COMPARATIVE ECONOMIC ANALYSIS OF HYBRID AND OPEN POLLINATED MAIZE PRODUCTION IN GIWA LOCAL GOVERNMENT AREA OF KADUNA STATE OF NIGERIA

BY

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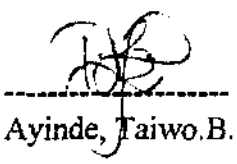
A Thesis submitted to the Post- Graduate School, Ahmadu Bello University, Zaria in partial fulfilment of the requirements for the Degree of Master of Science (Agricultural Economics).

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DECLARATION

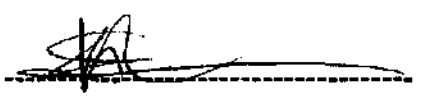
I hereby declare that this thesis was written by me and that it is a record of my own research work. It has not been presented in application/requirement for the award of a higher degree. References made to previous works were duly acknowledged.



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Date 14/3/11

CERTIFICATION

This thesis entitled "Comparative Economic Analysis of Hybrid and Open-pollinated Maize Production in Giwa Local Government Area of Kaduna State" by Ayinde, Taiwo Bintu meets the regulations governing the award of the Degree of Master of Science of Ahmadu Bello University, Zaria, and is approved for its contribution knowledge.

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DEDICATION

This thesis is dedicated to the memory of my Dad and Son.

And

"My Family" for making this thesis worthwhile

ABSTRACT

The aim of this study was to conduct a comparative study, on the productivity of hybrid and open-pollinated maize, of farmers in Giwa Local Government Area (LGA) of Kaduna state. Precisely, using structured questionnaire through purposive and random sampling, it evaluated current hybrid and open-pollinated maize production technologies by; describing the farmers' major socio-economic characteristics and most importantly identifying the economic difference between hybrid and open-pollinated maize, using the farm survey data collected from 160 maize farmers in October- December 2009 for the cropping year 2009-10. The cob-douglas production function model was best and the numbers of significant variables were four for hybrid maize production namely farm-size (land); seeds; labour and fertilizer. Open-pollinated maize production on the other hand, also has four significance variables namely farm size (land); labour, fertilizer and insecticides. Z-test was used to test the profitability of hybrid maize versus open-pollinated maize and the result revealed that hybrid maize production was more profitable and the difference was statistically significant at 1% level of significance.

The result of analysis of resource use efficiency of hybrid and open-pollinated maize shows that the ratios were not equal to one. The ratio indicates that sampled farmers underutilized fertilizer and insecticides. The efficiency ratio for seeds, labour and herbicides were less than one showing that the sampled farmers over-utilized seeds, labour and herbicides on the farms. This study recommends that credit facility particularly the procedure for loan should be made simple to improve hybrid and open-pollinated maize production in the study area.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 BACKGROUND OF STUDY

Maize belongs to the grass family plants and its botanical name is (*Zea mays* spp. mays), also known as corn, and is a cereal grain that was domesticated in Mesoamerica (Anonymous 2009). It spreads to the rest of the world after European contact with the Americas in the 15th and 16th centuries. It is grown throughout the tropics as well as in temperate region. Portuguese introduced maize to West Africa in the 16th Century (Onwueme, 1979). Maize is a strong, annual grass, usually producing one stem and growing to 1.5-3 m in height. Older varieties of the crop mature after 100-120 days, but more rapidly maturing varieties are now available which can mature at 45-50 days (David and Adams, 1985).

Maize will grow within the temperature range of 10 – 40°C, but the optimum temperature being around 30°C. It requires a great deal of sunshine, low level of humidity; otherwise it is prone to disease and inadequate pollination. Since its root system is shallow, maize has little resistance to drought and if the water supply is inadequate during the development of the tassels, the crop will be seriously affected (Susan and Anne, 1988).

Maize is becoming the miracle seed for Nigeria's agricultural and economic development (Ademola and Akinwumi, 1993); and has determined the cropping pattern of predominantly peasant farmers especially in the Northern States (Fajemisin, 1985; Ahmed, 1996). The traditional area of maize cultivation in Nigeria has been the south of latitude 8°N where it can be grown twice a year. However, it is recognized that the higher solar radiation received in

the northern part of the country where it has not been traditionally grown as a popular crop has led to the increasingly importance and expansion of maize production in this zone. (Ologunde, 1987). Since the potential for its production is greatest in the savannah zones of northern Nigeria, it has begun to attract the attention it deserves from farmers and researchers in the Guinea savannah zones (Alamu, 2001). These statement, collaborated with the result of Kogbe and Adediran, (2003) who, reported that the yield of maize differs from location to location, stating that, the yield of maize (for both hybrid and open-pollinated maize), are higher in the southern guinea savanna zones, than in the derived savanna zones of Nigeria. In Nigeria, many researchers have found improved production technology to be a major factor in effort to become self-sufficient in maize production (Iken and Amusa, 2004).

Recently, hybrid maize production has been given extensive promotion among farmers in Nigeria. Conversely, hybrid maize is famous for its high requirement for plant nutrients and other production inputs (Kogbe and Adediran, 2003). Although, it is widely grown in many countries of the world; generally farmers have been trained with the principle that every clause, vital for utmost performance of hybrid maize, have to be satisfied to maximum capacity, prior to attainment of optimal income. Consequently, additional production cost discourages most farmers engaging in hybrid maize production, (Kogbe and Adediran, 2003). They further added that the yield of hybrid maize, differ from species to species, place to place and besides, it relies on the availability of crucial factors such as soil nutrient status and application of fertilizer. But nearly all farmers in developing countries, like Nigeria usually depend on the natural soil fertility for crop production. Opening of a long fallow land, may grant sufficient nutrient to hybrid maize, but cropping of such land is only flourishing within few years of opening the fallowed land. The subsequent cropping season, needs supplementary fertilizer inputs (Kogbe and Adediran, 2003).

Production of hybrid maize simply put is the result of crossing two different breeding lines. They represent the first generation originating from the cross (F1). They differ from pure line varieties and open-pollinated varieties in that the seed they produce will not be saved and replanted but the parental lines have to be crossed each time to produce new seed. Hybrid maize was demonstrated in the early 20th century (Shull and East, 1910). After crossbred corn was invented by Beal, (1877). His work led to demonstrating hybrid vigour in corn. Various pioneers on plant breeding showed that hybrid maize out- yielded open-pollinated maize of that era, although it was not economically cultivated on large scale by farmers. Plant breeders later improved on the maize to produce a double–crossed breed after which a commercial breed in a single step (hybrid maize) was finally produced and sold commercially. These breed are known to be early flowery, drought resistant, more vigorous and uniform, traits not found in the existing open-pollinated breed (Duvick, 1999)). This process is achieved through detasseling (Anonymous, 2009) which is the act of removing the pollen–producing tassel from a corn plant and placing it on the ground.

Rusell, (1974) made severe effort to separate, the effect of proper management of farm operations, from the use of better genetic strains (i.e the use of hybrid maize). With hybrid seed conserved from 1930 to 1970 and growing the hybrid and open-pollinated maize under the similar environment, he found a homogeneous boost in yield from the newer strains (hybrid maize), as against the heterogeneous nature of open-pollinated maize variety. He concluded that 60% or more of the improved performance was genetic. Similar result was also reported by (Duvick, 1977; Crow (1998).

The importance of maize as both food and cash crop has necessitated the need for this study, which is to conduct a comparative study, on the productivity of hybrid and open-pollinated maize, of farmers in Giwa LGA of Kaduna state. Precisely, it will evaluate current hybrid and

open-pollinated maize production technologies by; describing their major socio-economic characteristics, and most importantly identifying the economic difference between hybrid and open-pollinated maize production.

1.2 PROBLEM STATEMENT.

According to Food and Agricultural Organisation, (FAO, 2010 data), the area planted to maize in West and Central Africa alone increased from 3.2 million hectare (mha) in 1961 to 8.9mha in 2005. This phenomenal expansion of the land area devoted to maize resulted in increased production from 2.4 million metric tonnes in 1961 to 10.6 million metric tonnes in 2005. While the average yield of maize in developed countries can reach up to 8.6 tonnes per hectare, production per hectare is still very low (1.3 tonnes per hectare).

In Nigeria, land area under maize cultivation peaked at 5.4mha in 1994; it has decreased lately to 4.5mha in 2004 Federal Ministry of Agriculture (FMA, 2005). Likely factors responsible for the decrease in the production of maize are because of little or no improved seed grown by farmers and low response to fertilizer by some local varieties (Ajala, 2005). Other possible factors are increased levels of biotic and abiotic constraints and inflation (Ajala, 2005). Global warming and its associated factors have also changed the pattern of rainfall resulting in unpredictable rainfall which eventually gave rise to drought, with its attendant reduction of farmers' interest in maize production (Iken and Amusa, 2004). Smallholders using simple technology dominate farming systems in Nigeria. For Nigeria to be self-sufficient in maize production, hybrid maize has been proposed by researchers, as a better alternative to the local varieties because it is considered to be high yielding, for there is much more potential to be realized for farmers in the region, potential that can raise farm families from below subsistence to annual surplus (IITA,2010). That will give them the option to sell surpluses to the rapidly growing urban markets or to devote some of their land

to other crops, in particular crops which contribute to restoring soil fertility and enhancing incomes (IITA, 2009). In either case, the farmer's overall risk is lessened and life and livelihoods improved. Maize can become a highly profitable cash crop provided a remunerative production price regime prevails (IITA, 2010). But despite the high yields obtainable from improved production technology, the national average grain yield of maize has consistently fallen short of the potential yields (Alamu, 2001). But the small holders have not fully noted the significance of improved farming practices (Olalere, 1991). The need to increase maize production and the recognition of the importance of survival of small-scale maize farmers, led to the introduction of hybrid maize (Iken and Amusa, 2004).

Hybrid maize was introduced on a limited scale in the tropics and the sub-tropical regions (mostly developing countries) in the 1960s (Duvick, 1999). Progress in utilizing hybrids was slow at first in most of these developing countries like Nigeria, with a few exceptions (Smith *et al.*, 1997). In West and Central Africa in the last two decades, there has been widespread acceptance of improved maize varieties in the savannah. This implies that maize is no longer a backyard crop grown for home consumption but for cash and food (Eckebil and Fajemisin, 1994). Additionally, the encouragement of private seed industry, as against the initial government monopoly, also accelerated the acceptance of hybrid maize (Duvick.1999)

Duvick (1999) further explained that hybrid maize is attractive, in view of the fact that it has deep-rooted security of hybrids, and although, due to inbreeding depression (ID-Reduced productivity of self-sterile plants resulting from forced self-pollination.); farmers need to procure seeds for every planting season, which ordinarily should discourage the farmers. However, paying for these seeds yearly can only be profitable, according to Duvick(1999); only if the important qualities needed by the farmers are found in the hybrid maize seed, since just being hybrids or illustrating heterosis (hybrid vigour) is not enough. He further illustrated, that the

price of the hybrid maize seed, ought to be low enough to assist, the farmer to make considerable profits from annual repeated investments in costly hybrid maize seed, when compared to the open-pollinated maize that can be recycled i.e. farmers will risk venturing into improved hybrid maize production technology only when they have some guarantee of a reasonable price, as well as a reliable market for their crop. Duvick (1999), concluded by adding that, as a rule of thumb, the first time application of hybrid maize seed, must enable the farmer receive an additional income, equal to at least three times, the added cost of procurement, of the hybrid maize seed.

Despite the introduction of hybrid maize the objective of sufficiency and security in maize production has still not been achieve, as there is still a significant drop in the output of maize. This study is an attempt to identify the economic difference between hybrid, and open-pollinated maize production of farmers in Kaduna` State with a view to providing relevant information to guide farmers, researchers and policy makers on comparative economic attributes of hybrid maize compared with open-pollinated maize. In order to do this, this study will provide answers to the following research questions:

1 What are the socio-economic characteristics of hybrid and open-pollinated maize farmers in the study area?

2. What are the inputs and output levels of hybrid and open-pollinated maize production in the study area?

3. What are the costs and returns in hybrid and open-pollinated maize production in the study area?

4. Is there any relationship between input and output in hybrid and open-pollinated maize production?

5. Are the resources efficiently utilized by hybrid and open-pollinated maize farmers in Giwa Local Government Area?

6. What are the constraints faced by hybrid and open-pollinated maize farmers in the study area?

1.3 OBJECTIVES OF THE STUDY

The broad objective of the study is to conduct a comparative economic analysis between hybrid and open-pollinated maize production in Giwa LGA of Kaduna State.

