COMPARATIVE ANALYSIS OF FARMERS' EFFICIENCY OF IAR DEVELOPED GROUNDNUT VARIETIES FOR POVERTY ALLEVIATION IN NORTH WESTERN NIGERIA

BY

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

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DECLARATION

I hereby declare that this dissertation titled "**Comparative Analysis Of Farmer Efficiency Of IAR Developed Groundnut Varieties For Poverty Alleviation In North Western Nigeria**" was written by me and it is a record of my research work. No part of this work has been presented in any previous application for another Degree or Diploma at any institution. All borrowed informationhave been acknowledged in the text and a list of references provided.

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CERTIFICATION

This dissertation, titled "**Comparative Analysis of Farmer Efficiency of IAR Developed Groundnut Varieties for Poverty Alleviation in North Western Nigeria**" by Suleman MOHAMMED, meets the regulations governing the award of Degree of Master of Science in Agricultural Economics,Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

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I dedicate this study to Ahmadu Bello.

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ABSTRACT

This study analyzed the efficiency of groundnut farmer‘s in the adoption of IAR developed groundnut varieties for poverty alleviation in north western Nigeria. Primary data were obtained through the use of well-structured questionnaires from a sample size of 112 comprising of 56 adopters and 56 non-adopters of IAR groundnut varieties. The data were analyzed using descriptive statistics, logit regression, and Foster-Greer-Thorbecke's (FGT) Weighted Poverty Index. That the average age of adopters was approximately 47 years. The estimated coefficients of parameters of the production function such as seed and agrochemical were significant and had effect on efficiency. The mean technical efficiency index for adopters was 0.62 with a mean allocative efficiency index of 0.96 and mean economic efficiency index of 0.59.The mean technical efficiency index for non-adopters was0.56 with a mean allocative efficiency index of 0.74and mean economic efficiency index of 0.41. From the estimates of FGT weighted class of poverty indices, using the poverty line of ₦45,964.88, the poverty incidence on adopters of IAR groundnut varieties was 29% while that of the non-adopters was 51%. The poverty gap index for the adopters of IAR groundnut varieties who are poor was 0.31 while that of the non-adopters was 0.34. Also, the poverty severity index among those who adopted IAR groundnut varieties was 0.09 while those who did not adopt the varieties was 0.11.The logit regression analysis shows that there is the high likelihood that poverty level will be reduced as adopters of IAR groundnut varieties increase their level of efficiency. The constraints faced by the farmers adopting IAR developed groundnut varieties identified includes, the problem of pest and disease, inadequacy of capital and credit facilities.The evidence from this study suggests that IAR developed groundnut varieties contributed to poverty reduction in the study area, and increases the efficiency of the adopters of the improved varieties which further helps alleviate poverty in the study area. It is recommended that stakeholders should encourage groundnut farmers to adopt IAR developed groundnut.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Groundnut (*Arachishypogaea*) is ranked the 6th most important oil seed crop in the world(Mukhtar, 2009). Groundnut is grown on 26.4 million hectare worldwide, with a total production of 37.1 million metric tonnes and an average productivity of 1.4 metric tonnes /ha. Developing countries constitute 97% of the global area and 94% of the global production of this crop (Food and Agriculture Organization, 2011). The production of groundnut is concentrated in Asia and Africa, where mostly smallholder farmers under rain-fed conditions with limited inputs grow the crop. Nigeria was the third largest producer of groundnut in the world with a production of 2,962,760 tonnes. China and India produced16,114,231 and 6,933,000, respectively in 2011. In Nigeria, the crop is presently grown throughout the country with the exception of the riverine and swampy areas. Groundnut is either cultivated sole or in mixtures with other crops like maize, sorghum, millet or cassava. In Nigeria, the leading producing states include Niger, Kano, Jigawa, Zamfara, Kebbi, Sokoto, Katsina, Kaduna, Adamawa, Yobe, Borno, Taraba, Plateau, Nasarawa, Bauchi, and Gombe (NAERLS, 2011).

Groundnut has contributed immensely to the development of the Nigerian economy. From the year 1956 to 1967, Groundnut products including cake and oil accounted for about 70% of total Nigeria export earnings, making it the country's most valuable single export crop ahead of other cash crops like cotton, oil palm, cocoa and rubber (Harkness*et al.,* 1976).The oil content of the seed varies from 44 to 50 per cent, depending on the varieties and agronomic conditions.

