, -----, s; i = 1, …., m.. (8)

Where Xij and Yij respectively are quantities of the ith input and rth output of the jth firm and αr, βi ≥ 0 are the variable weights to be determined by the solution to this problem. Scale efficiency can be obtained residually from CRS and VRS technical efficiency scores as follow:

SE= TECRS/TEVRS... (7)

SE= 1 indicates scale efficiency or constant return to scale (CRS) and SE <1 indicates scale inefficiency. Scale inefficiencies arise due to the presence of either increasing returns to scale or decreasing return to scale.

In estimation of scale efficiency relationship with maize productivity of this study, input-oriented DEA was employed to determine how much input size the farmers would have to change to achieve the maize productivity level that coincides with the best practice frontier. One output and inputs were used in the model; the output is obtained as residuals from CRS and VRS technical efficiency scores and the inputs are farm size, seed, fertilizer, labour and herbicide.

3.4.3 Multiple regression analysis

This was used to determine factors influencing technical efficiency in maize production and test hypotheses of the study. Functional form of Cobb-Doglass function was chosen and used; this is because it is linear in logarithmic form and therefore easy to estimate, and has been widely used for analysis by many authors. The function can estimate relationship using either the Maximum Likely hood technique (MLE) method or using a variant of the Ordinary Least square technique (OLS) method suggested by Richmond (1974). Several authors' present strength and weaknesses of various techniques used in the relationship measurement. The OLS approach is preferred because it is not too computational demanding.

The explicit form of the regression model is written as:

$Y = \beta o + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + u$

Where,

Y = Production efficiency indices of the mean efficiency scores from VRSTE

X_1 = Age of farmers (years),

X_2 = Education level (years of schooling),

X_3 = Family size (number of members of household),

X_4 = Farming experience (years),

X_5 =Cooperative membership (year),

X_6 = Extension visit (numbers),

X_7 = Access to credit (actual money borrowed),

βo = constant term,

$\beta_1 - \beta_7$ = regression coefficients of independent variables, and

u = Error term.

In testing hypothesis that said maize farmers are not technically efficient in the use of production resources in the study area, functional form of regression was also used as;

$$Y = \beta o + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + u$$

Where;

Y = Production efficiency indices of the mean efficiency scores from VRSTE

X_1 = quantity of seed (kg),

X_2 = quantity of fertilizer (kg),

X_3 =total labour used (man days),

X_4 = quantity of herbicide (litres),

X_5 = farm size (hectars),

βo = constant term,

$\beta_1 - \beta_5$ = regression coefficients, and

u = Error term.

3.4.4 Net farm income

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

NFI= TR-TC

Where,

NFI= net farm income,

TR= total revenue and

TC= total cost of production.

TC= TVC+TFC

The model for the estimating net farm income can be presented by the equation.

$$\sum_{i=1}^{m} pyiYi - \sum_{j=1}^{m} pxiXj - \sum_{k=1}^{k} fk$$

Where:

Y_i = output (maize, kg/ha),

py_i= unit price of maize (₦),

x_j= quantity of variable input (seed, fertilizer, labour and herbicide),

px_j= price per unit of variable inputs,

fk = cost of fixed input (where k= 1,2,3……k fixed input) and

$\sum$ = summation sign.

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

Therefore, RNI= GI/TC

Where,

RNI = return per naira invested,

GI = gross income and

TC = total cost.

Decision Rule

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

RNI = 1, the farmers is at breakeven.

RNI $<$1, the farmer is at loss.

For this study, fixed cost was used to measure the depreciation of durable farm tools such as knapsack sprayers, hoes and cutlasses. The straight line method of evaluating depreciation is used to obtained fixed cost for durable farm tools.

The straight line depreciation method is specified as:

$$D = \frac{P-S}{N}$$

Where:

D = depreciation,

P = purchase price,

S = salvage value and

N = number of years of life of the asset.

3.4.5 T-test Statistics

T-test statistics: two paired sample for mean was employed to achieve hypotheses of this study, it requires addressing the hypothesis that said maize production is not profitable in the study area.

3.5 Definition and Measurement of Independent Variables

Ten explanatory variables measured as continuous and discrete variables were hypothesized for determinants of farm size and maize productivity relationship and technical efficiency under DEA assumptions. Maize output was measured in kilogram.

i. **Age:** This refers to the number of years an individual attained from birth. It is a continuous variable and was measured in years. The apriori expectation for age is expected to be positive, this implies that the age of the farmer is increasing technical efficiency or reducing inefficiency.

ii. **Household size:** This means the total number of people in the house which includes the wives, children and dependents that reside within the same house. Since food requirements increases with the number of person in the household and also because land and finance to purchase agricultural inputs are limited. Increasing family size, according to Brown (2004), tends to exert more pressure on consumption than the labour it contributes to production. This was measured in numbers. The apriori expectation for household size is expected to be positive, this implies that the household size of the farmer is reducing inefficiency or increasing technical efficiency.

iii. **Educational status:** This refers to the acquisition of knowledge through formal schooling. This was measured by the number of years spent in school. The apriori expectation for educational status of the farmer is expected to be positive, this implies that the educational status of the farmer is reducing inefficiency or increasing technical efficiency.

iv. **Access to credit:** This refers to amount of money received from both formal and informal sources. It was measured as the actual money/credit borrowed. The apriori expectation for amount of money received is expected to be positive, this implies that the amount of money received by the farmer is reducing inefficiency or increasing technical efficiency.

v. **Farming experience:** This refers to the long time a farmer stay in farming activities. It was measured in numbers. The apriori expectation is expected to be positive, this implies that the years of Farming experience is reducing inefficiency or increasing technical efficiency.

vi. **Numbers of extension visit/period:** This refers to the access to government extension services by the farmers in the production cycle. It was measured in number of times of contact between the extension agent and the farmer. The apriori expectation for extension contact is expected to be positive, this implies that the extension contact of the farmer is reducing inefficiency or increasing technical efficiency.

vii. **Number of years in Cooperative society:** This refers to coming together of individuals into group of farmers for interaction and sharing of ideas for a common goal attainment. Thus it influences the attitude of members towards community developmental projects. This variable was used to characterize farmers based on particular involvement in production and/or marketing organization at the time of data collection. It was measured in years. The apriori expectation for cooperative society is expected to be positive, this implies that the cooperative society of the farmer is reducing inefficiency or increasing technical efficiency.

viii. **Quantity of seeds:** This was measured in kilograms (kg). It was included in the model to examine the actual kilograms of the maize seed. The apriori 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.

ix. **Quantity of fertilizer:** This was measured in kilograms (kg). It will be included in the model to examine the actual kilograms of the fertilizer used which affect output. The apriori expectation for quantity of fertilizer is expected to be positive; this implies that, a unit increase in quantity of fertilizer will bring about increase in output.

x. **Labour:** This consist of family and hired labour, it will be included in the model to examine how variability in labour used affect output. Following Norman (1972), children age 7-14years are accorded 0.5 of adult male equivalent, female adult of 15-46years are accorded 0.75 and male adults of 15-64years are accorded 1.00. Labour was measured in man-days. The apriori 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.

xi. **Farm size:** This variable was used to measure the total size of land used for cultivation. Farm size was measured in hectares. The estimated coefficient of farm size is expected to be positive; this implies that, a unit increase in farm size will bring about increase in productivity.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Socio-economic Characteristics of Maize Farmers

4.1.1 Age of maize farmers

Result in Table 4.1 revealed that majority (36.9%) of the maize farmers were between the ages of 40-49 years, 23.4% were between 50-59 years while 20.1% were between 60-69 years and 13.4% were between 30-39 years of age. only 5.6% of the farmers were 60-85 years of age while the minimum and maximum age of the maize farmers range between 28–85 years with an average mean of 42 years. This result shows that majority of the farming population were young and in the active age group implying that the farmers can make positive contribution to agricultural production as well as serve as agents of innovation transfer in 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 production. This finding is similar to that of Adegboye (2011), in which he observed that youth constitute the majority of the maize farmers. Again in line with these findings, Hamidu *et al.* (2006) reported that age factor in traditional agriculture significantly influences productivity and increased rate of adoption, hence, these youths are dynamic and willing to take such risk connected with adoption of new agricultural technology. This result is also conform to the results obtained by Buba, (2005), in his study on economic analysis of maize production in Kaduna State, Nigeria, who reported that 44% of the maize farmers fell within the age range of 41-50 years and the average age of the farmers was 46 years.