The specific objectives are to:

i. describe the socio-economic characteristics of hybrid and open-pollinated maize farmers in the study area;

ii. determine and compare the input-output levels in hybrid and open-pollinated maize production in the study area;

iii. estimate and compare the costs, returns and profitability in hybrid and open-pollinated maize production in the study area;

iv. estimate the input – output relationship in hybrid and open-pollinated maize production in the study area;

v. estimate the resource use efficiency in hybrid and open-pollinated maize in the study area;

vi. identify and compare the constraints to hybrid and open-pollinated maize production in the study area;

1.4 JUSTIFICATION OF THE STUDY

Sufficiency and security in food is of immense anxiety to everyone interested in the wellbeing of millions of people living in developing countries including Nigeria (Charlotee, 2004). Maize has huge lucrative potentials for food security (Ajayi and Onuche, 2005). It's a major source of energy for man, feed for livestock and raw material for industries (Alabi and

Alabi, 2002). In Nigeria, available information illustrates, that the entire requirement for domestic (industrial and consumption) and in some cases of adversity aid purposes stood at 10m metric tons (MAAN, 2002).

Given that, the rate of population growth in Nigeria is increasing rapidly, and in order to meet the demand of this growing population in maize consumption, there must be an increase in maize production (Iken and Amusa, 2004). The results emanating from this study ought to be, of immense importance to farmers, as it will further reveal the economic advantage inherent in the production of hybrid compared with open pollinated maize. The result of this study would also serve as a guide to researchers, who intend to carry out further research on other topics in hybrid maize and open-pollinated maize. It could also be useful to the research institutes and private seed companies that produce and market these seeds. Also, given the benefits derivable from maize, it would provide more useful information on their rate of diffusion, which would subsequently contribute greatly to supplying the government with suitable information in coming up with appropriate policies.

1.5 HYPOTHESES OF THE STUDY

The hypotheses tested in this study are:

(1) There is no significant difference in the profitability between hybrid and open-pollinated maize production in the study area.

(2) There is no significant relationship between some technical variables and output in the production of hybrid and open-pollinated maize in the study area.

CHAPTER TWO

2.0 REVIEW OF RELEVANT LITERATURE

2.1EVOLUTION AND ORIGIN OF MAIZE

Relevant literature has been reviewed based on the evolution and origin of maize, the economic importance of maize in comparison with other cereal crops, history of improved hybrid maize production technologies, constraints facing hybrid maize production in Nigeria; review of analytical technique.

Maize (Zea mays ssp. Mays) also recognized as corn or Indian corn, is a cereal crop of the Gramineae family of grasses that now constitutes the most commonly dispersed food sown in the world. Its history and domestication could be traced back some 8,000 years. Maize extends from corner to corner the span and breadth of Americas, and later to Europe, Africa, and Asia. Teosinite (Zea mexicana) has been related among the original maize in Mesoamerica and was initially harvested as early as 10,000 years back. It was obtained from specimens recovered within a cave in the neighbourhood of Oaxaca. Maize later spread rapidly into Central America and then into South America by way of the eastern slopes of the Andes approximately 4,000 years back (Anonymous, 2009).

The history of African evolution/origin of maize on the other hand, remains unclear. Scholars now argue that the Portuguese colonies of Africa served as the initial channel to the hemisphere. The domestication of maize is of kin interest to researchers, archaeologists, geneticists, ethno botanists, geographers. Latest genetic data suggests that maize domestication occurred 9,000 years ago in fundamental Mexico.

Maize cultivation has been identified with distinctive useful farming practices, extension settlement patterns, storage distribution as well as food processing technologies (Byerlee and Eicher, 1997). Also, in Africa's Emerging Maize revolution, Byerlee and Eicher in 1997 recognized that embracing maize cultivation has been the most important mechanism motivating the change of African societal, political and financial background.

2.2. ECONOMIC IMPORTANCE OF MAIZE, IN COMPARISON TO OTHER CEREAL CROPS.

The financial magnitude of every crop is capable of being judged through region put under its cultivation, and contribution to trade. Similar measure can be applied to maize to evaluate its value as cereal crop.

Area under Cultivation; Production and Utilization.

Maize is the most extensively cultivated crop of the world. It is cultivated within the tropics, sub-tropics and temperate regions. Remarkable varieties can be obtained as regards to varieties maturing as early as 85days to as late as 200days with variability in the colour of the grains (grain shade).

Considering the area under agriculture, maize is placed third in world production (380MT from 120MH) next is wheat (440MT from 240MH) then rice (420MT from 140MH). This represents 24% of the entire cereal production as compared to 27% for wheat and 25% for rice. Over seventy countries (including 15 developed and 58 developing) cultivate maize having more than 100,000ha (Anonymous, 2009). In the USA and Canada, the most important use for maize is as nourishment for livestock, forage, silage (result of fermented chopped green cornstalks) and finally grain. Where as in developing countries, it is usually used as food.

Even though there is great fraction of the green maize in the southwestern part of Nigeria, there has been an impressive swing to dry grain production in the savannah, particularly the Northern Guinea Savannah. This is considered as the maize zone of Nigeria. (Iken and Amusa, 2004). Maize is in addition largely fruitful in this region, as sunshine is sufficient and precipitation moderate. It has adaptive potential to subsidiary surroundings by optimally utilizing radiant energy with carbon dioxide in spite of its shallow source (Obi, 1991).

Although, maize was not preferred among existing grain crops like rice, wheat, oats, millet, and barley. Nonetheless, maize was chosen as it prospered in extraordinarily dripping environment incompatible for wheat or somewhat arid section unsuitable for rice cultivation. More so, maize has the bonus of swift profits as well as double the productive yield for each unit of land of wheat. The World's most lucrative and utmost yield plant resource, offered for the production of livestock fodder, forage and feed is maize (Dowswell, et al., 1999).

Contribution to trade

Maize is extensively grown all over the world, and a better output of maize is produced every year than other grain. Whereas the USA produces approximately half of the World's maize yield, other top producing countries are as follows China, Brazil, France, Indonesia and South Africa. Global production was in excess of 600 million metric tons and it is now a little more than rice or wheat. In 2004, virtually 33 million hectares of maize were planted worldwide, with a production worth of more than $23 billion (Anonymous, 2009).

In Nigeria, ease of use of tall –yielding local production has risen to meet up use for human consumption, breweries, and other industrial uses (Iken and Amusa, 2004). Maize has multitude of uses, which are processed into different product both at traditional level and at industrial scale. Nutritionally, maize has 60 to 68% starch and 7 to 15% protein. The opaque

seeded ones are superior in essential amino acid as such more nutritious. The embryo forms about 12% of the whole grain and is the source of protein, fats and sugars. Yellow maize is the richest sources of vitamin-A. Maize has more riboflavin than wheat or rice, and is rich in phosphorus and potash. Maize have 1.2 to 5.7% edible oil, amongst cereals and millet, oil is only gotten from maize. Maize oil is extensively used for catering (it has the ability to cut down cholesterol as sunflower) and for manufacturing hydrogenated oil. Maize is an input in starch, syrup (used in confectionaries), dextrose (or corn sugar), oil, gelatine, lactic acid. Corn flour is used as a thickening agent in the preparation of many edible like soups, sauces and custard powder. Corn sugar is used as sweetening agents in soft drinks and in some pharmaceutical formulations. Because of its moisture retention features, corn gel is used as a bonding agent for ice- cream cones, and as a dehydrating dustin agent for baking products. Other food gotten from maize are cornflakes, corn meal or masa used as corn bread; popcorn is the kernels of some definite varieties with the intention of exploding once heated, with fluffy appearance and are eaten as snack. Sweet corn is a hereditary deviation towards high sugar but low in starch and eaten as vegetable (Anonymous, 2009).

Forage and Feed is the next important area where maize finds extensive use as livestock feeds viz, cattle, poultry and piggery both in the form of seed and fodder. The assimilation capability of maize fodder is superior to sorghum, and other non-leguminous forage crops. Maize does not induce trouble of hydrogenic acid or prussic acid making; therefore, crops can be gathered and nourished to cattle at every phase of its development. The elevated carotene height of yellow maize is valuable in introducing yellow colour to egg yolk and yellow tinge to milk. No other concentrate is so far, identified to replace maize in this value (Anonymous, 2009).

Maize has a whole host of uses, and is positioned second to wheat amongst the World's cereal crops in terms of total production. As maize is a major cereal crop and it has been in

the diet of Nigerians for centuries. It started as a subsistence crop and has now risen to a commercial crop on which many agro-based Industries depend as source of raw material (Iken and Amusa, 2004). In addition, because of its worldwide circulation and lower prices relative to other cereals, maize has a wider scope of uses than any other cereal. Within the developing world, there are a number of countries where maize is a major staple food and the per capita human consumption reach high levels. Maize can be processed into different products for various end uses at the traditional level and on an industrial scale.

Technologically, maize based on it physical properties once the cob is ground to powder are used as fillers for explosives in the construction of plastics, glues, adhesives, reyon, resin, vinegar and artificial leather and as diluents and transporters in the formulation of insecticides and pesticides. Based on the chemical properties of maize, processed cobs can be used in the generation of furfurol, fermented sugars (ethanol), solvents, liquid fuels, charcoal gas and other chemicals by destructive distillation. In addition, maize is used in the manufacture of pulp, paper and hard boards. The water within which the maize grain is soaked for the production of glucose is utilized for budding penicillin moulds (Anonymous, 2009). Other uses of maize are for fish bait, particularly used in Europe for coarse fishing; the stigmas from female corn flowers (corn silk), are sold as herbal supplements. A remarkable use of maize is to fashion a maize maze for sightseer or decorative use in gardens.

Likewise, in several developing countries like Nigeria, a small number of business maize processing mills are functional producing brewers' grits, maize flour; maize meal. Quality factors that influence the choice and suitability of maize varieties meant for various uses including chemical, physical, biochemical, physico-chemical, organoleptic and rheological properties. Luckily, a quantity of these properties can be influenced and changed well in the course of breeding and other agronomic practices (IITA, 2009)

Maize is utilized principally:

1) as a staple foodstuff for human being

2) as food and shelters for animals

3) as raw substance for industrial uses

It is also used as seed. In industrialized countries, a larger proportion of maize is used for livestock feeding and as industrial raw material for food and non-food uses (Anonymous, 2009). On the other hand, the bulk of maize produced in developing countries is used as human food although its uses as animal feed are increasing. Grain types utilized are flint, dent, floury or intermediate endosperm texture. White and yellow coloured varieties are used. (IITA, 2009).

2.3 IMPROVED HYBRID MAIZE PRODUCTION TECHNOLOGIES

Production of hybrid maize (technically 'double-cross inbred-hybrid corn') is simply the results of superior qualities arising from the cross breeding of genetically different species of maize. It was famously demonstrated in the early 20th century (Shull and East, 1910). After which crossbred corn was invented by Beal, (1877). His work led to demonstrating hybrid vigour in corn. Various pioneers on plant breeding showed that hybrid maize out yielded open-pollinated maize of that era, although it was not economically cultivated on large scale by farmers. Plant breeders later improved on the maize to produce a double – crossed breed after which a commercial breed in a single step (hybrid maize) was finally produced and sold commercially. These breeds are known to be early flowering, drought resistant, more vigorous and uniform, traits not found in the existing open-pollinated breed (Duvick, 1999). This process is achieved through detasseling (Anonymous, 2009) which is the act of removing the pollen–producing tassel from a corn plant and placing it on the ground.