Groundnut is used to produce groundnut oil. Groundnut oil is edible oil;It finds extensive use as a cooking medium. Groundnuts are also eaten raw, roasted or sweetened. They are rich in protein and vitamins A, B and some members of B2 group. Their calorific value is 349 per 100 grams. The residual oilcake contains 7 to 8% of N, 1.5% of P_2O_5 and 1.2% of K_2O and is used as a fertilizer. It is an important protein supplement in cattle and poultry rations. It is also consumed as confectionary product. The cake can be used for manufacturing artificial fibre. The haulms (plant stalks) are fed (green, dried or silage) to livestock. Groundnut shell is used as fuel for ‘manufacturing coarse boards, cork substitutes etc. Groundnut is also of value as rotation crop. Being a legume with root nodules, it can synthesize atmospheric nitrogen and therefore improve soilfertility .

The Institute for Agricultural Research (IAR) in collaboration with the International Crop Research Institutes for Semi-Arid Tropics,(ICRISAT) developed and released several groundnut varieties since 1990. The latest varieties developed and released are the SAMNUT24in 2011(allafrica.com,2014),SAMNUT 25 and SAMNUT 26in 2013(ICRISAT,2014).Other varieties are SAMNUT 1, SAMNUT 2, SAMNUT 3, SAMNUT 5, SAMNUT 6, SAMNUT 9, SAMNUT 10, SAMNUT 11, SAMNUT 16, SAMNUT 17, SAMNUT 18, SAMNUT 19, SAMNUT 20, SAMNUT 21, SAMNUT 22 and 23 SAMNUT. Part of the aims of releasing these improved groundnut variety is to ultimately improve the poverty status of the farmers **(Feyisipo,2013)**.

There tend to be a relationship between rural poverty and agriculture (Becerril and Abdulai, 2009). Agricultural technologies including developed seed varieties can help reduce poverty (Becerril and Abdulai, 2009). The effects of technology adoption on poverty reduction include productivity gains and lower per unit costs of production (Mendola, 2007). Increased productivity may generate higher income and stimulate development of the rural economy through multiplier effects, which also contribute to poverty reduction. Poverty contributes to poor agricultural productivity, as many farmers in Nigeria cannot afford to purchase necessary farm inputs such as fertilizers, pesticides and improved seeds, which would bring about increased productivity. In addition, the ability of poor farmers to purchase food necessary for maintenance of health and productive life is reduced.

Boosting agricultural growth by applying new technologies is one important way to reduce rural poverty. Agricultural technology development is an essential strategy for increasing agricultural productivity, achieving food self-sufficiency and alleviating poverty and food insecurity among smallholder farmers in sub-Saharan Africa (MuzariGatsi and Muvhunz,2012).Escaping poverty traps in the North West Zone of Nigeria may therefore be hinged on the adoption of improved groundnut varieties.Therefore the efforts of agricultural research institutes including that of IAR are indispensable.

1.2 Problem Statement

The yield of groundnut in Nigeria decreased largely from 16,492 kg/ha in 1990 to 10,000 kg/ha in 2010. One of the reasons is that drought and the rosette diseasehave being the bane of groundnut farmers and have led to farmers diverting their resources to the production of other crops **(Feyisipo,2013).**Secondly, the foliar diseases and the aflatoxin contaminationhas also plagued groundnut production(Bashir, 2012); furthermore insufficient improved seeds have affected its production(Bashir, 2012).The groundnut production that was so highhas dropped to a low ebb**(Feyisipo,2013).** Although since 2000 groundnut areas grew annually by 2.6% in Nigeria, It is reported that groundnut yield in Nigeria declines by 3.3% annually (ICRISAT, 2014).

Most of the groundnut varieties of IAR have shown to be widely accepted by farmers of the crop in the targeted ecological zone(ICRISAT, 2014**; Feyisipo,2013;**Abate *et al.*, 2011).The essence of these IAR improved varieties is to withstand drought, combat diseases, boost groundnut productivity, improve farmers income and ultimately livelihood.However, empirical reports on economic analysis of these varieties showing their productivity in North-Western Nigeria is lacking; furthermore, reports on the implication of the economic efficiency in production of these varieties on poverty alleviation for the farmers in this region is equally trace, given that, the NorthWest geopolitical zone has the highest average poverty rate (77.6%)(Sowunmi*et al.*, 2012).