Table 4.1: Distribution of maize farmers according to their Age

Age (years)	Frequency	Percentage (%)
<30	1	0.6
30-39	24	13.4
40-49	66	36.9
50-59	42	23.4
60-69	36	20.1
70-85	10	5.6
Total	**179**	**100**
Mean	**42**	
Standard Error	**0.89**	
Minimum	**28**	
Maximum	**85**	

4.1.2 Educational level of maize farmers

Education is an important socio-economic factor that influence farmer's decision making because of its influence on farmers' awareness, perception and adoption of innovations that can bring about increase in productivity. The results in Table 4.2 revealed that 26.3% of maize farmers had no formal education while 73.7% of the farmers had one form of education or the other; about 29.5% had primary education, 17.9% had secondary education and 26.3% had tertiary education. This result showed that majority of the maize farmers (73.7 %) in the study area had one form of formal education or the other implying that there is potential for increased maize production since education will enable farmers to have access to information on new agricultural innovation which can be adopted to enhance their productivity. According to Abdullahi and Abdullahi (2011), western education facilitates the adoption of modern technologies and improved farm practices. Notably, formal education is an essential tool for the adoption of modern production technologies and effective communication system that encourage increase in the productivity of any agricultural venture (Nwaru, 2004;

Akanni, 2007; Albert and Okidhum, 2012; Nenna and Ugwumba, 2012). This finding is in line with Amaza (2000), who observed that formal education has a positive and significant impact on farmer's efficiency in food production in Gombe State of Nigeria. Thus, literacy level will greatly influence the decision making which may bring about increase in productivity and efficiency in maize production.

Table 4.2: Distribution of maize farmers according to their level of education

Education (years)	**Frequency**	**Percentage (%)**
No formal education	47	26.3
Primary education	53	29.5
Secondary education	32	17.9
Tertiary education	47	26.3
Total	**179**	**100**

4.1.3 Household size of maize farmers

Table 4.3 shows the distribution of maize farmers by household size. Majority (61.45%) of the farmers had household size that ranged between 11-20 persons, followed by 1-10 persons which constituted 24.14%. Only 11.27% had household size which ranged between 21-30 persons. The mean household size was 15 persons. This implies that family labour would be readily available when needed for maize farming operations. Household size influences the availability of family labour for agricultural operations, since the main source of labour for a typical traditional farmer is his immediate dependents, it is therefore expected that, household size would influence the adoption of agricultural technologies, especially where joint labour is needed, implying that they have enough unpaid labour for farm activities (Okoedo-Okojie and Onemolease, 2009).

The result is also in line with the findings of Orojobi and Damisa (2007), who asserted that household size is crucial to traditional agriculture where the main source of labour is the family particularly in Nigeria. According to the report by Oluwatayo *et al.* (2008), in their study on resource use efficiency of maize farmers in rural Nigeria; evidence from Ekiti State, that there is a positive and significant relationship between household size and farmer's efficiency in production. The result also agrees with the finding of Buba, (2005), in the study on economic analysis of maize production in Kaduna State, Nigeria, among the maize farmers, 49% had more than 12 people in the household, the average household size was 10 persons, this could mean that there was a reasonable supply of family labour for farm operations in the study area. However, the absolute number of people in a certain family cannot be used to justify the potential for productive farm work. This is because it can be affected by some important factors namely; migration, age, sex and health status. Essentially, it is the composition of the household that determine labour supply for the accomplishment of farm operations.

Table 4.3: Distribution of maize farmers according to the household size

Household size (number)	Frequency	Percentage (%)
1-10	45	25.14
11-20	110	61.45
21-30	21	11.73
31-40	3	01.68
Total	**179**	**100**
Mean	**15.0**	
Standard Error	**0.46**	
Minimum	**2.00**	
Maximum	**42.00**	

4.1.4 Farming experience of maize farmers

The distribution of maize farmers by their farming experience in Table 4.4 revealed that 37.9% of maize farmers had 11-20 years of maize farming experience, 32% had 21-30 years and 16.20% had 23-40 years of farming experience, while only 10.10% had farming experience 1-10 years. Whereas the mean farming experience found was 24 years. This result shows that majority of the farmers are experienced in maize production. This implies that 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. This finding is in line with Ajani (2002), who worked on productivity in food farming in Northern Nigeria. He reported that year of farming experience increased agricultural productivity among farming households in Nigeria, the more the number of years of production by maize farmer, the more knowledge and skills gained which in turn brings about efficiency. This result is also conform to the result obtained by Buba, (2005), who indicates that majority of the farmers (53%) have been producing maize for more than 25 years in Kaduna State.

Table 4.4: Distribution of maize farmers according to maize farming experience

Farming Experience (years)	Frequency	Percentage (%)
1-10	18	10.10
11-20	68	37.90
21-30	59	32.00
31-40	29	16.20
41-50	5	02.80
Total	**179**	**100**
Mean	**24.00**	
Standard Error	**0.72**	
Minimum	**1.00**	
Maximum	**50.00**	

4.1.5 Cooperative membership of maize farmers

The result in Table 4.5 shows the number of years spent as members of Cooperative. About 65.36% of maize farmers did not participate in any Cooperative Association while 34.64% participated with an average of 6 years cooperatives. The result indicate low membership of cooperatives by a significant proportion of maize farmers in the area, which implies that farmers had less access to resources and information that will improve their production practices and highlighting them the importance of some social capital involve in improving productivity. Ekong (2003) and Ajayi and Ogunlola (2005), observed that membership of cooperative societies has advantages of accessibility to micro-credit and input subsidy. Also serve as an avenue of availing ideas and information that could help them in pooling of resources together in order to expand their production efficiency and for profit maximization. A study by the Natural Resources Institute and Concern Worldwide in 2012 indicated that for smallholder farmers to increase productivity for their income and food security to be enhanced, among other things, they should be encouraged to form cooperatives, this they said will support them in the provision of training on savings and loans based on rotation credit of small groups and harnessed production of key crops that would otherwise not be produced by a single farmer.