Crabb, (1947) reported a shockingly swift shift in the production of open-pollinated to hybrid maize in Iowa, in the United State. He found that hybrid maize grew from less than 10% in 1935, to well over 90%, four years later. It was the period of hybrid revolution (Griliches, 1957; Sutch, 2008). The move in other maize-belt states was also rapid, even though it was slower in other parts of the United State. Nevertheless by the 1950s, a quantifiable volume of maize throughout the United State was hybrid. The reason for this rapid acceptance particularly in the maize belt was to a large extent better yield. But how noticeable was this to the individual farmers? The evenness of hybrids was helpful for machine harvesting, and this according to Crabb, (1947) was definitely a factor. In addition, Crabb, (1947) noted that, a field of maize in which the entire plants are alike, all with a single ear and equivalent height is aesthetically lovely, and these appealed to many farmers. Hybrid maize has integrated favourable qualitative qualities derived from breeding. These integrated qualities enable hybrid maize to adapt to diverse habitats, particularly during the growing period. The practises of having foremost farmers display the robust hybrid maize plant to their neighbours was also suggested by Crabb, (1947). Yet another basis for the rapid spread perhaps, the most vital one was in the dust-bowl period, and the hybrid strains were outstandingly more resistant to drought than the open-pollinated maize then in use.

Perhaps, hybrid maize is being over rated and over published. After all, farming tradition did not ground to a halt all through this period, there has been an improved rate in the application of fertilizer, better plant density, and production inputs like herbicides, agrochemicals, etc in entirety added to larger yield. Additionally, enhanced technology made it achievable to time the field operation better, consequently, enhancing good organization of the operations, and thus reducing waste. The question to be asked is, can we separate these effects from the use of better genetic strains (i.e the use of hybrid maize)? Rusell, (1974) made several efforts to answer this question. With hybrid seed conserved from 1930 to 1970 and growing the hybrid

and open-pollinated maize under the similar environment, he found a homogeneous boost in yield from the newer strains (hybrid maize), as against the heterogeneous nature of open-pollinated maize variety. He concluded that 60% or more of the improved performance was genetic. Similar result was also reported by (Duvick 1977; Crow, 1998).

The yield advantage, of these several type of hybrids over open-pollinated varieties were also revealed by Correjado and Magulama, (2008) and collaborated by Paliwal,(2000) indicating 46% for single cross, 30% for three way cross, 37% for double top cross, 28% for top cross and 17% for variety cross. This also collaborated with the work of (Magulama, et al., 2007) they recognized hybrid maize (USM var 18) as tolerant to low nitrogen fertilizer. Recently, it was further supported by Librando and Magulama, (2007). Kogbe and Adediran, (2003) produced similar results stating that the hybrid maize (8516-12, 8321-18 and 8329-5) gave higher yield, and used production inputs (nitrogen and phosphorus fertilizer) more efficiently than open-pollinated maize (TZSR-W). Results from demonstrated trials conducted by FAO shows that prospective yields of superior varieties from either on-station or on-farm research would be superior (FAO, 2000).

There are proofs to sustain the benefit of hybrid maize production (over the open-pollinated maize). International Institute for Tropical Agriculture (IITA, 1989). Falaki and Hussani, (2002), for example reported that the average on-farm trials of hybrid maize was over 4.5 tons/ha in savannah zone. Kim, (1988) also reported the potential of hybrid maize in increasing production spectacularly in Nigeria. On average, about 37% of total areas (8.2 million hectares) were planted with improved maize varieties consequential in a yield advantage of 45.3% over local varieties. The area planted with enhanced varieties of maize varied largely between countries from 89% in Senegal to 1.3 % in Togo. The yield benefit also varied, from 17% in Cameroon to 100% in Togo. The gross economic benefit ranged

from US$36 per hectare in Chad to US$200 per hectare in Nigeria; and the percentage of the population that gain food security varied from 0.5% in Togo to 5.6% in Nigeria. (Manyong, et al., 2000).

In the face of these research findings on yield, there are universal interpretations that the intensity of acceptance of hybrid maize is at a standstill amongst farmers. Furthermore, the categories of farmers producing hybrid maize are large/medium scale farmers (Olalere, 1991). This trend may possibly have been brought with reference to a number of reasons together with accessibility of streak resistant varieties for all ecological zones like Nigeria; ease of use of high – yielding hybrid varieties. Local production had to be geared up to meet the demand for direct human consumption, breweries, pharmaceutical companies, baby cereals, livestock feeds and other industries (Iken and Amusa, 2004). Maize can become a highly profitable cash crop provided a remunerative production price regime prevails. But despite the high yields obtainable from improved production technology, the national average grain yield of maize has consistently fallen short of the potential yields (Alamu, 2001). In order to reduce the deficit, there must be a significant increase in the domestic production of maize. One of the solutions being adopted to achieve this is the introduction of new production technologies such as hybrid maize (Alamu, 2001).

The initial attempt to improve on the quality of maize in Nigeria was made in 1899 (Fakorede et al., 1993). Previously, Agricultural research work in Nigeria was directed at promoting the development of various cash crops like cocoa, oil palm, cotton and groundnut for export purposes (Iken and Amusa, 2004). The advent of a very destructive rust disease known as the American rust, incited by Puccinia polestar, which entered West Africa in 1950, called the attention to the importance of maize as a food crop. The lack of resistance or tolerance in the local varieties to the American rust led to the initial attempt at improvement of the maize crop

and introduction of the maize materials from all over the world. Subsequently, organised approach towards a systematic study of the crop was established at the Federal Department of Agriculture Research (FDAR) Moor Plantation, Ibadan in 1956 (Iken and Amusa, 2004). The initial approach was, to improve the quality of maize for disease resistance, by screening local and introduced varieties, after which selection aimed at improving the adaptability and suitability of the new varieties was done (Iken and Amusa, 2004).

Several attempts have been made by economist to evaluate the economic difference between hybrid and open-pollinated maize. Griliches for several decades (1930-1999) made the acceptance of hybrid maize in the United States the exemplar for his model of technological diffusion. It was greatly publicised by being taught in every graduate school, and it won many awards. Nevertheless, the worth and importance of maize, hitherto the introduction of hybrid maize, can never be over emphasized.

2.4 CONSTRAINTS FACING MAIZE PRODUCTION IN NIGERIA.

More than a quarter of a billion Africans depend on maize as their staple food, often eating a quarter kilo or more of maize and maize products every day. Any interference to make maize available, either at the farm level or to the markets, has negative cost for the most vulnerable farmers (CIMMYT, 2007). Irregular rainfall, persistent drought, and loss of soil fertility have all made the maize harvests in Africa vague. At the moment, several farm families cannot grow sufficient food to last the year and do not have income to buy food. Accepting donated food aid is often the only way to survive. This robs families of their dignity and restraints development (IITA 2009).

According to (Kumwenda et al, 1995) there are no specific ways to enhanced maize productivity for African farmers. In the 'developed' world, farmers are guided in the use of

new and expensive technologies by carefully formulated farm management advice. Such counsel is hardly ever offered to African farmers. At the same time obviously, the cost of having highly qualified farm management advisors readily available to all African farmers is unaffordable, so too are the costs (both social and economic) of accepting the continuing decline in African farm productivity. It is convenient to look, through joint ventures with donors and with private sector input suppliers, at making good quality farm management advice more readily accessible to those farmers already using modern inputs and to those whose efficiency can be readily improved so as to make modern inputs profitable. They further illustrated important moves from making inputs "within the farmers' means" to making them profitable. It also moves from the diagnostic (typified by efforts in Farming Systems Research and various forms of Rapid Rural Appraisal) and the prescriptive (from top down extension efforts to the Training and Visit (T+V) system favored by the World Bank) to a problem solving format in which the farmer is actively involved. It provides a framework for effective research/extension linkages and facilitates the evolution of a demand driven technology development process by smallholders.

There are recommended agricultural practices put forward by researchers through extension agent for the production of hybrid maize. Nevertheless, despite these recommended practices, farmers are still faced with other hindrances, which in no little way affect their output. The yearly production of hybrid and open-pollinated maize would be elevated, if these constraints were eliminated or minimized. A number of the constraints militating against the yield potential of the superior varieties released so far are;

-low soil fertility: Smaling (1993) considered the nutrient equilibrium for 10 countries in Africa and found a negative, and rising, variation amid nutrient inputs and outputs. The densely populated, erosion prone, countries of eastern and southern Africa (which are also

those where maize is a major food crop) are those with the most aggregate nutrient loss. While the raise in maize area in drought prone semi-arid areas has contributed to reducing average yields per unit of land (Gilbert et al, 1993), the greater influence is a decline in soil fertility in the wetter, higher yield potential areas.

The old and already highly leached soils of humid and subhumid zones in Africa have naturally low micronutrient levels. Other factors interact with soil fertility - and the significance of these interactions will be expanded in subsequent sections. Weeds are a problem when there is insufficient labor for timely weeding. Moisture is often the key constraining factor in semi-arid zones. But the most widespread leading constraint on yield improvement, and on the sustainability of the maize-based systems of southern and eastern Africa, is the decline in soil fertility.

Two approaches can be recognized in managing soil fertility (Sanchez, 1995). The best known is that of overcoming soil constraints to fit plant requirements through the application of purchased inputs. Most of the food produced in the world is based on this approach and its relevance in the Green Revolution is responsible for much of the increased yield especially in Latin America and Asia (Pinstrup-Andersen, 1993). The second approach relies further on biological processes to optimize nutrient cycling, reduce external inputs and maximize the efficiency of their use. Knowledge and understanding of the principles underlying the second is a more complex approach, and are not well developed.

-poor crop management practises: Latest major summaries of past impacts and future prospects for maize research in sub-Saharan Africa, Byerlee et al (1994) contrasts the high adoption of improved maize by farmers in opposition to a comparative need of resource

management technology for maintaining soil fertility and rising labor productivity. Many technologies are potentially available but few are easy for farmers to adopt.

Intercropping; is a cropping system, where two or more crops are grown mixed together on the same ground for all or most of their life cycle. It is a wide-spread traditional African agricultural practice (Andrews and Kassam, 1976). Legumes in intercropping systems often contribute some residual nitrogen to maize (Willey, 1979).

However, low growing legumes are often shaded by taller cereals (Dalal, 1974; Chang and Shibles, 1985; Manson *et al.*, 1986) and under smallholder management in low fertility conditions, poor emergence and growth of the legume in the intercrop is common. This limits the Nitrogen and organic matter contribution of the legume on-farm to levels well below the potentials found on research stations (Kumwenda *et al* , 1993; Kumwenda, 1995). Legume rotations are an important practice for restoring soil fertility for farmers with larger land holdings. But the amount of Nitrogen returned from rotations depends, in part, on whether the legume is harvested for seed, forage or incorporated as green manure. In the United States, estimates of net Nitrogen returned to the soil by soyabean residues after seed harvest ranged from 14 to 123 kg N ha-1 (Hunt *et al,* 1987). In Malawi, MacColl (1989) estimated net N of 23 to 110 kg ha-1 from pigeonpea, 23 to 50 kg ha-1 from Dolichos bean, and 25 kg ha-1 from groundnuts. In Nigeria, Jones (1974) and Giri and De (1980) estimated 60 kg N ha-1 from groundnuts.

-poor soil management practises: Soil Organic Matter (SOM) maintenance and management is essential to the sustainability of soil fertility on smallholder farms in the tropics (Swift and Woomer, 1993; Woomer *et al,* 1994). Recent SOM inputs are inadequate to maintain SOM levels in agricultural soils. Continuous cropping of land year-after- year and the associated

tillage are well known to lead to initial rapid declines in SOM. SOM then stabilizes at a low level (Woomer *et al,* 1994).

In sedentary agriculture, the conventional mechanisms for addressing loss of SOM are rotations (especially involving legumes), the addition of animal manures and forms of intercropping. As pressure for arable land rises, cropping encroaches into areas previously used for grazing. Agricultural intensification can be associated with a decline in the availability of animal manures as livestock are squeezed out.

Traditional African agricultural systems were largely based around extended fallows and the harvesting of nutrients stored in woody plants. The site to be cultivated was cleared by cutting and slashing plant growth, and then by burning the dried plant material (Blackie and Jones, 1993; Blackie, 1994). Extensive exploitation of land by few families characterized these systems. There is a single consistent outcome from an agricultural economy based on nonexistent fallows and extensive, low input cultivation - crop yields decline and soils erode. Buddenhagen, (1992) estimates that, discounting erosion effects, the weathering of minerals and biological nitrogen fixation will enable, at most, 1000 kg of grain per hectare per year on a sustainable basis in the tropics. Loss of soil through erosion (and soils cultivated with annual crops in the upland tropics are very prone to erosion) will reduce this level considerably. With farmers locked into low crop productivity per unit of land from a degrading natural resource base, there is increased pressure to open new land for agriculture.