In a view to fill up the research gap on the economic analysis of the IAR improved groundnut varieties and its implication on poverty alleviation for its farmers in North-West Nigeria,the questions of interest in this research were the following:

i. what are the socio-economic characteristics of farmers of IAR groundnut varieties?

ii. what is the economic efficiency of groundnut production by farmers cultivating IAR groundnut varieties ?

iii. what is the poverty status of the groundnut farmers cultivating IAR groundnut varieties?

iv. what are the factors influencing poverty status of farmers cultivating IAR groundnut varieties?

v. what is the implication of increasing efficiency of groundnut farmerswho are cultivating IAR groundnut varieties to poverty alleviation?

vi. what is the constraint faced by farmers cultivating IAR groundnut varieties ?

1.3 Objectives of the Study

The broad objective of this study was to analyze the efficiency of farmers adopting IAR developed groundnut varieties in North Western Nigeria and estimate the influence of their efficiency level on their poverty status. The specific objectives are to:

i. describe the socio-economic characteristics of farmers of IAR groundnut varieties

ii. determine the economic efficiency of groundnut production by farmers cultivating IAR groundnut varieties

iii. determine the poverty status of the groundnut farmers cultivating IAR groundnut varieties

iv. estimate the factors influencing poverty status of IAR groundnut farmers

v. describe the implication of increasing efficiency of groundnut farmers who are cultivating IAR groundnut varieties to poverty alleviation

vi. identify and describe the constraint(s) faced by famers of IAR groundnut varieties

1.4 Hypotheses

The hypotheses tested in this study were:

i. Socio-economic factors has no significant effect on thepoverty status of adopters of IAR groundnut varieties

ii. Economic efficiency has no significant effect on the poverty status of adopters of IAR groundnut varieties

1.5 Justification of the Study

This study is expected to provide valuable information on economic efficiency of growing IAR groundnut varieties to enable small-scale farmers consider its production as a viable option. This study focuses on economic efficiency of farmers of IAR groundnut varieties and poverty alleviation for small-scale farmers of the crop in North Western Nigeria. This will help farmers and other agencies by identifying problems and areas for improvements. Similarly, the study will be useful to the Federal Government of Nigeria, as a basis for rational and empirical policy formulation for IAR groundnut varieties production in the zone. Finally, it is hoped that this work will be of assistance to researchers who will identify other areas for further studies on IAR groundnutvarieties.

CHAPTER TWO

LITERATURE REVIEW

2.1 Origin and Distribution of groundnut

Groundnut (*Arachis hypogea)* also known as peanut is one o the world's principal oil seed crop. Groundnut originated in an area spanning southern Bolivia and northwest Argentina(Consultative Group on International Agricultural Research,2014). Indian tribe probably domesticated groundnut long before the Spanish Conquest. Spanish traders spread the groundnut to Asia and Africa and it is now grown in over 100 countries around the world.(Consultative Group on International Agricultural Research,2014). Groundnut is put into many uses. It is an economic crop. The haulms are important fodder for livestock, especially sheep and goat. The plant through its biological activities is an important soil fertility conserver. The nuts are consumed raw, roasted, boiled or as confectionary, snack nuts and peanut butter. The nut is crushed to produce oil, which is principally used for cooking. It is also used for other industrial purposes such as pharmaceuticals as carrier cosmetic. It is also used for the production of margarine; and the by-product meal cake is also consumed by humans and livestock (Ilu and Damisa, 2007).

2.2 Production of Groundnut in Nigeria

The production of groundnut in Nigeria started around 1912. This was in response to the worlds high prices; Nigeria was prominent among world producers since then. Nigeria became the largest producer and exporter of groundnut in the 60s with a production of 500,000 metric tons a year (Purseglove, 1988). Nigeria reached a peak production of 1.6 million metric tons in 1973. Production fell by almost half the 1973 figure in less than a decade, due to combination of two important factors. First, the drought of 1974/75 growing season, which brought with aphid infestation wiped more than 750,000 hectares of groundnut field (Ntare *etal*., 2005). This brought tremendous loss to both farmers and the merchants. Secondly is the oil boom in Nigeria which was about the same time (Ntare *etal*., 2005).The loss from groundnut and the availability of oil money transformed groundnut merchants to government contractors. Government on its part equally shifted its attention from agriculture as a whole to the oil industry (Ilu and Damisa, 2007). The table below shows world leading exporters of groundnut

Table 2.1 World leading Exporters of Groundnut

No.	Country	Share World Exporter(%)
1	China	26.00
2	USA	19.80
3	Argentina	16.00
4	India	9.10
5	Vietnam	8.20
6	South Africa	2.20

Source: Ilu and Damisa, 2007.