Table 4.5: Distribution of maize farmers according to cooperative membership

Cooperative association (years)	Frequency	Percentage (%)
1-5 years	42	23.47
6-10 years	12	06.70
11-15	8	04.47
Total	**179**	**100**
Mean	**2.44**	
Standard Error	**0.08**	
Minimum	**1.00**	
Maximum	**4.00**	

4.1.6 Access to credit of maize farmers

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. Farmers obtained their funds through formal and informal sources as presented in Table 4.6; the result shows that 85.5% of maize farmers financed their maize production from personal savings while 14% had access to credit. The amount obtained ranged between ₦10,000 - ₦100, 000 with the minimum and maximum amount being ₦10,000 and ₦300,000 respectively. The implication is that the size of maize production will be smaller and other inputs will be affected since capital is not available to enhance production. Lack of 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. It also agrees with the findings of

Nasiru (2010), who noted that access to micro-credit could have prospects in improving the productivity of farmers and contributing to uplifting the livelihoods of disadvantaged rural farming communities.

Table 4.6: Distribution of maize farmers according to access to credit

Variable (naira)	Frequency	Percentage (%)
No access to credit	153	85.50
10,000 - 100,000	21	11.70
110,000- 200,000	5	02.80
210,000-300,000	0	00.00
Total	**179**	**100**
Mean	**0.15**	
Standard Error	**0.07**	
Minimum	**10000**	
Maximum	**300000**	

4.1.7 Number of extension visit

The ultimate aim of extension services is to enhance farmers' ability to efficiently utilize resources through the adoption of new and improved methods used in maize production instead of using traditional crude methods which are inefficient, resulting to low yield. The distribution of the farmers based on numbers of extension visit is presented in Table 4.7. The result presented in Table 4.7 revealed that 62.6% of maize farmers in the study area had access to extension service while only 8.9% had no access to extension service with average of 4 times contact. This could be attributed to high extension agent-farmers' ratio in the study area. This implies that effective extension visits and supervision will go a long way to improve maize farmer's productivity level.

According to Obwona (2006), extension service is very essential to the improvement of farm productivity and efficiency among farmers.

Table 4.7: Distribution of maize farmers according to extension visit

Extension Contact (number)	Frequency	Percentage (%)
No contact	16	08.90
1-5	112	62.60
6-10	44	24.60
11-15	5	02.80
16-20	2	01.10
Total	**179**	**100**
Mean	**4.00**	
Standard Error	**0.35**	
Minimum	**0.00**	
Maximum	**20.00**	

4.2 Productivity and Efficiency in Maize Production

4.2.1 Input and output levels in maize production in the study area

DEA models can be either output or input oriented. The input-oriented model measures the quantities of inputs that can be reduced without any reduction in the output quantity produced. On the other hand, output oriented model measures the degree to which output quantity can be increased without any change in the quantities of inputs used. However, the relative range of the efficiency scores remains the same whether input or output-oriented methods are employed. We therefor need to compute the level of inputs used and outputs realized for better understanding.

The summary statistics of level of inputs used and outputs realized in maize production in the study area are reported in Table 4.8. The inputs that were used in maize production include; seed, fertilizer, labour, herbicide and farm size. Table 4.8 revealed that the average quantity of seed used by maize farmers was 24.15kg/ha. The minimum and maximum quantities of seed used were 5.00kg/ha and 500kg/ha, respectively. Average fertilizer used by maize farmers was 452.70kg/ha, while the minimum and maximum were found to be 75.00kg/ha and 3000kg/ha respectively. The mean labour recorded was 74.03mandays/ha while the minimum and maximum were observed to be 4.00mandays/ha and 1250mandays/ha respectively. Mean herbicide recorded for maize farmers was 3.35liters/ha while the minimum and maximum used were 2.00liters/ha and 240liters/ha respectively. The mean farm size was 4.06ha. The minimum and maximum farm sizes were 0.25ha and 100ha, respectively. The output of maize varies from one farmer to another depending on the input utilization and the management practices. The average output of maize in the study area was 3788kg/ha (3.8ton/ha) while the minimum and maximum output produced by maize farmers were 1000kg/ha (1.0ton/ha) and 6700kg/ha (6.7ton/ha) respectivily.

The coefficient of variation of each variable inputs used and output realized are presented in Table 4.8. The higher the coefficient of variation, the greater the dispersion of the variable are while the lower the ratio of standard deviation to mean return, the better your risk-return trade-off. The coefficient of variation for a model aims to describe the model fit in terms of the relative sizes of the squared residuals and outcome values, whereas the lower the coefficient of variation, the smaller the residuals relative to the predicted value. The low coefficient of variation is a reflection of reliability (precision) of the result (Johnson and Welch, 1939) they reported that for a normal distribution, the ratio of mean to standard deviation should be of order of three or more and 33% is often stated as the permissible upper fiducial limit of coefficient of variation.

The finding shows that the coefficient of variation of all the variable inputs used; seed, fertilizer, labour and herbicide were 102.32%, 54.13%, 54.20% and 60.28% respectively. The high coefficient of variation of variable inputs implies high level of variation in the use of variable input among maize farmers in the study area. However, the coefficient of variation for fertilizer and labour were lower compared to other variable inputs used for maize production. The wide variation in input used by the farmers could be attributed to the fact that they differ in purchasing power and size of production. The coefficient of variation in maize output was 131.74% which implies high inconsistency in output level among maize farmers in the study area. However, if efficiency and productivity status of maize output is adequately checked, will lead the country to attaining food security and poverty reduction, the instability in output of maize could be attributed to inconsistency and inadequacy of variable inputs among farmers in the study area.

Table 4.8: Summary statistics of input and output levels in maize production per hectare

Variables	**Minimum**	**Maximum**	**Mean**	**SD**	**SE**	C.V (%)
Seed (kg/ha)	5.00	500	24.15	14.71	284.04	102.32
Fertilizer (kg/ha)	75.00	3000	452.70	245.06	323.57	54.13
Labour (manday/ha)	4.00	1250	18.23	09.88	132.20	54.20
Herbicide (liters/ha)	2.00	240	03.35	02.14	281.65	60.28
Yield (kg/ha)	1000	6700	3788	4990.52	6682.15	131.74

4.2.2 Estimation of scale efficiency on maize productivity

Using DEA, the input oriented models can be either constant returns to scale (CRS) or variable returns to scale (VRS). The study used both CRS and VRS models with input orientations. In using the DEA method, the study seeks to estimate the scale efficiency on maize productivity across all various farm sizes. DEA Frontier Results in Table 4.9 revealed the nature of scale efficiency score with which the sample maize farms operated. This is important because in addition to knowing the number of efficient maize farms, degree of inefficiency and optimal scale of operation, it is also vital to know how many numbers of farms are operating under increasing returns to scale (IRS), decreasing returns to scale (DRS) or constant returns to scale (CRS) assumptions. Using DEA, every maize farm was evaluated, given its farm size level to determine its scale measures. This type of analysis according to Anderson *et al.* (2002) would be useful to each farm as they could determine the implications for expansion to production.

The scale efficiency score of maize farmers range from 0.34 to 1.00 with a mean score of 0.55 (55%) as shown in Table 4.9. This implies that the maize farms are operating in less than optimal scale size, in other words, scale efficiency among the maize farmers could be increased by 45% to operate in an optimum scale size, given the current state of technology. Out of the 179 maize farms (DMU's) studied; 14 DMU's representing 18% of the maize farms were scale efficient while 165 DMU's representing 82% of the maize farms were scale inefficient. This implies that a large proportion of maize farms were operating far below optimal scale, these farms could increase their maize productivity and income by decreasing costs of inputs used whereas only 18% operating at an optimum scale which is the most productive scale size, given the current state of technology. This result is in consonance with that of Benjamin *et al.* (2011), who used data envelopment analysis application to evaluate farm resource management of Nigerian farmers, reported that most (80%) of the DMU's studied were scale inefficient and operating in less than optimal scale size.