-high cost of production inputs like fertilizer; herbicides; insecticides and hybrid seed: Throughout the tropics and subtropics, small-scale farmers grow maize, mostly for subsistence as part of agricultural systems that feature several crops and sometimes livestock production (CIMMYT, 2007). Unlike in the developed countries where hybrid maize varieties are commonly grown with high inputs using mechanized operations, the production

systems in sub-Saharan Africa often lack inputs such as fertilizer, improved seed, irrigation, and labor (IITA,2009).

In most parts of the world, chemical fertilizers play a major role in maintaining or increasing soil fertility. However, in southern and eastern Africa, the use of chemical fertilizer outside of the large scale commercial sector is still very low, probably near the seven kg of fertilizer per hectare is the average for sub- Saharan Africa (FAO, 1988). Fertilizer is already the most costly cash input used by the typical smallholder in the maize producing regions of southern and eastern Africa, and within many countries its real price is rising each year. Fertilizer recommendations typically ignore soil and climatic variations found in smallholder farming areas, are incompatible with farmer resources, or are inefficient, leading to farmers incurring unnecessary expense. For example, the commendation for basal fertilizer on maize is to apply it in the planting hole at planting. Yet farmers almost always apply it just after crop emergence because they experience negligible loss of yield under farm conditions (Shumba, 1989). Their practice allows them, during the wet season, to plant more area more quickly (important on a drying sandy soil), get better crop emergence and have more labor available for other operations.

The limited use of nitrogenous fertilizers and the declining soil fertility are problems for maize production in sub-Saharan Africa. Also, periodic drought caused by irregular rainfall distribution reduces maize yields by an average of 15% each year. This is equivalent to at least US$200 million in foregone grain. The effects of prolonged droughts, such as those that have struck Eastern and Southern Africa in recent years, have been disastrous (IITA, 2010).

-a biotic stresses: Throughout the tropics and subtropics, small-scale farmers grow maize, mostly for subsistence as part of agricultural systems that feature several crops and sometimes livestock production (CIMMYT, 2007). Unlike in the developed countries where

hybrid maize varieties are commonly grown with high inputs using mechanized operations, the production systems in sub-Saharan Africa often lack inputs such as fertilizer, improved seed, irrigation, and labor. Careful attention needs to be paid to the interactions between fertilizer and other management factors.

In southern Africa, the defining feature of the ecology is the 7-8 month dry season. This means that farm operations, particularly of planting, weeding, and fertilizing are highly concentrated in the critical early weeks of the season (IITA, 2009). The options for addressing soil fertility open to the farmer are influenced by crop choices, by the season, the climate and by a range of other factors - some of which the farmer can control or modify, and some of which he or she cannot. Thus it is the interaction of soil fertility technology with other, possibly more readily adoptable farmer inputs and management practices that needs particular consideration. Interactions can be expected with fertilizer responsive and efficient maize and weed control practices, and with moisture availability, with labor, and with draught power (IITA, 2010).

-pest and diseases: Maize farmers often suffer from infestation of parasitic weeds and prolonged droughts, rendering farms almost harvestless and farming households with little food and insufficient income for most of the year. Low soil fertility is often as devastating as droughts, while stem borers in the forest regions also hurt productivity (IITA, 2010). An array of diseases plague maize growing areas in sub-Saharan Africa (IITA, 2009) these include downy mildew, rust, leaf blight, stalk and ear rots, leaf spot, and maize streak virus. Insect pests, including stem and ear borers, armyworms, cutworms, grain moths, beetles, weevils, grain borers, rootworms, and whitegrubs are also a great threat to the survival of maize in Africa (IITA, 2009).

In the Nigerian savanna, for example, weed-related yield losses ranging from 65 to 92% have been recorded. The parasitic weed, known as witchweed (*Striga*), is a major pest in sub-Saharan Africa and causes estimated cereal grain losses of up to US$7 billion. This adversely affects the lives of about 300 million people (IITA, 2009). Kabambe and Kumwenda, (1995) examined the interaction between weed growth and fertilizer use efficiency. Their results show that farmers who weed twice at the critical periods for maize can achieve a higher yield, with half the amount of fertilizer, than farmers who only weed once. Where animal draught power is available, the options for exploring interactions with weed management methods are increased (Low and Waddington, 1990).

Results from Zambia show that combining basal and top-dress fertilizer, applied when weeding the 20 cm tall maize resulted in a saving of six person days per hectare during the peak demand period for family labor. The practice also gave a 19% yield increase compared with the standard farmer practice of a basal application just after planting, followed by late weeding and top-dressing. These results were developed into separate recommendations for ox-cultivators and for farmers who used hand hoes for weeding. Ox-cultivators should weed with oxen two weeks after emergence while covering the mixed basal and top dress fertilizer (applied immediately before) in the same operation. This should be followed by hand weeding on the crop row within the subsequent two weeks. Hand-hoe weeders were recommended to combine the first hoe-weeding with a mixed basal and top dress fertilizer application, beginning 10 days after emergence. The second weeding would follow two weeks later (Low and Waddington, 1990; 1991).

Cardwell et al. (1997) showed that losses due to pest and diseases ranged from 20-50% and in the specific case of the grey leaf spot disease, grain yield losses of 90% or more have been reported in several part of the country. Some factor influencing production of hybrid and open-pollinated maize are illustrated as Follows; Diseases and pest, maize post-harvest

perish-ability, high labour requirement, inadequate fertilizer, insecticides and pesticides; inadequate infrastructure, shortage of funds for maize land expansion amongst others. To increase productivity, through land expansion, farmers need access to credit, agricultural extension, land, labour and technology.

Soil fertility decline may also pre-dispose to the build-up of some weeds and pests and thereby may indirectly further affect crop production. A well-known example is Striga spp.. This parasitic weed tends to build up when soils are depleted (although once it is established it is hard to control just through improved soil fertility). Data from long-term trials in Kenya have shown that incorporated crop residues play an important role in reducing Striga parasitism (Odhiambo and Ransom, 1995). Further work is required to determine the effect of soil fertility on the control and build-up of Striga .

Drought: Moisture and soil fertility work both with and against each other. The climate of southern and eastern Africa means that moisture is a frequent constraint to maize yield and to yield response to fertilizer. The efficiency (measured through grain production) of both water use and N use is raised when both are in adequate supply. But the high risk of poor response to fertilizer in dry years is a major reason why most farmers in semi-arid areas use little or no fertilizer.

A partial solution to this can be found in "response farming" techniques (Stewart and Kashasha, 1984; Stewart, 1991) that use early rainfall events to decide on the amounts of fertilizer to apply. Piha, (1993) has explored the interaction between nutrient use and rainfall. His data show how, by adjusting fertilizer use to the evolving rainfall pattern in any one season, the profitability of fertilizer use can be significantly increased. His results, from trials over 5 years and on farmers' fields, show that his approach gave 25 - 42% more yield and 21 - 41% more profit than did existing fertilizer recommendations. He also showed that

existing recommendations were too risky for lower rainfall areas and needed to be adjusted downwards if fertilizer use was to be profitable in those areas. The significance of the recent work by Piha, (1993) and other similar efforts is that productive and profitable agriculture is reliably possible on poor soils, and in semi-arid conditions, with the judicious use of inorganic fertilizers. Many of Africa's smallholders live in exactly these environments.

According to Paudel and Matsuoka, (2008), the production of maize varieties is influenced significantly by rainfall, age family size and education of household head, access to extension, land type either sc upland or lowland They suggested the need to bring more area under maize cultivation during raining season especially in the low-lying area. Furthermore; there is need for special training, seminars, field demonstrations and technical support for the maize farmers. Majority of households have no formal education, the extension program should be extended to the less educated people. In addition, the credit facilities especially the procedure for loan should be made simple to improve the adoption rate of improved maize varieties in the study area. Also due to rising income in most of the developing country and the subsequent growth in meat and poultry consumption there is a rapid increase in demand of maize as livestock feed. However a large proportion of products utilized in developing countries are obtained via traditional processing methods (IITA, 2009).

2.5 REVIEW OF ANALYTICAL TECHNIQUE

The analytical tools that were used for achieving the objectives of this study were reviewed as follows;

2.5.1 Farm Budgeting Technique

Farm budgeting technique is a report from the farmer, illustrating a farm plan or a change in the farm plan, and the forecast of financial results (Barnard and Nix, 1979). It tells if a

desired alteration can enhance the income of a farm enterprise based on scale of preference or priorities.

This could be an entire or partial (budget). It is partly or partial, when a partial change is occurring and total when an important change is made (Castle and Becker, 1982). Nevertheless, as a planning tool, budgeting will not give specific answers and prices hence; it will not carry out sensitivity-analysis adequately.

Farm budgeting more often than not assumes a linear relationship and ignores the complementary co-existence between enterprises as well as diminishing returns (Barnard and Nix, 1979). It is still a simple and flexible tool in spite of its limitations (Upton, 1973).

2.5.2 Production Function Analysis

The production function expresses the technical relationship between inputs and output in any production plan or processes (Olayide and Heady, 1982). As an analytical technique, it is based on the following assumptions according to (Sankhayan, 1988; Hussaini, 2002)

1) It is defined only for non-negative values of both inputs and output.
2) It presupposes technical efficiency
3) The input-output relationships or the production function is single valued and continuous for which there exist first and second order partial derivatives of the output with respect to the inputs
4) The returns to scales are assumed to be decreasing
5) All the products and factors of production are perfectly divisible
6) The parameters determining the firm's production function do not change over the period considered

The method of production function analysis breaks down if one or more of these assumptions do not hold. Furthermore, the aim of the functional analysis is obviously achieved only when

certain theoretical deductions are made from the estimated production function, or else the essence is defeated. These deductions include, Average Physical Product, Marginal Physical Product, Elasticity of Production, Isoquant, Rate of Technical Substitution, Isoclines, Expansion Path, Ridgelines, and Elasticity of substitution (Sankhayan, 1988; Hussaini,2002) Principally, production function estimates are useful in providing answers to economic problems of the farm firm. Secondly, the estimates are functional in biological research such as fertilizer, feeding and other response studies. In general, marginal analyses can be assessed and analysed by employing production functions. With fairly accurate data, the production functions are essentially useful for planning and prediction (Olayide and Heady, 1982). However, the production function has some limitations. In practice, it is difficult to find situations where the production functions are well established to present perfect definition of the point of optimal output. Secondly, there are un accountable factors that affect production function analysis. However the greatest danger in the use of production function depends on the usage for planning another farm firm as no two farms are completely alike in resource utilization, technology and management (Olayide and Heady, 1982).

CHAPTER THREE

3.0 METHODOLOGY

3.1 The Study Area.

This study was conducted in Giwa Local Government Area of Kaduna State. It is located between Latitudes 11°and 12°N and Longitudes 7° and 8°E of the Prime Meridian (Anonymous, 1994). Kaduna state is located in the Savannah ecological region of Nigeria, with a cultivatable area of about 34,000 sqkm, the actual area cultivated is about 32,230 sqkm from an estimated land area of about 43,000 sqkm. (Anonymous, 1994)

The typical weather is mostly categorized by constant dry and wet seasons. The wet season begin in April/May and stops in October, while the dry season sets in, in late October and ends in March of the subsequent year. The rainfall duration varies from 150 days (in the Northern parts, where Giwa LGA is located) to 190 days (in the Southern parts) of the state. The average annual rainfall ranges between 1107mm and 1286mm. Relative humidity varies between 20% and 40% in January, and 60% and 80% in July. The mean annual high temperature also varies between 34° and 28°C. Crop cultivation is practiced in the upland and lowland (fadama) areas, of Kaduna state which essentially rain is fed in upland system while in low land areas; both wet and dry season farming occurs. Upland farming is being practised by farmers in Giwa LGA which is, for the most part cereals (like millet, rice, maize and sorghum); legumes (including cowpea; groundnut and soyabean). There are 23 Local Government Area (LGAs) in Kaduna State, from which Giwa LGA was purposively selected because of proximity of some institutions and organizations concerned with the cultivation of hybrid and open-pollinated maize, the intense activities of seed companies in the area and farmer's participation in on- farm trials. Small-scale farmers carry out agricultural production

predominantly. The cropping systems in the area are also dominated by mixed cropping, although sole cropping is practiced. In addition, significant parts of the populations are involved in livestock keeping which depends on grazing (Oguntolu, 2005). The nomadic Fulanis predominantly do the grazing and livestock rearing in the state.