2.3 Economic Importance of groundnut

Groundnut is a significant source of cash, through the sales of seeds, cakes, oil and haulms (Olorunju, Alabi, and Tanimu, 1999). Groundnut plays an important role in the diets of rural populations, particularly children, because of its high contents of protein and carbohydrate. It is also rich in calcium, potassium, phosphorus, magnesium and vitamin E. Groundnut meal, a by-product of oil extraction, is an important ingredient in livestock feed. Groundnut haulms are nutritious and widely used for feeding livestock. The oil of groundnut is also used to make margarine and mayonnaise (Hui, 1996).

Confectionary products such as snack nuts, sauce, flour, peanut butter and cookies are made from high quality nuts of the crop. In the Northern part of Nigeria, apart from being consumed whole, edible groundnuts are processed into or included as an ingredient in a wide range of other products which includes, groundnut paste which is fried to obtain groundnut cake (*kulikuli)*, salted groundnut (*gyadamaigishiri)*, a gruel for porridge made with millet and groundnut (*kunungyada)*, groundnut candy *(kantungyada)* and groundnut soup (*miyargyada)*. The shells are used for fuel by some local oil factories or they are sometimes spread on the field as a soil amendment. They could also be used as bulk in livestock rations or in making chipboard for use in joinery (Mukhtar, 2009). Groundnuts can be used to produce over 330 products (Adama, 2000). Massive groundnut production is possible, with small improvement of technology and use of improved variety with corresponding increase in cultivated hectares (Adama, 2000).

Small scale groundnut production has been an integral part of rural economy. This is because proceeds from the production are used to complement other household’s income.

2.4 Concept of Efficiency

The decrease output of food production over the years may not only be connected with deviations of farmer’s practices from technical recommendations, but also with the use of resources at sub-optimal levels which ultimately leads to technical and allocative inefficiency (Coelli and Battese, 1996). An underling premise behind much of research in efficiency is that farmers are not making efficient use of existing technology, then efforts designed to improve efficiency would be more cost-effective than introducing new technologies as a means of increasing agricultural output (Belbase and Grabowski, 1985). Production efficiency has two components: technical and allocative efficiency.

Technical efficiency is the extent to which the maximum possible output is achieved from a given combination of inputs or the ability of a firm to obtain maximum output from a given set of input. Allocative efficiency is the ability of a firm to use inputs in optimal proportions given their respective prices and production technology (Coelli, Raoand Battese, 1998). Technical inefficiency occurs when the level of production for the firm is less than the frontier output and it increases when timing and methods of application of production inputs are mismanaged. Allocative inefficiency increases when the ratio of marginal products of input is not the same to the ratio of market prices (Bakhsh , 2007).

2.5 Profitability Analysis

This involves estimation of costs and return of production. Gomez (1975) developed a farm level model to evaluate alternative cropping mixtures and patterns. These involves as follows: (i) profitability: this is measured as the differences between value of yield and cost of production, and (ii) Net return: this involves the difference between value of yield and cost of inputs, including hired labour. In choosing economic indicators on the basis of production factors affected by potentials innovation. Werner (1993) suggested the use of the following: (i) the gross margin and returns to variable cost, where only capital is affected. (ii) Yield/labour ratio, where only labour is affected, and (iii) Gross margin, return to variable costs and monetary return to labour, where capital and labour are affected.

The major problems associated with cost-return analysis as basis for profitability assessment are: (i) It does not indicate the relative importance of each of the resources in production and (ii) It is location bound and specific in applicability due to use of money as the common unit of measurement and the prevailing price for estimates. According to Gomez (1975), in spite of the limitations, Cost-return analysis is a useful tool of enterprise comparison and indicating a profitability pattern of aggregate input use.