The result in Table 4.9 also revealed the nature of returns to scale summary statistics of efficiency measures with the number of farms operating under increasing, decreasing, and constant returns to scale. The result shows that 147 maize farms representing majority (82.12%) of maize farmers in the study area were found to be operating within IRS and this implies that they have huge potentials to increase their maize productivity status through expanding their size of production, given that they were performing below or sub-optimum scale with their various farm sizes. Therefore, operated at stage I of production process, where a proportionate increase in inputs for maize production will lead to a more than proportionate increase in output of maize productivity. 18 maize farms representing 10.6% of maize farmers exhibited DRS, which implies that they were operating above or supra-optimal scale of production. Hence, operated at stage III of production process, were a proportional increase in inputs for maize production will lead to a less than proportionate increase in output of maize productivity. Therefore, reducing the scale of production inputs will be the best option for the farmers to enhance their productivity. This is in conformity with Asghar *et al.* (2013) who noted that DMUs operating in DRS status can improve their overall productivity by reducing their production size.

On the other hand, only 14 maize farms representing 7.82% of maize farmers exhibited CRS, which implies that they were operating at an optimal scale of production. They operated at stage II of production process; hence a proportionate increase in inputs for maize production will lead to a proportionate increase in output of maize productivity level. Given that majority (92.18%) of the maize farms were operating under IRS and DRS, this suggests that maize farmers in the study area generally were scale inefficient in terms of resource used for obtaining optimum maize productivity level, since scale inefficiency is usually due to the presence of either IRS or DRS. This is in agreement with (Sharma *et al.*, 2003; Nasiru, 2010; Benjamin *et al.*, 2011). Although in the short run, DMU's may operate with IRS or DRS, in the long run however, DMU's must shift towards CRS by expanding their size of operation and reducing their inputs cost, so as to be efficient in order to achieve the desired increase in productivity. There are also interesting results regarding the effect of the control variables on agricultural productivity growth.

Table 4.9: Frequency distribution of scale efficiency estimates

Return to scale	**Frequency**	**Percentage (%)**	**Scale eff. score**	**Percentage %**
IRS	147	82.12	0.48	48
DRS	18	10.06	0.34	34
CRS	14	7.82	0.18	18
Total	**179**	**100**	**1**	**100**

4.3 Estimation of Technical Efficiency in Maize Production

Technical efficiency estimates for maize farmers in the study area was obtained from the data envelopment analysis (DEA) model using input-oriented DEA on single stage scale assumption; technical efficiency from constant return to scale data envelopment analysis (CRSTE-DEA) and technical efficiency from variable return to scale data envelopment analysis (VRSTE-DEA).

4.3.1 Technical efficiency from constant return to scale

Result presented in Table 4.10, shows the frequency distribution of the technical efficiency estimates for maize farmers in the study area from constant return to scale data envelopment analysis (CRSTE-DEA), the study suggests that, overall technical efficiency of the maize farmers varies substantially ranging between 0.18 to 1.00 representing 18% and 100% respectably, with a mean technical efficiency of 0.62 (62%). As observed from this study, 31.84% of the maize farmers operated near frontier within technical efficiency range of 0.81 and less than 1.00 whereas 0.56%, 21.23%, 25.70% and 20.67% (68.16%) of the maize farmers operated within a technical efficiency range of less than 0.20, 0.20-40, 0.41-60 and 0.61-80. The implication of this result is that, majority (68.16%) of the maize farmers are not technically efficient under CRS in the use of production resources (input orientations). This result suggests that the farmers are not utilizing their input resources efficiently, in other words, technical efficiency among the maize farmers can be increased by 38% through better use of their available production resources, given the current state of technology to obtaining maximal maize productivity and means that the inefficiency effects make significant contribution to the technical efficiencies of maize farmers as they are below the frontier level. This finding agrees with Asogwa *et al*, (2011), who maintain that Nigerian rural farmers do not obtained maximum output from their given quantum of inputs. This maximum possible level attainable may be due to inefficiency and hence results to low productivity.

Table 4.10: Frequency distribution of overall technical efficiency estimates from constant return to scale (CRTSTE-DEA)

Technical Efficiency (CRSTE)		Frequency	Percentage (%)
<0.2		1	0.56
0.20-0.40		38	21.23
0.41-0.60		46	25.7
0.61-0.80		37	20.67
0.81-1.00		57	31.84
Total		**179**	**100**
Minimum	**0.18**		
Maximum	**1.00**		
Mean	**0.62**		

4.3.2 Technical efficiency from variable return to scale

The result in Table 4.11 shows the frequency distribution of the technical efficiency estimates for maize farmers from variable return to scale data envelopment analysis (VRSTE-DEA). The study suggests that pure technical efficiency among maize farmers varied substantially ranging between 0.16 to 1.00 representing 16% and 100% respectably, with a mean efficiency of 0.47 (47%). As observed from this study, 22.35% of the maize farmers operated near frontier within technical efficiency ranges of 0.81 and less than 1.00, whereas 13.41%, 46.93%, 9.50% and 7.82% (77.66%) of the maize farmers operated within a technical efficiency range of less than 0.20, 0.20-40, 0.41-60 and 0.61-80 respectably. This result suggests that the maize farmers are not utilizing their input resources efficiently, indicating that they are not technically efficient in obtaining maximal output from their given inputs. In other words, technical efficiency among the maize farmers can be increased by 53% through better use of their available production resources, given the current state of technology to obtaining maximal maize productivity.

Table 4.11: Frequency distribution of pure technical efficiency estimates from variable return to scale (VRTS-DEA)

Technical Efficiency (VRSTE)	Frequency	Percentage (%)
<0.2	24	13.41
0.20-0.40	17	9.50
0.41-0.60	84	46.93
0.61-0.80	14	7.82
0.81-1.00	40	22.35
Total	**179**	**100**
Minimum **0.16**		
Maximum **1.00**		
Mean **0.47**		

The mean technical efficiencies estimated for the CRSTE and VRSTE approaches are 0.62 and 0.47 representing 62% and 47% respectably. The mean technical efficiencies in the models indicate that there is substantial inefficiency of the maize farmers in the study area due to inability to reach a frontier threshold of 100%. These results are consistence with the theory that, the CRS frontier is more flexible and envelops the data in a tighter way than the VRS frontier. This finding agrees with Asogwa *et al*, (2011) who reported that Nigerian rural farmers are not obtaining maximum output from their given quantum of inputs and also in line with Rahman (2013) who asserted that if there is a difference between efficiency scores of technical efficiency under CRS and VRS, the difference indicates scale inefficiency. Therefore can be established that maize farmers in the study area are not only inefficient in the management of inputs used but scale inefficient as found in table 4.9 of this study.

Hypothesis Testing: maize farmers are not technically efficient

The null hypothesis (H_o) i which stated that the maize farmers are not technically efficient in the study area was tested using the result of multiple regression analysis. When the estimated value of efficiency of each production resource inputs used is (100%), the production resource inputs (seed, fertilizer, labour, herbicide and farm size) are said to be efficiently utilized and thus, the null-hypothesis will be rejected or otherwise, the null-hypothesis will be accepted.