3.2 Sampling Procedure:

The study adopted a cross-sectional sample survey design. The targeted population of farmers involved in the study are hybrid and open-pollinated maize farmers in Giwa LGA of Kaduna State. Based on the list of maize farmers obtained from the state's Agricultural Development Programme, a multi-stage sampling procedure was used for the study. In the first stage, eight wards were purposively selected based on the intensity of maize production in the study area. The surveyed ward were *shika, Giwa, Kaya/idosu, Galadima, Yakawada, Fatika, Kidandan and Gangara*. Secondly, a community was also randomly selected from each of the wards. Finally, 20 maize farmers comprising of 10 hybrid and 10 open-pollinated maize farmers each were randomly selected and interviewed from each community to make up a sample size of 160.

3.3 Method of Data Collection

Primary and Secondary data were used for this study. The primary data were collected based on 2009 cropping season using detailed structured questionnaires, with the aid of an enumerator. The interview method of data collection was used. The data collected include:

1) demographic information such as age, educational level, farm size, farming experience.

2) production information on hybrid and open-pollinated maize, this includes inputs used, like fertilizer and other agro-chemicals, land, seed planted, quantity of input, labour and output.

3) finally marketing information like prices of inputs and output, quantity sold, and mode of sales.

4) Data were also, obtained from Journals, Monogram, published books, which are significant to the scope of this study.

3.4 Analytical Techniques.

The analytical tools that were used for achieving the objectives of this study include Descriptive Statistics; Farm Budgeting Technique and the Production function analysis.

3.4.1 Descriptive Statistics.

The Descriptive and inferential Statistics i.e the use of measures of central tendency such as the mean, median; measures of dispersion such as standard deviation and percentages were used to achieve objectives 1, 2 and 6.

3.4.2 Gross Margin Analysis

Gross Margin Analysis was used to achieve objective 3. By definition, Gross Margin is the difference between the Total revenue and the Total Variable Cost. i.e.

GM = TR – TVC

Where: GM = Gross Margin from hybrid and open-pollinated maize product (N/ha)

TR = Total Revenue from hybrid and open-pollinated maize production (N/ha) i.e Yield per hectare multiplied by the unit price. The prevailing market price during the period of study was used to calculate the cost and returns of hybrid and open-pollinated maize production.

TVC= Total Variable Cost (N/ha) these includes cost of hybrid and open-pollinated maize seeds, fertilizer, agrochemicals and labour.

3.4.3 Production Function Analysis

Different functional forms such as square root, quadratic, the linear, the semi-log and the Cobb-douglas production functions were used to analyse the data. The lead equation was the cobb-douglas model. It was chosen for further analysis, to determine the production function for hybrid and open-pollinated maize production, which was used to achieve objectives four.

The criteria that guided the choice of the lead equation were:

i) The value of coefficient of multiple determination (R^2);

ii) The correctness of the signs of the regression coefficients and

iii) The significant t-values

3.4.3.1 Specification of the Models

Cobb-Douglas in its general form is given as:

$Y = a + X_1^{b_1} X_2^{b_2} X_3^{b_3} X_4^{b_4} X_5^{b_5} X_6^{b_6} e$ in the linear form it is expressed as

$$\text{Log } Y = a + b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 \log X_4 + b_5 \log X_5 + b_6 \log X_6 + e$$

Where

Y = *crop output from hybrid and open pollinated maize (Kg).*

X_1 = *farmsize*(ha)

$X_2 = seeds(kg)$

$X_3 = fertilizer(Kg)$

$X_5 = Agrochemicals(litre)$

$X_5 = Herbicide(litre)$

$X_6 = Labour(man-day)$

$Y_1 X_1 to X_6$ are already defined in the implicit form.

b_1 to b_6 are the regression coefficients

a = constant term

e = error term

Estimation of Resource Use Efficiency:

This is computed as follows:

$$r = \frac{Marginal - value - product}{Marginal - factor - cost} = \frac{MVP}{MFC}$$

Where

r = is the efficiency ratio

MFC = cost of one unit of a particular resource

The MVP was estimated as follows:

$$MVP_{xi} = MPP_{xi} * P_y$$

$$MPP_{xi} = {}^{d_y}/_{d_{xi}} = \beta\, {}^{\overline{Y}}/_{\overline{X}_i}$$

Where Cobb-Douglas or double log form is the lead equation.

Note: $\overline{Y}$ and $\overline{X}$ are the arithmetic mean values of output and input being considered respectively.

In the case of a Cobb-Douglas log form, the values of Log Y and the Log X

Where they assume their arithmetic means.

Where:

β = is the estimated regression coefficient of input X_1

P_y = is the unit price of output.

X_i = is the various input i.e. 1 to n.

If r = 1, implies that resources are efficiently utilized i.e. MVP = MFC=1

r > 1, it implies that resources are underutilized i.e. MVP >MFC

r < 1, it implies that resources are over utilized i.e. MVP < MFC

Estimation of the resource use efficiencies was for the purpose of achieving objective five.

Specification of hypotheses testing:

a. Z-test

The Z-test was conducted to confirm hypothesis (i) i.e there is no difference in the profitability (gross margin) between hybrid and open-pollinated maize production in the study area.

The formula for the Z-test is given as:

$$Z = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}$$

Where

Z = The calculated Z value

$\bar{X}_1$ and $\bar{X}_2$ = gross-margin of hybrid and open-pollinated maize farmers respectively.

S_1^2 and S_2^2 = Estimated variance

n_1 and n_2 = are the samples sizes of the hybrid and open-pollinated maize farmers respectively.

b) Resource use efficiency was used to confirm hypothesis ii i.e. there is no relationship between input and output in the production of hybrid and open-pollinated maize in the study area.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

This chapter describes the socio-economic characteristics of hybrid and open-pollinated maize farmers; the input and output levels in hybrid and open pollinated maize production; its cost and returns; regression analysis as well as the determination of resource use efficiency; and finally it listed the constraints faced by hybrid and open pollinated maize farmers.

4.1 SOCIO- ECONOMIC CHARACTERISTICS OF HYBRID AND OPEN POLLINATED MAIZE FARMERS

The first objective of this study is to describe the socio-economic characteristics of hybrid and open-pollinated maize farmers.

4.1.1 Age distribution

Table 4.1. Shows the age distribution of the hybrid and open pollinated maize farmers in the study area. The study indicates that about 18% and 10% of hybrid and open-pollinated maize farmers respectively, were less than 29 years. While 18.75% and 10% of hybrid and open-pollinated maize farmers were between the ranges of 30 and 39 years respectively. The hybrid and open-pollinated maize farmers that were between the age of 40 and 49years were about 29% and 19% respectively. About 19% and 23% of hybrid and open-pollinated maize farmers were between the ages of 50 and 59 years respectively. About 11.25% and 18.74% of hybrid and open-pollinated maize farmers respectively were between the ages of 60 and 69 years. Only 5% and 20% of hybrid and open-pollinated maize farmers were above 70years. The study indicates that 65% and about 39% of hybrid and open-pollinated maize farmers respectively were between the ages of 29 and 49 years are in active production. This implies that these ages can have positive effect on the acceptance and adoption of innovations from extension agents, which invariably will influence the level of maize production. According to

FAO (1992), the active age group which is economically industrious is within the ranges of 15 to 64 years. Therefore, both groups of maize farmers are within this age bracket.

Table 4.1 Distribution of Hybrid and Open-pollinated Maize Farmers by Age

AGE GROUP	HYBRID		OPEN POLLINATED	
	FREQUENCY	PERCENTAGE	FREQUENCY	PERCENTAGE
≤ 29	14	17.5	8	10
30-39	15	18.75	8	10
40-49	23	28.75	15	18.75
50-59	15	18.75	18	22.5
60-69	9	11.25	15	18.75
≥70	4	5	16	20
Total	80	100	80	100

Source: Field survey, 2010.

4.1.2 Family sizes

Table 4.2 reveals that17.5% and 18.75% of hybrid and open-pollinated maize farmers respectively had a family size of 1-5 persons. Most of hybrid and open-pollinated maize farmers about 54% and 50% respectively had a family size of 6-15 people. About 28% of hybrid and open-pollinated maize farmers have a family size of 16-25 people. Only 1.25% and 3.75% of hybrid and open-pollinated maize farmers have family size of 26-30 persons. Family size is a significant input in convectional agriculture as it affects relatively the supply of labour for immediate farm employment. (Akinyemi, 1998). Large family size also implies that, there is a source of family labour and high food demand in the household. Consequently, an increase in crop production to secure subsistence food need becomes necessary.

Table 4.2. Distribution of Hybrid and Open-pollinated Maize Farmers by Family Size

FAMILY SIZE	HYBRID		OPEN POLLINATED	
	FREQUENCY	PERCENTAGE	FREQUENCY	PERCENTAGE
01-05	14	17.5	15	18.75
06-10	24	30.0	23	28.75
11-15	19	23.75	17	21.25
16-20	19	23.75	19	23.75
21-25	3	3.75	3	3.75
26-30	1	1.25	3	3.75
TOTAL	80	100	80	100

Source: Field survey data, 2010.

4.1.3 Farming experience

Table 4.3 shows the farming experience of the respondents in maize production. The table indicates 71.25% of farmers, has practiced hybrid maize production for less than 10 years, while about 1% of open pollinated maize farmers have less than 10 years experience. Some 22.5% and 7.5% of hybrid and open-pollinated maize farmers respectively have 11-15 years of farming experience. Over 6% and 19% of hybrid and open-pollinated maize farmers respectively have16-25 years of maize farming experience. No farmer, has practised hybrid maize production for between 26-30years however, 20% of open pollinated maize have an experience of between 26-30 years. No hybrid maize farmer has over 31 years experience, while over 19% of open-pollinated maize farmers have over 31 years of experience. This may probably be due to high expenditure on fertilizer input to meet up with the recommended dose needed by hybrid maize plants and weak extension programme in the study area. The modal years of farming experience in hybrid and open pollinated maize production are 10 and 36 years respectively.

Table 4.3 Farming Experience of Farmers

FARMING EXPERIENCE	HYBRID		OPEN POLLINATED	
	FREQUENCY	PERCENTAGE	FREQUENCY	PERCENTAGE
≤ 10	57	71.25	1	1.25
11-15	18	22.5	6	7.5
16-20	3	3.75	7	8.75
21-25	2	2.5	8	10
26-30	0	0	16	20
31-35	0	0	15	18.75
≥ 36	0	0	27	33.75
TOTAL	80	100	80	100

Source: Field survey data, 2010.

4.1.4 Educational level

Table 4.4 shows the educational levels of both open-pollinated and hybrid maize farmers in the study area. A few (5% and over 1%) of hybrid and open-pollinated farmers respectively have no formal education. Some 20% and over 53% of hybrid and open-pollinated maize farmers have either quranic or primary school education respectively. About 44% and 33% of hybrid and open-pollinated maize farmers have secondary and adult education respectively. More than 31% and over 11% of hybrid and open pollinated maize farmers have tertiary education respectively, indicating that hybrid farmers acquired higher tertiary education than their counterpart. The high level of literacy in the study area may imply that the respondents would be willing to accept and adopt innovations brought to them by extension agents. This supports the statement of Imonike (2004) that education would significantly enhance farmer's ability to make accurate and meaningful management decisions as regards to perceptions, adoption and acceptance of innovation as he/she is able to read and interpret the recommended practices.

Table 4.4. Educational qualification of hybrid and open-pollinated maize farmers.

EDUCATIONAL QUALIFICATION	HYBRID		OPEN POLLINATED	
	FREQUENCY	PERCENTAGE	FREQUENCY	PERCENTAGES
No formal education	4	5	1	1.25
Quaranic education	7	8.75	27	33.75
Primary school education	9	11.25	16	20
Secondary school educ	17	21.25	12	15
Adult education	18	22.5	15	18.75
Tertiary education	25	31.25	9	11.25
TOTAL	80	100	80	100

Source: Field survey data, 2010.