2.6 Poverty in Nigeria and its Causes

There is the evidence of Poverty in Nigeria. Its presenceremains significant despite high economic growth. It first started sometime during the British Empire. Nigeriahas one of the world's highest economic growth rates (averaging 7.4%over the last decade), a well-developed economy, and plenty of natural resources Such as oil. However, it retains a high level of poverty, with 63% living on below 1 dollar per daily, implying a decline in equity (Wikipedia, 2014).Causes of poverty include slow growth of total output or output per capita. This may emanate from lack of adequate savings in the economy for investment, or inability to invest the available savings productively to generate increases in physical assets that will lead to economic growth. Lack of technical knowledge, inadequate productive resources particularly capital also leads to poverty. Other causes are geographical and occupational factors. Some occurrences that can cause poverty include drought, flood, war, famine, etc. Others include location, family background, population, norms, cultural values, mismanagement of public resources, deprivation, exploitation, market imperfection, and low technological development and the vision and mission of government. There can also be some external factors such as political and international influences on forms of assistance, ban or restriction on the products of the countries or communities. These rub on poverty incidences and their alleviation. (Okuneye*et al*., 2004).

The northwest geopolitical zone has the highest average poverty rate (77.6%);this is followed by northeast (74.5%)**;**and northcentral (68.1%)(Sowunmi*et al.,* 2012). The southern zone has most of the industries and many export crops while the northern zone is largely rural and agricultural with a fragile agro – climatic environment and a different socioeconomic history (Sowunmi,*et al.*, 2012).

2.7 Poverty Status and Poverty Reduction among Farming Householdsin Nigeria

The link between poverty status and poverty reduction among the farming households is indirect through the relationship between productivity (efficiency), growth and poverty (Norman, 1975; Ajibefun, 2000; Ajibefun, 2002; Ater, 2003; Ajibefun and Daramola, 2003; Amalu, 2005). Bigsten*et al*. (2003), Amalu (2005) and Federal Republic of Nigeria (2007) argued that in order to reduce poverty, it is fundamental that economic policies should aim at promoting rapid economic growth. Furthermore, many authors believe that an effective approach towards more comprehensive poverty reduction is to enhance economic growth (Dollarand Kraay, 2002; Ravallion, 2001). Others argued that growth in incomes of the poor is strongly correlated with overall growth of the economy especially growth in the agricultural sector, and this fact has been demonstrated in cross-country and individual country studies (Hoekman*et al.*, 2001). Chirwa (2005) therefore argued that macroeconomic policies that promote growth in income are likely to lead into poverty reduction. For instance, with respect to agriculture, changes in price will provide incentives for agricultural production and specialization, which in turn may lead into growth and distribution of income through employment generation and revenue enhancement, and consequently poverty reduction (Chirwa, 2005).

It is worth noting that the agricultural sector remains the important sector for livelihood especially in rural Nigeria, which accounts for more than 70% of the population. According to Ajibefun (2002), there is crucial need to raise agricultural growth as such growth is the most efficient means of alleviating poverty. For Nigeria, raising productivity per area of land is the key to effectively addressing the challenges of achieving food security, as most cultivable land has already been brought under cultivation, and in areas where wide expanse of cultivable land is still available, physical and technological constraints prevent large-scale conversion of potentially cultivable land. The table below describes the extent of poverty in Nigeria between the periods 1980 to 2010.

Table 2.2: Relative poverty: Non-poor, Moderate poor and the Extremely poor (%), 1980-2010

Year	**Non-poor**	**Moderately poor**	**Extremely poor**
1980	72.8	21.2	6.2
1985	53.7	3.2	12.1
1992	57.3	28.9	13.9
1996	34.4	36.3	29.3
2004	43.3	32.4	22.0
2010	31.0	30.3	38.7

Source: National Bureau of Statistics. 2010

2.8 Poverty Alleviation Measures and Programmes

The earliest effort at poverty alleviation was made in 1972 by General Yakubu Gowon(Legislative Digest, 2014). He established the National Accelerated Food Production Programme (NAFPP), and the Nigerian Agricultural Co-operative Bank (NACB), which was devoted tofunding agriculture.

In 1976, Gen. OlusegunObasanjo introduced the Operation Feed the Nation (OFN) programme which, like the Gen. Gowon’s programme, was designed to encourage food

production and food security in an economy that had become increasingly dependent on crude oil (Legislative Digest, 2014).
President Alhaji Shehu Shagari established the Green Revolution Programmein 1979. The aim of this programme, like the one before it, was primarily to provide more food for the teeming Nigerian population. Gen. Ibrahim Babangida in 1986 established the People's Bank (PB) and empowered it to offer soft loans to prospective entrepreneurs without collaterals. Community Banks were encouraged to exist as adjuncts to the People's Bank and the PB regulated their activities. The Directorate of Food Roads and Rural Infrastructure (DFFRI) was created in 1986 with a mandate to open up rural areas through massive construction of feeder roads and provision of basic amenities which would transform them into production centers for the national economy. The hinterland was to be opened and made more accessible so that farmers could transport their produce to the markets easily at cheaper rates, thereby reducing the cost of food production(Legislative Digest, 2014).