From this result in Table 4.10 and 4.11, it implies that, the production resource inputs are said to be inefficiently utilized as majority representing 68.16%) of the maize farmers are not technically efficient. The null-hypothesis (H_o) of maize farmers in the study area are being technically not efficient is therefore accepted Otherwise, the alternate-hypothesis (H_1) is there by rejected.

Technical efficiency effects on maize production

The estimated parameters and related statistical result obtained from the analysis is presented in Table 4.12. The gamma-value of 0.50 implies that 50% of the variances in production output among the maize farms are due to differences in overall technical efficiency or degree of inefficiency. The coefficient denotes the variation or possible change in aggregate output of maize crop as a result of a unit change in the input. The signs of the entire coefficients except fertilizer are positive and almost all coefficients are statistically significant at different levels of probability except herbicide (non-significant). The significant coefficients are seed, fertilizer, labour and farm size.

The coefficient of seed input was observed to be positive and statistically significant at 1% level of probability. This implies direct relationship between seed and maize output and seed is an important component of farm input that if underutilized or over utilized could affect total output of farmers. This agrees with Okoruwa and Ogundele (2006), who examined technical efficiency differentials in crop production in Nigeria. They reported that the coefficient of seed was positive and statistically significant for traditional technology and that an increase in seed input would increase output levels of crop farmers. The coefficient of fertilizer was negative and statistically significant at 10% levels of probability. This implies that increase in the use of fertilizer would lead to increase in output levels of maize farmers. This finding agrees with the result obtained by Rahman and Umar (2009), in their work measurement of technical efficiency and its determinants in crop production in Lafia local government area of Nasarawa state, Nigeria who found that the coefficient of fertilizer were statistically significant. This coefficient denotes the variation or possible change in aggregate output of crops as a result of a unit change in the input.

The coefficient of labour was positive and statistically significant at 5% levels of probability. This implies that increase in the use of labour would lead to increase in output level of maize farmers. This finding agrees with the other studies such as Muhammad-Lawal *et al.* (2009) and Amaza and Maurice (2005) who obtained similar result.

The coefficient of farm size was positive and statistically significant at 1% levels of probability. This implies that increase in farm size would result to increase in output level in maize production in the study area. This result agrees with the finding of

Muhammad-Lawa *et al.* (2009), worked on technical efficiency of youth participation in agricultural programme in Ondo State, Nigeria. They reported that the coefficient of farm size was positive and statistically significant for traditional technology and that an increase in farm size would increase output level of farmers. Also agrees with result obtained by Rahman and Umar (2009) in their work measurement of technical efficiency and its determinants in crop production in Lafia local government area of Nasarawa state, Nigeria who found that the coefficient of farm size were positive and statistically significant. This coefficient denotes the variation or possible change in aggregate output of crops as a result of a unit change in the input.

Table 4.12: Estimated regression Result showing technical efficiency effects on maize production

Variables	**Coefficient**	**Standard Deviation**	**t-ratio**	**Sign**
Constant	8.423	0.576	14.616	+
Seed	0.282	0.093	3.024***	+
Fertilizer	-0.324	0.172	-1.864*	-
Labour	0.384	0.169	2.265**	+
Herbicides	0.002	0.014	0.172 **NS**	**+**
Farm size	0.528	0.105	4.998***	+
Sigma square	**0.29**			
Gamma	**0.50**			

***P<0.01
**P<0.05
*P<0.10

4.3.3 Determinants of technical efficiency of maize production

The result of the multiple regression estimates (OLS) was used for the determinants of technical efficiency of maize farmers in the study area as presented in Table 4.13. The adjusted R square of 0.58; implies that 58% variation in the technical efficiency of maize farmers in the study area is explained by the explanatory variables (age, education, family size, farming experience, cooperative membership, access to credit and extension contact) specified in the model. The F-value of 7.492 is statistically significant at 1% probability level and this indicates the joint significance of the specified variables on the technical efficiency of maize farmers in the study area. This suggests that the model has a good explanatory power on the variation in the technical efficiency of maize farmers. The determinant that had significant influence on technical efficiency of maize farmers in the study area were age, education, extension contact and farming experience and have the expected sings that corresponds to apriori expectations and important factors in enhancing agricultural productivity, while family size, cooperative membership, access to credit were not statistically significant.

The coefficient of age (0.005) was directly related to technical efficiency. The coefficient of age was positive and statistically significant at 10% probability level influencing the technical efficiency of maize farmers. This implies that holding other factors constant, a unit increase in the age of maize producers will increase their technical efficiency by magnitude of 10%. this result disagrees with Begun *et al.* (2009) who found out that age was not a significant determinant of technical efficiency but agrees with the study of Ajibefun and Abdulkadir (2004) who worked on the impact of farm size operation on resource use efficiency in small scale farming in south-west Nigeria. They reported that age of farmers increased farm productivity and decrease technical inefficiency effects.

The coefficient of Education was found to have a positive relationship with the technical efficiency of the maize farmers and was statistically significant at 10% probability level. It conforms to *apriori* expectation. The estimated coefficient of 0.012

implies that the technical efficiency of the maize producers will increase by a magnitude of 24% as their level of education increases by one unit *ceteris paribus*. A plausible explanation for this is that higher educational level leads to higher rate of improved technology and techniques of production adoption. Onumah and Acquah (2010), noted that formal education that enlightens farmers about the technical aspect of production is important in enhancing productivity and efficiency. Hence, education is a very important policy tool that can be employed to enhance the technical efficiency of maize production in the study area.

The coefficients of years of farming experience were positive and statistically significant at 5% probability level. This implies that farmers with more years of experience tend to be more efficient in maize production. This agrees with Adeoti (2002), who reported that years of experience reduce farmers' inefficiency. The coefficient of cooperative membership is negative and statistically not significant. This relationship signifies that as the years of cooperative membership increases, farmer's technical efficiency reduces.

The coefficient of household size is negative and statistically not significant. The negative relationship signifies that as the household size increases, farmers technical efficiency reduces. This agrees with Okike (2000), who reported that family size have negative influence on farmers productivity. In a situation where the family size is large and only a small proportion of farm labour is derived from it, then the inefficiency effect are expected to be greater.

The coefficient of extension contact had the expected positive relationship with the technical efficiency of maize farmers and statistically significant at 5% level of probability. This implies that holding other factors constant, a unit increase in extension contact of maize producers will increase their technical efficiency by a magnitude of 16%. This finding is in line with the study of Ajani and Olayemi (2001), who observed that extension contact enhance farm productivity and efficiency in a study of resource productivity in food crop farming in Northern area of Oyo State, Nigeria.

The coefficient of credit access had the negative relationship with the technical efficiency of maize farmers and was significant at 5% probability level. The estimated coefficient of 0.073 implies that the technical efficiency of the maize farmers will decrease by a magnitude of 0.073 as the amount of credit obtained increases by one unit. This result disagrees with that of Adewuyi *et al*. (2013), who reported that access to credit was significant in influencing the technical efficiency of maize farmers in a study on production efficiency of credit and non-credit users of poultry in Ogun State, Nigeria.