4.1.5 Farm sizes

Table 4.5 reveals that, the majority of the respondents (90% and over 86%) of hybrid and open-pollinated maize farmers have farm sizes that range between 0.1 and 5.9 hectare respectively. Some 10% and over 12% of hybrid and open-pollinated maize farmers have farm sizes ranging between 6 and 9.9 hectares respectively. While there are no hybrid maize farmers having greater than 10 hectares, 1.25% of open-pollinated maize farmers have greater than 10 hectare. This finding shows that hybrid and open pollinated maize production in the study area is practice mainly by small-scale farmers on lands below 10 hectare. This opposes the findings of Olalere, (1991) who stated that small holders have not fully noted the significance of improved farming practices. Land is a significant input as it determines the size of farm produce, although it also depends on other factors of production like fertilizer, herbicides, labour, access to credit and experience of farmers. It can also affect the cost of adoption, labour requirement and tenure arrangement.

Table 4.5 Distribution of farmers based on farm size

FARM SIZE(Ha)	HYBRID		OPEN POLLINATED	
	FREQUENCY	PERCENTAGE	FREQUENCY	PERCENTAGE
0.1- 5.9	72	90	69	86.25
06-9.9	8	10	10	12.5
≥ 10	0	0	1	1.25
TOTAL	80	100	80	100

Source: Field survey, 2010

4.1.6 Extension contact

Table 4.6 reveals that 8.75% and 6.25% of hybrid and open-pollinated maize farmers have once in a month contact with an extension agent. While about 24% and 34% of the hybrid and open pollinated maize farmers respectively were not visited by extension agents during the production season. The implication of this finding is that the extension programmes in the study area are either understaffed or underequipped as indicated by a large percentage of the respondents that were unreached by the extension services in the study area.

Table 4.6 Distribution of Respondents According To Extension Visit

NUMBER OF EXTENSION VISIT	HYBRID		OPEN-POLLINATED	
	FREQUENCY	PERCENTAGE	FREQUENCY	PERCENTAGE
Once/ month	7	8.75	5	6.25
Twice/month	23	28.75	20	25
Once/2 months	31	38.75	28	35
Not at all	19	23.75	27	33.75
TOTAL	80	100	80	100

Source: Field survey data, 2010

4.1.7 Cropping System

Table 4.7 reveals that the highest percentage (over 62%) of hybrid maize farmers grew sole maize; interestingly no open-pollinated maize farmer grew sole maize. Some 16% of hybrid maize farmers grew maize/sorghum combination; but a higher percentage of open-pollinated maize farmers (24%) grew maize/sorghum combination; About 8% of hybrid maize farmer grew maize/soyabean combination, which was much lower than the open-pollinated maize/soyabean combination of about 21%. The highest percentage of open-pollinated farmers (55%) grew maize/cowpea combination as against a mere 14% for hybrid maize farmers. Mixed cropping was the dominate cropping system for open-pollinated maize (100%) as against a meagre 38% for hybrid maize. Possible reasons for growing maize in mixtures especially by open-pollinated maize farmers were; majorly for risk diversification involved with crop failure as a result of biotic and a-biotic constraints such as flooding due to

global warming; drought caused by the unpredictable pattern of rainfall, these seriously affects teaselling (due to the shallow root system of maize); pest and diseases like striga, stalk and ear rots, leaf spot, and maize streak virus was also a factor. There was also diversification due to cost of production in order to obtain optimum profit. Some farmer also felt it was a tradition inherited from their pre-cessors as such they continued with it.

Table 4.7 Distribution of Farmers Based on the Cropping System:

	HYBRID MAIZE		OPEN-POLLINATED MAIZE	
CROPPING SYSTEM	**FREQUENCY**	**PERCNTAGE**	**FREQUENCY**	**PERCNTAGE**
SOLE	50	62.5	0	0
MAIZE/SORGHUM	13	16.25	19	23.75
MAIZE/SOYABEANS	6	7.5	17	21.25
MAIZE/COWPEA	11	13.75	44	55
TOTAL	80	100	80	100

4.2 INPUT AND OUTPUT LEVELS IN HYBRID AND OPEN-POLLINATED MAIZE PRODUCTION.

The second objective of this study is to determine and compare the input-output level of hybrid and open-pollinated maize production in Giwa LGA. Table 4.8 shows that 16.12 kg of seed, 6.04bags (i.e 302kg) of fertilizer and 65.12 man-hours, was used for hybrid maize, while 68.31kg of seed, 2.23bags (i.e 111.5kg) of fertilizer and 55.9 man-hours was used for open-pollinated maize. The average quantity of agrochemicals and herbicide used in both hybrid and open pollinated maize production were 1.07lit and 0.79lit, 1.41lit and 1.36lit respectively. The average yield per hectare obtained by hybrid maize farmers was 2240.6kg. On the other hand, the open pollinated maize farmers realized a much lower average yield per hectare of 1261.04kg.

Table 4.8: Summary of inputs and output

Variable	Hybrid			Open pollinated		
	Max	Min	Mean	Max	Min	Mean
Seed (kg)	22	14	16.12	85	26	68.32
Fertilizer (50 kg bags)	17	2	6.04	4	1	2.23
Agrochemicals (litres)	14	0	1.07	5	0	0.79
Herbicide (litres)	29	0	1.41	11	0	1.36
Labour (man-day)	142	48	65.12	95	47	55.9
Yield (kg)	7600	1800	2240.6	3300	800	1260.04

Source: Field survey, 2010.

4.3 COSTS AND RETURNS ANALYSIS

The third objective of this study is to estimate and compares the cost and returns of hybrid and open-pollinated farmers in the study area.

4.3.1 Costs of production

Cost of production can be broadly classified into two types – fixed and variable. Fixed costs are those costs incurred on fixed inputs which do not change as production changes. Variable costs are those costs that relate directly to the level of production. In this study, only the short run variable costs were considered because in peasant agriculture, fixed cost is very negligible and usually ignored. The variable costs consist of costs incurred on variable inputs in production such as seeds, fertilizer, labour, herbicide, agrochemicals.

4.3.1.1 Cost of seed

Table 4.9 reveals an average market price of ₦ 200 per kg was used for the hybrid seed while ₦ 55 per Kg was adopted for the open-pollinated seeds. The average value of hybrid and open pollinated maize seed used were computed to be ₦ 3224.15and ₦ 1887.05 per hectare respectively. Hybrid maize seeds used by the farmers in the study area were mainly obtained from market or seed agencies, like premier seeds and Alheri seeds. But the open pollinated farmers get their local seeds usually from the previous harvest. Some obtained their seeds from the open market.

4.3.1.2 Cost of fertilizer

The average cost of fertilizer in the study area was ₦ 5500 per 50kg bag. The average cost per hectare for hybrid maize production was ₦ 30219.03 while for the open pollinated maize production was ₦ 11158.2.

4.3.1.3 Cost of labour

A mean labour wage of ₦400 per man-day i.e. ₦50 per man-hour was adopted, given the average labour cost per hectare in both enterprises to be ₦ 26047.33 for hybrid maize and ₦22378.6 for open-pollinated maize respectively. Labour costs consist of both family and hired labour input. The family labour employed in the both enterprises was computed on the basis of the forgone cost (opportunity cost) principle in man-hour. The various types of farm operation have different wages.

4.3.1.4 Others Costs

Other costs incurred on variable inputs in maize production in the study under the two enterprises includes cost of agrochemicals, herbicides, sacks, transportation and manure were computed to be ₦ 4570.87 and ₦ 4243.8 per hectare for Hybrid maize and open pollinated maize production respectively.

4.3.1.5 Total Variable Costs (TVC)

Table 4.9 revealed that the TVC was ₦ 64061.38 and ₦ 39667.65 for hybrid and open pollinated maize production per hectare respectively. The summation of variable costs incurred on variable inputs in hybrid and open pollinated maize production gave the total variable costs in each enterprises.

4.3.1.6 Gross return

The average market price at the time of the survey was ₦ 5500 per 100 kg bag of output of maize and an average market price of ₦ 55 per kg of maize was adopted for the study.

The gross return per hectare obtained by hybrid and open pollinated maize farmers were computed by multiplying the average yields of 2240.5kg and 1261.04 kg respectively by average market price of ₦ 55per kg. This gave the gross return of ₦ 123,233.0 and ₦ 69,357.2 per hectare in that order. The gross return for individual maize farmer was computed by multiplying the total yields of each farmer by the average prevailing market price.

4.3.1.7 Gross Margin

Table 4.9 indicates that hybrid maize and open pollinated maize farmers obtained Gross Margin of ₦ 59,171.62 and ₦ 29,689.55 per hectare which implies that hybrid maize production in the study area is more profitable than open pollinated maize production.
The Gross Margin per hectare is the subtraction of the total variable cost from the total revenue per hectare (gross return).

4.3.1.8 Average rate of return

Table 4.9 above shows the average rate of returns for hybrid and open pollinated maize enterprises were computed to be 0.92 and 0.67 respectively, implying that for every naira invested in hybrid maize production there will be a profit of 92k, which is greater than that of open pollinated maize production in which only a profit of 67k will be obtained for every naira invested, *ceteris peribus*. The average rate of return in each maize enterprise was obtained by dividing the Gross Margin obtained in Table 4.8 by the corresponding total variable cost

Table 4.9: Average Gross Margin per hectare for hybrid and open-pollinated maize production

Variable	Hybrid			Open pollinated		
	Mean quantity/ha	Unity price (₦)	Value(₦)	Mean quantity/ha	Unity price (₦)	Value(₦)
1) Inputs						
Seeds (kg)	16.12	200	3224	68.32	55	3757.5
Fertilizer (50 kg)	302	5000	30219.03	111.58	5000	11158.2
Labour (Man-hour)	65.12	400	26047.22	55.95	400	22378.6
Insecticide (Litres)	1.07	950	1019.83	0.79	950	747.24
Herbicide (litres)	1.41	1100	1551.04	1.36	1100	1496.6
Other			2000			2000
2) Total variable cost			64061.38			41538.14
3) Mean yield (kg)	2240.6			1261.04		
4) Gross returns	2240.6	55	122233	1261.04	55	69357.2
5) Gross margin (1-3)			59171.62			27819.06
6) GM/N (ARR)			0.92			0.67

Source: Field survey, 2010. ARR-Average Rate of Returns

The gross margin statistical test for significance.

Table 4.10 shows that the gross margin data were statistically tested for significance using the Z-test for comparing two samples mean between farmers using hybrid and open-pollinated maize. The null hypothesis (H^o) tested was that there is no significant difference in the profitability of farmers using hybrid and open pollinated maize, while the alternate hypothesis (H^1) was that there is a statistical significant difference in the profitability of farmers using hybrid and open pollinated maize.

The result revealed that the calculated Z-statistic was 5.16 whereas the tabulated Z-statistic for a two tailed test at 0.0 for the mean difference of hybrid maize and of open-pollinated maize at 1 level of significance was -1.96 to 1.96. The calculated Z-value of 5.16 lies outside the range of -1.96 to 1.96, hence we reject the null hypothesis that says the gross margin of hybrid maize is not different from the gross margin of open-pollinated maize and accept the alternative hypothesis that hybrid maize is more profitable than open-pollinated maize. Since $H^1 > H^o$ (i.e 5.16 > 1.96) the null hypothesis was rejected and the alternative hypothesis accepted, we conclude that there was statistical significant difference in the profitability of

farmers using hybrid maize seed and those using open-pollinated maize seed at 1% level of significance.

Table 4.10: Means and standard deviation of gross-margin of the two groups of farmers

Farmers group	N	Mean	SD	Z-value	Z-table	LOS
Hybrid maize	80	59171.62	18527.01	5.16	1.96	0.01*
Open-pollinated maize	80	27819.06	9405.92			

Source: Field survey, 2010

4.4 Input-Output relationship in hybrid and open-pollinated maize production.

The fourth objective of this study is to estimate the input-output relationship in hybrid and open-pollinated maize production in the study area. The cobb-doglass function was chosen because it gave the most excellent fit to the data, based on its coefficient of multiple determinations, signs of the estimated coefficients and the least the number of significant variables. In table 4.11 the Ordinary Least Square (OLS) estimation of the parameter reveals the average performance of the sample farms from hybrid maize enterprise and open pollinated maize enterprise. An adjusted R^2 value of 0.59, for hybrid maize production and 0.82, for open-pollinated maize production was reported, implying that the inputs used in maize production explained 66 % of the variation in the output of hybrid maize production and 85% for open-pollinated maize production in the study area. The numbers of significant variables were five for hybrid maize production namely farm-size (land); labour; and Fertilizer being significant at 5% level of probability and seeds and agrochemicals at 10% level of probability. Open-pollinated maize production on the other hand, had four significant variables namely farm size (land); labour and seeds were significant at 5% level of probability while fertilizer was significant at 10% level of probability.