Table 4.13: Regression estimates of determinant factors influencing technical efficiency of maize production

Variable	Coefficient	Stand. Error	t-value	Sign
Constant	6.130	0.982	6.246***	+
Age	0.005	0.003	1.667*	+
Education	0.012	0.007	1.714*	+
Household size	-0.004	0.003	-1.474	-
Farming experience	0.004	0.002	2.119**	+
Cooperative membership	-0.002	0.003	-0.621	-
Extension contact	0.008	0.004	2.000**	+
Access to Credit	-0.073	0.053	-1.376	-
R-Square	**0.62**			
Adjusted R-Square	**0.58**			
F-value	**7.492*****			

***P<0.0, **P<0.05, *P<0.10 **n = 179**

4.4 Profitability of Maize Production

4.4.1 Cost of maize production

Maize seed used by the farmers in the study area were mostly local variety seeds obtained from the last harvest. Table 4.14 shows that the quantity of maize seed was 24.15kg/ha with an average market price of ₦35 per kg which constitutes 1.29% of the total cost of production. The quantity of fertilizer used was 452.70kg/ha with an average market price of ₦100 per kg constituting 69.25% of the total cost of production. Labour costs consisted of cost of land preparation, planting, fertilizer applications, weeding, herbicide application and harvesting. Family labour was computed on the basis of opportunity cost in man-days. The wage rate varied from ₦400 - ₦800 according to the farm operation performed per man-day was used giving an average labour cost per hectare to be ₦15900 constituting 24.30% of the total cost of production. The quantity of herbicide was 3.35liters/ha with an average market price of ₦1000 per litre which constitutes 5.10% of the total cost of production. While the total cost of fixed inputs in maize production was ₦1250 and this constitute 1.91% of the total cost.

4.4.2 Revenue in maize production

Result from Table 4.15 shows that the total revenue (TR) was ₦132,595/ ha while the total cost (TVC + TFC) was ₦66,615.25/ ha. The net farm income was therefore ₦65,979.75/ ha the average rate of return on investment (return per naira invested) was ₦1.99, indicating that for every ₦1 invested in maize production in Doguwa local government area of Kano state, a profit of ₦0.99 kobo was made. Thus, it could be concluded that maize production in the area was economically viable.

Table 4.14: Average cost and return per hectare of maize production

Variables	Unit price (₦)	Quantity (kg/ha)	Values (₦) /ha	% Total Cost
Variable Costs:				
seed (kg)	35	24.15	845 .25	01.14
fertilizer (kg)	100	452.70	45270	69.25
Herbicide (litres)	1000	335.00	3350	05.10
labour (man-days)				
land preparation	800	3.00	2400	03.67
planting	400	2.00	800	01.22
fertilizer application	400	2.00	800	01.22
weeding	800	12.00	9600	14.68
herbicide application	400	2.00	800	01.22
harvesting	500	3.00	1500	02.29
Total variable cost			**65,365.25**	
Fixed Costs:				
Depreciation of tools			1250	01.91
Total fixed cost			**1250**	**01.91**
Total cost			**66,615.25**	**100**
Total Revenue			**132,595**	
Net Farm Income(NFI)			6**5,979.75**	
Return per Naira Invested			**1.99**	

Hypothesis Testing: maize production is not profitable

The null hypothesis (H_o) which stated that maize production is not profitable in the study area was tested using t-test statistics and the result is presented in Table 4.15. It can be seen from the result that the average cost was ₦251,335.33 and average return was ₦541,630.45. Calculated t-value was 6.491 which exceeds the critical value (t-critical two-tail) of 1.97. Because the calculated t-statistics value is greater than the t-critical value (6.49 > 1.97), therefore H_o is rejected at 1% level of significance and the alternative hypothesis (Hi) is accepted. This result of the analysis indicates that maize production is profitable in the study area.

Table 4.15: The result of t-test: showing significant differences between costs and revenue in maize production

Variable	**Costs**	**Revenue**
Mean	251,335.33	541,630.45
Variance	1.41	8.853
Observations	179	179
Pearson Correlation	0.95	
Hypothesized Mean Difference	0	
Df	178	
t Stat	-6.49	
P(T<=t) one-tail	4.10	
t Critical one-tail	1.65	
P(T<=t) two-tail	8.19	
t Critical two-tail	1.97***	

***P<0.01
**P<0.05
*P<0.10

4.5 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 4.16). High cost of inputs like fertilizer, improved seeds and labour was the most severe constraint in maize production with about 34% of maize farmers attesting to this fact. The coping strategy adopted were purchase of fertilizer at least cost off-season, recycling of seeds obtained from previous production season and predominant family labour use which are not reliable and can reduce maize productivity. The demand for labour is normally very high and expensive during the peak period of land clearing, ridging, weeding and harvesting. Ugbajah and Uzuegbuna (2012), opined that labour shortage was responsible for causative factors of decline in production in Ezeagu Local Government Area of Enugu State. This finding is also in line with Ekong (2003), who opined that most farmers have little or no access to improved seeds and continue to recycle seeds obtained from previous harvest.

About 27.90% of the maize farmers reported that low price of output was serious constraint faced by farmers and sometime result to loss in investment. The coping strategy adopted was to sell outputs off-season at the detriment of their basic needs. Farmers in the study area did not sell all the farms produce at the same time because farm produce is associated with seasonal price variation and therefore try to take advantage of periods when supply is low and the demand is high so as to get good prices, thereby maximizing profit. Again, the farmers used selling their produce to the final consumer to manage risk in marketing. Kureh *et al*. (2006), reported that, if maize prices increase relative to legumes and fertilizer prices decrease, continuous maize production can become more profitable.

Lack of asses to credit accounted for 16.20% of identified constraints 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 access credit in the area. Some copping strategies employed by the farmers ware personal savings and borrowing from friends to finance their production. Credit is a very strong factor that is needed in 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 can contributes in improving the livelihood of disadvantaged rural farming communities.

Non availability of tractor hire purchase attributes about 8.38% of constrains at moderately sever level in maize production as asserts by the farmers. The coping strategy employed by the farmers was Use of available animal tractions. The availability of modern machineries not only reduces drudge farm operations but also contributes to increase in farm size cultivated and thereby increase productivity or output. About 5.57%, 4.50% and 3.35% of drought, pest and diseases, and bad road network to farm respectively, were among maize production constrains imposed to attainment of high productivity by farmers. In line with these, crop is susceptible to attack by numerous insects and diseases throughout the life cycle and the effective control of these is inevitable if reasonable yield is expected, this were responsible for pre-harvest and post-harvest losses which automatically represent a serious decline in quality and substantial reduction in product price.

Table 4.16: Constraints faced by maize producing farmers

Constraining factors	**Frequency**	**Percentage**	**Rank**	**Coping strategy**
High cost of inputs	61	34.10	5	Purchase of fertilizer at least cost off season, recycling of seeds and predominant family labour use.
Low output price	50	27.90	5	Selling outputs off -seasons is prepared.
Lack of access to credit	29	16.20	4	Personal savings and borrowing from friends.
Non availability of tractor hire implement	15	8.38	3	Use of animal tractions.
Drought	10	5.57	2	Late planting.
Pest and diseases	8	4.50	1	Use of chemicals.
Lack of access road network.	6	3.35	1	Local provision of road Linkage.
Total	**179**	**100**		

Ranking according to severity: 1=least severe, 2=moderately severe, 3=severe, 4=more severe and 5=most severe

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

The broad objective of this study was to analyze the productivity among maize farmers in Doguwa Local Government Area, Kano State, Nigeria during 2014 production season. A multi-stage sampling technique was employed which follows random election of 179 maize farmers for the study. Primary data was used, the information collected is on a single visit with the aid of structured questionnaire and analyzed using descriptive statistics, Data Envelopment Analysis (DEA) model, multiple regression estimates, net farm income and profit function model. The results of the socio-economic analysis shows that 36.9% of the maize farmers in the study area fall within the active age group of 40-49 years with an average mean of 42 years, 73.7% of the farmers had one form of formal education or the other. 61.5% household size ranged from 11-20 persons with mean of 15 persons. 37.9% of farmers had 11-20 years of maize farming experience. Majority (65%) of the farmers was not members of any cooperative society, 85.5% of maize farmers had no access to credits and 62.6% had access to extension services. The summary statistics of variables revealed that the output per hectare of maize was 3788 kg/ ha (3.8 ton/ ha). The mean farm size was 4.06 ha. The input used varies from one farmer to another depending on the efficient utilization and the management practices.

Results from the DEA shows that mean scale efficiency observed was 0.55 representing 55%. Out of the 179 maize farms (DMU's) studied; 147 maize farms representing majority (82.12%) were found operating at IRS and therefore, operated at stage I of production process, 18 maize farms representing 10.6% exhibited DRS, and hence, operated at stage III of production process whereas only 14 maize farms representing 7.82% exhibited CRS and operated at stage II of production process which is productive stage and were scale efficient. Generally, 92.18% of the maize farms were operating under IRS and DRS; it suggests that maize farmers in the study area were scale inefficient in terms of inputs used, since size inefficiency is usually due to the presence of either IRS or DRS.

The results of technical efficiency estimates from DEA using CRSTE and VRSTE specifications revealed that; technical efficiency of the maize farms ranged from 18% to 100% with a mean efficiency scores of 62% and 47% respectably. The implication of this result is that, and only few (31.84% and 22.35%) of the sampled maize farms reached near frontier threshold and majority (68.16% and 77.66%) of the maize farms are not technically efficient in the use of production resource inputs in underlying both specifications. In other words, technical efficiency among the maize farmers can be increased by 38% and 53% through better use of their available production resources, given the current state of technology to obtain maximal maize productivity. The mean technical efficiencies in the models indicate that there is substantial inefficiency of the maize farmers in the study area due to inability to reach a frontier threshold of 100%. As observed from this study, these results are consistence with the theory that, the CRS frontier is more flexible and envelop the data in a tighter way than the VRS frontier and the differences between efficiency scores indicates difference scale inefficiency.

The estimated parameters and related statistical result obtained from the finding revealed that the gamma-value of 0.58 implies that 58% of the variances in production output among the maize farms are due to differences in overall technical efficiency or degree of inefficiency. The coefficient denotes the variation or possible change in aggregate output of maize crop as a result of a unit change in the input. The signs of the entire coefficients except fertilizer are positive and almost all coefficients are statistically significant at different levels of probability except herbicide (non-significant). The significant coefficients are seed, fertilizer, labour and farm size. Result also shows that age, education, extension contact and farming experience are positive and significant at different probability levels. The aggregate variables that are positive and statistically significant were the key determinants responsible for the variation in technical efficiency of the maize producers in the study area. While household size, cooperative membership and access to credit were not statistically significant, implies that the inefficiency effects make significant contribution to the technical inefficiencies of maize farmers.

The average costs incurred and revenue obtained per hectare for maize production were estimated to determine the profitability or otherwise of maize production in the study area. The total revenue was ₦132,595 while the total cost was ₦65,365.25. The net farm income was therefore ₦65,979.75. The average rate of return on investment (return per naira invested) is ₦1.99, indicating that for every ₦1 invested in maize production, a profit of ₦0.99 kobo was made.

Finally, the constraints associated with maize production are high cost of inputs, low market price, lack of access to capital been major problems militating chances of increasing production to achieve sustainable maize productivity. Also non-availability of hired implement, drought, pest and diseases and lack of access road to farms are identified among constraints of maize farming in the study are.

5.2 Conclusion

Findings in this study concluded that maize production in the study area is profitable venture. Generally, majority of the maize farms were operating under stage I and stage III of production process, which suggests that maize farmers in the study area were scale inefficient in terms of inputs used, since size inefficiency is usually due to the presence of either IRS or DRS. The results of the study also revealed that, the mean technical efficiencies in the models (CRTSTE and VRSTE) indicates that there is substantial inefficiency among maize farmers in the study area due to inability to reach a frontier threshold of 100%. Age, education, extension contact and farming experience have positive and significant and were key determinants responsible for the variation in technical efficiency among maize producers in the study area. This means that there are still opportunities to increase maize productivity and income through more efficient utilization of productive resources, were a proportionate increase in inputs will lead to a proportionate increase in output level, given the current state of technology.

5.3 Recommendations

In light of the findings of this study, the following recommendations are made:

i. Majority (92.18%) of the maize farms were operating under stage I and stage III of production process, which suggests that they were scale inefficient in terms of inputs used. It is recommended that for farmers to attain maximum output, they most shifts to a production stage were a proportionate increase in inputs will lead to a proportionate increase in output of maize productivity level.

ii. Maize production in the study area is profitable; positive returns to the venture could serve as incentives for agricultural households to increase their present level of maize supply in an effort to bridge the encroaching gap between production and consumption policies. It is recommended that, maize production should be a pivotal component in government programs geared toward empowerment especially the teaming unemployed youths in Nigerian.

iii. The mean technical efficiency of 62% implies that the inefficiency effects make significant contribution to the technical inefficiencies of maize farmers. An inefficient farm is wasting resources because it does not produce the maximum attainable output or revenue from the given quantity of inputs. Technical efficiency among the maize farmers can be increased by 38% through better use of their available production resources, the factors responsible for variation in productivity need to be revisited by farmers as there is still chance for farmers to improve production so as to reach the frontier threshold.

iv. Since extension contacts, level of education and farming experience were significant determinants of technical efficiency, immediate effort should be made by maize farmers to form or join cooperative societies, so as to be able to benefit from economy of bulk purchase of input supply, farm advisory services, increased access to micro-credit, and access to modern farming techniques. These are essential indicators for the success in productivity and farming efficiency.

v. Fertilizer and labour are one of the inputs that constitute high cost of production; these are consequently significant factor in influencing maize production in the study area. Government and stakeholders should assist farmers beyond timely and adequate input supply, by creating effective services and enabling environment, for efficient utilization of agricultural inputs on farms, which will lead to prospect in improving the productivity of farmers and can contributes in improving the livelihood of disadvantaged rural farming communities.

vi. Based on the finding, the maize output price was very low as at the time of this research, there is the need for the government at federal, state and local levels to improve on better marketing system to be more robust to international linkages among farming community were by actors will find a place for investment thereby increase productivity level and livelihood standard of farmers.

5.4 Contribution of the Study to Knowledge

i. The study indicates that 92.18% of the maize farms were scale inefficient and operated at stage I and III of production processes. In long-run, maize farmers must shifts to a production stage were a proportionate increase in inputs will lead to proportionate increase in maize output level and cutting cost on input supplies.

ii. The study revealed that maize production in the study area is profitable with net farm income of ₦65,365.75/ ha and for every ₦1 invested, return of ₦0.99 kobo is realised despite constrains identified, maize production is viable for income generation, job creation and poverty alleviation.

iii. Finding revealed that maize farms were technically inefficient in the study area having an overall technical inefficiency of 68.16%. The maximum possible levels attainable are due to low efficiency of various inputs used and hence results to low productivity.

iv. The determinant that had significant influence on technical efficiency of maize farmers in the study area were age, education, extension contact and farming experience and are important factors for enhancing maize productivity.