Table 4.11: Input-Output relationship in hybrid and open-pollinated maize production using cobb-douglas production function.

VARIABLE	HYBRID			OPEN-POLLINATED		
	Co-efficient	Std-Error	T-value	Co-efficient	Std-Error	T-value
Constant	6.60	0.33	20.07***	6.55	0.45	14.55***
Farmsize	0.50	0.10	4.91**	0.72	0.09	7.82**
Seeds	0.05	0.03	1.98*	0.03	0.01	3.06**
Labour	0.37	0.08	4.62**	3.77	0.90	4.18**
Fertilizer	0.36	0.12	3.01**	1.61	0.10	16.1***
Agrochemicals	0.16	0.08	1.95*	0.08	0.08	1.01
Herbicides	0.11	0.08	1.38	0.09	0.09	1.01
R-squared	66%			85%		
Adjusted $\bar{R}^2$	0.59			0.82		
F-value	0.001***			22.72**		
N	80			80		

Where *- Significant at 10%** probability level - Significant at 5% probability level*** - Significant at 1% probability level

4.4.1 Marginal Physical Productivity (MPP) of Inputs in Hybrid and Open pollinated maize Production

Table 4. 12 show that the highest MPP (335.04) was observed for Agrochemicals for hybrid. The lowest MPP was fertilizer (2.67). It was closely followed by seeds, labour, land, and herbicides having MPPs of 3.11, 12.73, 140.04 and 174.8 respectively. The MPPs values of open-pollinated maize also peaked with agrochemicals (127.7), and were closely followed by land (91.3) then fertilizer (18.21). Herbicides and labour have MPPs of 9.27 and 0.90 respectively. Seeds had the lowest MPP of 0.55. Since MPP is the addition to total product(yield) resulting from a unit increase in the use of a variable input, we can conclude that the use of hybrid maize seed gave a higher output than the open-pollinated maize seed counterpart as the additional inputs used resulted in a greater output. This opposes the test of hypothesis that says there is no relationship between input and output in the production of hybrid and open-pollinated maize.

Table 4.12: Marginal physical products of inputs in hybrid ad open-pollinated maize production

INPUT	HYBRID					OPEN-POLLINATED				
	$\bar{Y}$	X	APP	B	MPP	$\bar{Y}$	X	APP	b	MPP
Land (ha)	2240.6	8.0	280.1	0.50	140.04	1261	9.95	126.74	0.72	91.3
Seed(Kg)	2240.6	36.1	62.22	0.05	3.11	1261	68.31	18.46	0.03	0.55
Labour(man-day)	2240.6	65.1	34.42	0.37	12.73	1261	55.9	22.56	0.04	0.90
Fertilizer(kg)	2240.6	302	7.42	0.36	2.67	1261	111.5	11.31	1.61	18.21
Agrochemicals(lit)	2240.6	1.07	2094.	0.16	335.04	1261	0.79	1596	0.08	127.7
Herbicides(litre)	2240.6	1.41	1589.	0.11	174.8	1261	1.36	927.2	0.01	9.27

Source: Field survey, 2010. APP = Mean yield/Mean input, MPP = APP*Input elasticity, MPP – Marginal Physical Product

4.5 Resource Use Efficiency

The fourth objective of this study is to estimate and compare the resource use efficiency of hybrid and open-pollinated maize in the study area. Table 4. 13 shows that all the resources used in the production of hybrid and open-pollinated maize were not efficiently utilized. For hybrid maize production agrochemicals and herbicides were underutilized because the ratios were greater than one (19.40 and 8.74) respectively. While the open-pollinated maize counterpart had labour and agrochemicals with efficiency ratio of (2.50 and 7.39) respectively. This implies that an increase in their usage may have increased the yield per hectare of maize. The reasons for underutilization could be due to the high price and scarcity of labour due to the fact that most of the youths are now in school. The efficiency ratio of hybrid maize production, for seeds, fertilizer and labour were less than one (0.85, 0.14 and 0.36) respectively. On the other hand, open-pollinated maize production has efficiency ratio of (0.001 and 0.46) showing that despite the high price of fertilizer and herbicides it was over-utilized on the farms. This could be inferred to be as a result of the believe that hybrid maize is famous for its high requirement for plant nutrients and other production inputs (Kogbe and Adediran, 2003) generally farmers have been trained with the principle that every clause, vital for utmost performance of hybrid maize, have to be satisfied to maximum capacity, prior to attainment of optimal income. However, additional production cost discourages most farmers engaging in hybrid maize production, (Kogbe and Adediran, 2003).

The resource use efficiency in hybrid and open pollinated maize production in the study area was computed using equation ($\frac{MVP}{MFC}$). The result of hypothesis test of resource use efficiency of hybrid compared with open pollinated maize, shows that all the resources used in the production of hybrid and open-pollinated maize were not efficiently utilized. Hence we reject the null hypothesis and conclude that there was in proper utilization of resources in the production of hybrid and open-pollinated maize.

Table 4.13: Efficiency of resource use in hybrid and open-pollinated maize production

Resources	Hybrid				Open-Pollinated			
	MPP	MVP	MFC	r = $\frac{MVP}{MFC}$	MPP	MVP	MFC	r = $\frac{MVP}{MFC}$
Seeds(Kg)	3.11	171.05	200	0.86	0.55	30.25	55	55
Fertilizer(Kg)	12.73	700.15	5000	0.14	0.09	4.95	5000	0.001
Labour(Man-day)	2.6	143	400	0.36	18.21	1001.55	400	2.50
Agrochemicals(Lit)	335.04	18427.2	950	19.40	127.7	7023.5	950	7.39
Herbicides(Litre)	174.8	9614	1100	8.74	9.27	509.85	1100	0.46

Source: Field survey, 2010. Marginal Value Product (MVP). $MVP = MPP * P_y$

4.6. CONSTRAINTS ENCOUNTERED BY FARMERS IN MAIZE PRODUCTION

The fifth objective of this study is to identify and compare the constraints associated with hybrid and open-pollinated maize production in the study area. Table 4.14 presents some of the constraints faced in maize production in the study area. The greatest constraint of hybrid and open-pollinated maize farmers is access to credit (about 20% and 20.3% respectively) this could be due to the in ability of farmers to obtain loan due to lack of collateral. This was followed by high cost of fertilizer and labour both ranking 2nd and 3rd for hybrid maize with 16.17% and 15.41% respectively. High cost of labour and fertilizer also tied ranking 2nd for open-pollinated maize with 16.1%. High cost of hybrid maize seed and storage, ranked 4th and 5th with 11.28% and 10.53% respectively for hybrid maize. Lack of adequate storage facilities leads to post harvest losses. However for open-pollinated maize, it was storage and pest and diseases attack with 11.9% and 10.0% respectively. High cost of herbicides and pesticides in hybrid and open-pollinated maize production tied in ranking 6th with 9.39% and

9.2% respectively. Possible reason, was due to lack of proper extension contacts on how to use the production inputs i.e herbicides and agrochemicals which were although expensive to obtain but over utilized due to poor management. Lastly hybrid maize farmers encounter problem of pest and diseases attack ranking 8th with 8.27% while high cost of seed ranked 8th with 7.3% for open-pollinated maize.

Table 4.14 Constraints to hybrid and open-pollinated maize production.

	HYBRID			OPEN		
Constraints	Freq	*%Response	Ranking	Freq	*%Response	Ranking
Lack of access to credit	52	65	1st	53	66.25	1st
High cost of fertilizer	43	53.75	2nd	42	52.5	2nd
High cost of labour	41	51.25	3rd	42	52.5	2nd
High cost of seeds	30	37.5	4th	19	23.75	8th
Lack of Storage facilities	28	35	5th	31	38.75	4th
High cost of herbicides	25	31	6th	24	30	6th
High cost of pesticides	25	31	6th	24	30	6th
Pest and Diseases	22	27.5	8th	26	32.5	5th

Source: Field survey, 2010. *Multiple response

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 SUMMARY

The broad objective of the study was to make comparative economic analysis between hybrid and open-pollinated maize farming in Giwa Local Government Area of Kaduna State. In order to achieve this goal, the study adopted a cross-sectional sample survey design. The list of both hybrid maize growers and open pollinated maize growers were obtained from the Agricultural Development Programme. This formed the sampling frame for selection of the sample. A multi-stage sampling procedure was applied to select 160 farmers involved in maize production. In the first stage, eight wards were purposively selected based on the intensity of maize production. Secondly, a community was also randomly selected from each of the wards. Finally, 20 maize farmers were selected, and interviewed from the list of households in the village to make up a sample size of 160. The result was analyzed through descriptive statistics, Gross margin analysis and production function analysis using Ordinary Least Square regression analysis and z-test and resource use efficiency.

Descriptive statistics was used to describe the socio-economic characteristics of hybrid and open-pollinated maize farmers as well as the various constraints faced by these farmers. A modal age group of 40-49 years for hybrid maize farmers and 50-59 years for open-pollinated maize farmers. Majority of hybrid maize farmers about 31% have tertiary education, while the open-pollinated maize counterpart has 33% majority in Quranic education. Analysis of farm size shows that majorities about 72% and 69% of hybrid and open-pollinated maize farmers respectively are small scale farmers cultivating less than 5ha of land. Majority (about 71%) of the hybrid maize farmers have less than 10years experience and only 7.5% of open-pollinated maize farmers have about 11-15years experience. About 38% of the hybrid maize

farmers have twice- a- month number of contacts with an extension agent while 28% of open pollinated maize farmers have once-in- two- month numbers of contact with an extension agent.

In terms of input-output level of hybrid and open-pollinated maize, the average yield per hectare obtained by hybrid maize farmers was 2240.6kg. This is obtained by using less quantity of hybrid seed (16.12 kg), some 6.04bags (i.e. 302kg) of fertilizer and 65.12 man-hours. On the other hand, the open pollinated maize farmers realized an average yield per hectare of 1261.04kg, through the use of 68.31kg of seed, 2.23bags (i.e 111.5kg) of fertilizer and 55.9 man-hours. The average quantity of agrochemicals and herbicide used in both hybrid and open pollinated maize production were 1.07lit and 0.79lit, 1.41lit and 1.36lit respectively. Less quantity of hybrid maize seed was required for optimal yield because hybrid maize is high yielding (IITA, 2010). Hybrid maize has integrated favourable qualitative qualities derived from breeding. These integrated qualities enable hybrid maize to adapt to diverse habitats, particularly during the growing period Crabb, (1947).

Cost and return analysis results of hybrid and open-pollinated maize farmers revealed that the total cost of production used in hybrid and open pollinated maize was ₦ 64,061.38/ha and ₦ 41,538.14/ha respectively. The gross-margin during the same period was ₦59171.6 and ₦ 27,819.06 per hectare. A mean difference in the gross margin of hybrid and open pollinated maize of 59,171.62 and 27,819.06 respectively at 1% level of probability was revealed, showing that hybrid maize production is more profitable than open-pollinated maize production.

An adjusted R^2 value of 0.59, for hybrid maize production and 0.82, for open-pollinated maize production was reported, implying that the inputs used in maize production explained 66% of the variation in the output of hybrid maize production and 85 % for open-pollinated

maize production in the study area. The numbers of significant variables were five for hybrid maize production namely farm-size (land); labour; and Fertilizer being significant at 5% level of probability and seeds and agrochemicals at 10% level of probability. Open-pollinated maize production on the other hand, had four significant variables namely farm size (land); labour and seeds were significant at 5% level of probability while fertilizer was significant at 10% level of probability.

The result of analysis of resource use efficiency of hybrid and open-pollinated maize shows that all resources ratios were not equal to one. The ratio indicates that sampled farmers underutilized agrochemicals and herbicides for hybrid maize production. The efficiency ratio for seeds, fertilizer and labour were less than one showing that the sampled farmers over-utilized seeds, fertilizer and labour on the farms.