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APPENDIX

DEPARTMENT OF AGRICULTURAL ECONOMICS AND RURAL SOCIOLOGY, FACULTY OF AGRICULTURE, AHMADU BELLO UNIVERSITY, ZARIA

<u>RESEARCH QUESTIONNAIRE FOR RESPONDENTS</u>

Dear Respondent,

I am a post graduate student (M.sc) of the aforementioned department carrying out a research on the topic**; ANALYSIS OF FARM SIZE AND PRODUCTIVITY AMONG MAIZE FARMERS IN DOGUWA LOCAL GOVERNMENT AREA OF KANO STATE, NIGERIA.** Please kindly answer the following questions to the best of your knowledge. Information provided will be treated confidentially.

Instruction: Kindly tick (√) or fill in the blank spaces as appropriate.

Village/Community………………………L.G.A………………......................................

SECTION A: SOCIO–ECONOMIC CHARATERISTICS

1. Name of farmer……………………………………………………………………….
2. Sex: Male ( ) Female ( )

3. Age (years)……………………………………………………………………………

4. Marital status: Married ( ) Single ( )

5. Highest level of Education: (a) No Formal Education ( ) (b) Primary school Education ( ) (c) Secondary School Education ( ) (d) Tertiary Education ( )

6. Family Size (All the number of people depending on you for living)…………………

(a) No of Adult Male ( ) (b) No of Adult female ( ) (c) Children >15yrs ( ) (d) Children <15yrs ( )

7. What is your Major occupation? ....
(a) Farming ( ) (b) Business ( ) (c) Civil servant ( ) (d) Student ( )
8. What are five most important crops cultivated? (Tick appropriate): a. Maize ( ) b. Sorghum ( ) (c) millet ( ) (d) rice ( ) (e) cowpea ( ) (f) groundnut ( ) (g) soybeans ( ) (h) pepper ( ) (i) sweet potato ( )
9. How long have you been in maize farming? (Years of experience)…………………

10. Do you belong to any co-operative/Association? Yes ( ) No ( )

11. If yes, (Years of participation)…………………………………………………………..

12. What benefit did you derive as a member? ....

13. What is your major source of capital for maize farming? ....

14. If you borrow, what were the sources of the credit and the amount borrowed? (Use the table below):

SOURCE OF LOAN (**Tick as appropriate**)	AMOUNT (₦)	INTERST RATE (%)
Commercial Bank		
Nigeria agricultural Cooperative And Rural Development Bank		
Cooperative Societies		
Money Lenders		
Friends And Family		
Others (Specify)		

15. Have you been visited by an extension agent in the last one year? Yes ( ) No ( )

16. If Yes, How many times in last one year? ....

17. Did you visit an extension agent last year? Yes ( ) No ( )

18. If Yes, How many times in last one year did you visit an extension agent? ....

19. What activities did the agent teach you and of what benefit mean to you? (Use the table below):

Activities/Technology	Benefit (see code below the table)
Fertilizer application	
Intercropping	
Plant Spacing	
Pest Control	

CODE: a. not beneficial b. somehow beneficial c. beneficial d. very beneficial

20. Have you been trained on maize farming? Yes ( ) No ( )

21. If yes; what activities, which organization conducted the training and what benefit did you derived from the training? (Use the table below and indicate appropriately):

Activities/Technology	Organization	Benefit (see code below the table)
Fertilizer application		
Intercropping		
Plant Spacing		
Pest Control		

CODE: a. not beneficial b. somehow beneficial c. beneficial d. very beneficial

SECTION B: INFORMATION ON INPUTS USED IN PRODUCTION

a. Farm size (Ha)

22. What was the total farm size do you have? ....

23. How many plot of land is allocated to sole maize production………………………..

No. of Plots cultivated	Size (ha)	Mode of Acquisition (use the code below)
1		
2		
3		
4		

CODE: (a) Inheritance (b) Lease (c) Borrowed (d) Gift (e) Purchased

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

b. Variable inputs (Last production Cycle)

25. Seed of maize crop

Plot No	Quantity of Seed (Kg)	Variety Type		Cost (₦)/Unit	Total Cost (₦)
		Hybrid	Local		
1					
2					
3					
4					

26. Fertilizer applied to maize crop

Plot No	Fertilizer type		Quantity (Kg)	Cost (₦)
	Organic	Inorganic		
1				
2				
3				
4				

27. Agrochemical applied to maize crop

Plot No	Agrochemical type	Quantity (Liter)	Cost (₦)
1			
2			
3			
4			

28. Labour input on maize crop;

(a) Land preparation

Plot No.	Hired Labour			Family Labour		
	No. of people	No of Hours (man day)	Cost (₦)	No. of people	No of Hours (man day)	Cost (₦)
1						
2						
3						
4						

(b) Planting of maize

Plot No.	Hired Labour			Family Labour		
	No. of people	No of Hours (man day)	Cost (₦)	No. of people	No of Hours (man day)	Cost (₦)
1						
2						
3						
4						

(c) Fertilizer Application

Plot No.	Hired Labour			Family Labour		
	No. of people	No of Hours (man day)	Cost (₦)	No. of people	No of Hours (man day)	Cost (₦)
1						
2						
3						
4						

(d) First Weeding

Plot No.	Hired Labour			Family Labour		
	No. of people	No of Hours (man day)	Cost (₦)	No. of people	No of Hours (man day)	Cost(₦)
1						
2						
3						
4						

(e) Second Weeding

Plot No.	Hired Labour			Family Labour		
	No. of people	No of Hours (man day)	Cost (₦)	No. of people	No of Hours (man day)	Cost (₦)
1						
2						
3						
4						

(f) Harvesting

Plot No	Hired Labour			Family Labour		
	No of people	No of Hours	Cost (₦)	No of people	No of Hours	Cost (₦)
1						
2						
3						
4						

(g) Post harvest activities cost

Activities	Quantity/kg	Price/Unit (₦)	Total Cost (₦)
Threshing			
Transportation			
Packaging materials			
Chemicals			

SECTION C: INFORMATION ON OUTPUT

29. Output of maize (Kg)

Plot No	Quantity harvested (Kg)	Total Qty sold	Price/Unit	Total revenue (TR)	Total cost (TC)	Profit (TR-TC)
1						
2						
3						
4						
TOTAL						

Unit = kg, bags, muds, tiya.

30. Where do you sell your produce?

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

31. To whom did you sell your produce?

(a) Assemblers ( ) (b) Wholesalers ( ) (c) Retailers ( ) (d) Consumers ( )

32. When do you sell your produce?

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

SECTION D: DEPRICIATION

33. Depreciation

S/No.	Type of tools	Years of purchase	Purchase price(₦)	Years of utilization	Resale value(₦)

SECTION E: CONSTRAINS OF MAIZE PRODUCTION

34**.** Constraints faced by maize farmers and coping strategy in the study area.

S/No.	Constraints faced by maize farmers in the study area.	Ranking according to severity: 1= least severe 2=moderately severe 3= severe 4= more severe 5= most severe.	Coping Strategy
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Thanks for your co-operation