5.2 CONCLUSION

This study has shown that hybrid and open-pollinated maize production are reasonably profitable ventures. However, the use of hybrid maize was found to be more profitable than the open-pollinated maize in the study area, although its productivity is still small. Possible reason for this near to the ground profit were due to the unpredictable pattern of rainfall, lack of funds and also lack of access to credit, lack of proper education and even when visited by extension agents to be enlightened on least cost combination for optimum productivity, the farmers (open-pollinated maize farmers) lack proper skill on how to comprehend the technicality of the package. Low yield of maize was also attributed to non-optimal use of some of the production inputs. However, higher outputs can be realized by increasing the level of resources dedicated to hybrid maize production principally by improving the farmer's contact to credits to purchase inputs like fertilizer and helpful services.

5.3 RECOMMENDATIONS

Based on the results of this study, the following recommendations were made.

(1) The farmers should organize co-operative society amongst themselves in other to obtain loans from such co-operatives and such co-operatives can serve as collaterals in obtaining loans from banks for production inputs like fertilizer, labour, agrochemicals and herbicides are accessible amongst the farmers at the start of the planting period at affordable rates.

(2) This study suggests the need to bring more area under hybrid maize cultivation, through special training, seminars, field demonstrations and technical support for the maize farmers. As most of the communities had no formal education, the extension program should be intended to the less educated farmers.

3)The National Agricultural Research Institutes and Organizations and seed companies interested in the improvement and production of hybrid maize should be encouraged to generate drought resistant and new stable, superior yielding hybrid varieties that can survive under minimum inputs like fertilizer, herbicides and agrochemicals at affordable prices; and

(4) In view of the fact that the production of hybrid and open pollinated maize is labour and capital intensive, mechanised farming with the use of tractors for ploughing, harvesting and threshing should be enhanced to encourage farmers, through adequate training by extension agents and cooperatives.

(5) Government plan should grant precedence to storage in order to build up and boost the maize reserve levels of farmers, thereby creating food sufficiency and security in maize production.

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APPENDIX A

Estimates of Input-Output relationship in hybrid and open-pollinated maize production using cobb-douglas production function.

VARIABLE	HYBRID			OPEN-POLLINATED		
	Co-efficient	Std-Error	T-value	Co-efficient	Std-Error	T-value
Constant	6.60	0.33	20.07***	6.55	0.45	14.55***
Farmsize	0.50	0.10	4.91**	0.72	0.09	7.82**
Seeds	0.05	0.03	1.98*	0.03	0.01	3.06**
Labour	0.37	0.08	4.62**	3.77	0.90	4.18**
Fertilizer	0.36	0.12	3.01**	1.61	0.10	16.1***
Agrochemicals	0.16	0.08	1.95*	0.08	0.08	1.01
Herbicides	0.11	0.08	1.38	0.09	0.09	1.01
R-squared	66%			85%		
Adjusted $\bar{R}^2$	0.59			0.82		
F-value	0.001***			22.72		
N	80			80		

Where *- Significant at 10%** probability level - Significant at 5% probability level*** - Significant at 1% probability level

APPENDIX B

QUESTIONNAIRE

DEPARTMENT OF AGRICULTURAL ECONOMICS AND RURAL SOCIOLOGY AHMADU BELLO UNIVERSITY ZARIA

Ward.....

Village.....

1. Age (years).....

2. Hybrid maize based cropping system

a) Sole maize-------- b) maize/sorghum----------

c) maize/soyabeans---- d) maize/cowpea----------

3. Open-maize based cropping system

a) Sole maize-------- b) maize/sorghum----------

c) maize/soyabeans---- d) maize/cowpea----------

4. How many years experience do you have in the chosen maize-based cropping system? a) Hybrid maize------- b) Open-pollinated maize

5. Educational level attained.

a) No formal Education----- b) Quranic Education--------

c) Primary Education--------- d) Adult Education-----

e) Secondary Education------- f) Tertiary education------ g) Others---------

6. Family size (including the household head)

a) No of Children less than 10years-----

b) Nso of children more than 10years----

c) No of other dependant----------

11. PRODUCTION VARIABLES (please fill only for the maize-based cropping system being considered)

a (i) Farm size for hybrid maize growers.

Field no	Field size(hectares)	Sole maize	Maize-based mixture
i			
ii			
iii			

a (ii) Farm size for open-pollinated maize growers.

Field no	Field size(hectares)	Sole maize	Maize-based mixture
i			
ii			
iii			

b (i) Seed quantity for hybrid maize growers

Field no	Sole maize		Maize-based mixture			
			Maize		Associated crop	
	Quantity(kg)	Cost(₦)	Quantity(kg)	Cost(₦)	Quantity(kg)	Cost(₦)
i						
ii						
iii						

b (i) Seed quantity for open-pollinated maize growers

Field no	Sole maize		Maize-based mixture			
			Maize		Associated crop	
	Quantity(kg)	Cost(₦)	Quantity(kg)	Cost(₦)	Quantity(kg)	Cost(₦)
i						
ii						
iii						

c (i) Fertilizer for hybrid maize growers

Field no	Sole maize			Maize-based mixture		
	Type of fertilizer	Quantity(kg)	Cost(₦)	Type of fertilizer	Quantity(kg)	Cost(₦)
i						
ii						
iii						

c (ii) Fertilizer foropen-pollinated maize growers

Field no	Sole maize			Maize-based mixture		
	Type of fertilizer	Quantity(kg)	Cost(₦)	Type of fertilizer	Quantity(kg)	Cost(₦)
i						
ii						
iii						

d (i) Pesticide for hybrid maize growers.

Field no	Sole maize			Maize-based mixture		
	Type of pesticide	Quantity(litres)	Cost(₦)	Type of pesticide	Quantity(litres)	Cost(₦)
I						
ii						
iii						

d (i) Pesticide for open-pollinated maize growers.

Field no	Sole maize			Maize-based mixture		
	Type of pesticide	Quantity(litres)	Cost(₦)	Type of pesticide	Quantity(litres)	Cost(₦)
i						
ii						
iii						

e (i) Herbicide for hybrid maize growers

Field No	Sole maize			Maize-based mixture		
	Type of herbicide	Quantity(litres)	Cost(₦)	Type of herbicide	Quantity(litres)	Cost(₦)
i						
ii						
iii						

e (i) Herbicide for open-pollinated maize growers

Field No	Sole maize			Maize-based mixture		
	Type of herbicide	Quantity(litres)	Cost(₦)	Type of herbicide	Quantity(litres)	Cost(₦)
i						
ii						
iii						

f) LABOUR INPUT

a (i) Land clearing for hybrid maize growers

Field no	Sole maize							Maize-based mixture						
	No of men	Days spent	No of women	Days spent	No of children	Days spent	Cost (₦)	No of men	Days spent	No of women	Days spent	No of children	Days spent	Cost (₦)
i														
ii														
iii														

a (ii) Land clearing for open-pollinated maize growers

Field no	Sole maize							Maize-based mixture						
	No of men	Days spent	No of women	Days spent	No of children	Days spent	Cost (₦)	No of men	Days spent	No of women	Days spent	No of children	Days spent	Cost (₦)
i														
ii														
iii														

b) i Ridging for hybrid maize

Field no	Sole maize			Maize-based mixture		
	No of persons	Days spent	Cost (₦)	No of persons	Days spent	Cost (₦)
i						
ii						
iii						

b) ii Ridging for open-pollinated maize

Field no	Sole maize			Maize-based mixture		
	No of persons	Days spent	Cost (₦)	No of persons	Days spent	Cost (₦)
i						
ii						
iii						

c (i) Planting for hybrid maize

Field no	Sole maize							Maize-based mixture						
	No of men	Days spent	No of women	Days spent	No of children	Days spent	Cost (₦)	No of men	Days spent	No of women	Days spent	No of children	Days spent	Cost (₦)
i														
ii														
iii														

c (ii) Planting for open-pollinated maize

Field no	Sole maize							Maize-based mixture						
	No of men	Days spent	No of women	Days spent	No of children	Days spent	Cost (₦)	No of men	Days spent	No of women	Days spent	No of children	Days spent	Cost (₦)
i														
ii														
iii														

d (i) Fertilizer application for hybrid maize growers

Field no	Sole maize							Maize-based mixture						
	No of men	Days spent	No of women	Days spent	No of children	Days spent	Cost (₦)	No of men	Days spent	No of women	Days spent	No of children	Days spent	Cost (₦)
i														
ii														
iii														

d (i) Fertilizer application open-pollinated maize growers

Field no	Sole maize							Maize-based mixture						
	No of men	Days spent	No of women	Days spent	No of children	Days spent	Cost (₦)	No of men	Days spent	No of women	Days spent	No of children	Days spent	Cost (₦)
i														
ii														
iii														

e (i) First weeding for hybrid maize growers

Field no	Sole maize							Maize-based mixture						
	No of men	Days spent	No of women	Days spent	No of children	Days spent	Cost (₦)	No of men	Days spent	No of women	Days spent	No of children	Days spent	Cost (₦)
i														
ii														
iii														

e (ii) First weeding for open-pollinated maize growers

Field no	Sole maize							Maize-based mixture						
	No of men	Days spent	No of women	Days spent	No of children	Days spent	Cost (₦)	No of men	Days spent	No of women	Days spent	No of children	Days spent	Cost (₦)
i														
ii														
iii														

f (i) Second weeding for hybrid maize growers

Field no	Sole maize							Maize-based mixture						
	No of men	Days spent	No of women	Days spent	No of children	Days spent	Cost (₦)	No of men	Days spent	No of women	Days spent	No of children	Days spent	Cost (₦)
i														
ii														
iii														

f (ii) Second weeding for open-pollinated maize growers

Field no	Sole maize							Maize-based mixture						
	No of men	Days spent	No of women	Days spent	No of children	Days spent	Cost (₦)	No of men	Days spent	No of women	Days spent	No of children	Days spent	Cost (₦)
i														
ii														
iii														

g (i) Harvesting for hybrid maize growers

Field no	Sole maize							Maize-based mixture						
	No of men	Days spent	No of women	Days spent	No of children	Days spent	Cost (₦)	No of men	Days spent	No of women	Days spent	No of children	Days spent	Cost (₦)
i														
ii														
iii														

g (ii) Harvesting for open-pollinated maize growers

Field no	Sole maize							Maize-based mixture						
	No of men	Days spent	No of women	Days spent	No of children	Days spent	Cost (₦)	No of men	Days spent	No of women	Days spent	No of children	Days spent	Cost (₦)
i														
ii														
iii														

h (i) Threshing for hybrid maize growers

Field no	Sole maize							Maize-based mixture						
	No of men	Days spent	No of women	Days spent	No of children	Days spent	Cost (₦)	No of men	Days spent	No of women	Days spent	No of children	Days spent	Cost (₦)
i														
ii														
iii														

h (ii) Threshing for open-pollinated maize growers

Field no	Sole maize							Maize-based mixture						
	No of men	Days spent	No of women	Days spent	No of children	Days spent	Cost (₦)	No of men	Days spent	No of women	Days spent	No of children	Days spent	Cost (₦)
i														
ii														
iii														

g (i) Output for hybrid maize growers

Field no	Sole maize		Maize-based mixture			
			Maize		Associated crop	
	Quantity harvested(kg)	Value(₦)	Quantity harvested(kg)	Value(₦)	Quantity harvested(kg)	Value(₦)
i						
ii						
iii						

g (ii) Output for open-pollinated maize growers

Field no	Sole maize		Maize-based mixture			
			Maize		Associated crop	
	Quantity harvested(kg)	Value(₦)	Quantity harvested(kg)	Value(₦)	Quantity harvested(kg)	Value(₦)
i						
iii						
iii						

7. Land ownership.

a) Rent--------- b) Inherited------- c) Purchased--------- d) leased----------

8) Did you rent the farmland on which you cultivated your crop? Yes----- No-------

9) If yes, how much did you pay as rent? ₦ ---------

10) Did you have access to credit during the farming season? Yes----- No--------

11) How many times were you visited by an Agricultural Extension Agent/Officer (ADP) during the growing season?----------

12. a). Do you face the following problems in the cultivation of hybrid maize whether as sole hybrid maize or in mixture with other crops?

S/No	Sole Hybrid-maize	Yes	No	Hybrid maize-based mixture	Yes	No

12. b). Do you face the following problems in the cultivation of open-pollinated maize whether as sole open-pollinated maize or in mixture with other crops?

S/No	Sole Hybrid-maize	Yes	No	Hybrid maize-based mixture	Yes	No