The Nigerian Agricultural Land Development Authority (NALDA) was another programme that General Babangida created in 1986 which targeted the agricultural sector and was aimed at encouraging large scale commercial farming by assisting farmers with inputs and developing land for them to the point of planting, at subsidized rates. This was to reduce the prevalence of subsistence agriculture in the country. The Structural Adjustment Programme (SAP) was also established during the Babangida administration stressed greater need for the realization of policies and programmes to alleviate poverty and provide safety nets for the poor.

The National Directorate of Employment (NDE) also introduced in 1986. The NDE was mandated to design and implement programmes to battle the menace of mass unemployment and also to articulate policies that would develop work programme with labour intensive potentials.The late Gen. SaniAbacha in 1993 introduced the Family Economic Advancement Programme (FEAP).

Programmes like the Better Life for Rural Women by the late Mrs. Maryam Babangida, and the Family Support Programme (FSP) spearheaded by Mrs. Mariam Abacha established in 1986 and 1993 respectively were, like other programmes before them, initiatives designed to bail out Nigerians from debilitating poverty. In 1999, the civilian administration of President OlusegunObasanjo formulated National Poverty Eradication Programme (NAPEP) which came to being in 2001 with the aim of wiping out poverty from Nigeria by the year 2010. (Legislative Digest, 2014).The over-riding objective of government's poverty alleviation policy is to broaden the opportunities available to the poor and ensure that every Nigerian has access to basic needs of life, food, potable water, clothing, shelter, basic health services and nutrition, basic education and communication. The overall goal is improved living conditions for the poor. The goals are, of course, an array of sector specific objectives to be pursued in order to ensure the success of the policy. Nigeria's poverty alleviation is buttressed on the integration of the citizens into an economically, politically and socially sound society with equal opportunities to live a healthier, richer and fuller life. It is now obvious that rural poverty alleviation cannot be accomplished without ensuring rural dwellers' access to resources and opportunities.

National Economic Empowerment and Development Strategy (NEEDS) is Nigeria's home grown poverty alleviation medium-term (2003-2007) strategy, which derives from the country's long-term goals on poverty reduction, wealth creation, employment generation, and value orientation (Federal Government of Nigeria, 2004). It is a nationally coordinated framework of action in close collaboration with the state and local governments (with their State Economic Empowerment and Development Strategy, SEEDS).

2.9 Review of Empirical Models

2.9.1 Stochastic Frontier Analysis

The stochastic frontier production function is a method of economic modeling. It has its starting point in the stochastic production frontier models simultaneously introduced by Ogundari, Ojo, and Ajibefun, (2006), Rahman and Umar (2009), Thomas (2007) and others which derived from the error model of Aigner, Lovell and Schmidt, (1977) and Meeusen and Vanden Brock (1977). The stochastic frontier production function is specified as:

$$Y_i = f(x_i.\beta) + e_i \quad \text{......} 1$$

$$e_i = v_i - u_i \quad \text{......} 2$$

where:

Y_i = Quantity of output of the i^{th} farm

x_i= Vector of the inputs used by the i^{th} farm

β = A vector of the parameters to be estimated

e_i = Composed error term

v_i= Random error outside farmer's control

u_i =Technical inefficiency effects

f (x_i, β) = A suitable function of the vector

This according to Ogundari, Ojoand Ajibefun, (2006), it has been used by many empirical studies, particularly those relating to agriculture in developing countries and also that the functional form meets the requirement of being self-dual (allowing an examination of economic efficiency):

$$\ln Y = \beta o + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + (Vi\text{-}Ui) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..3$$

where,

ln = the natural logarithm

Y = output of groundnut (ha)

βo = constant term

β_1- β_3 = regression coefficients

X_1 = quantity of seed (kg)

X_2 =quantity of fertilizer (kg)

X_3 = total labour used (man days)

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

U_i = deviation from maximum potential output attributable to technically inefficiency.

The inefficiency of production, U_i was modeled in terms of the factors that are assumed to affect the efficiency of production of farmers. Such factors are related to the socio-economic and management variables of the farmers. The determinant of technical inefficiency is defined by:

$$U_i = \delta_0 + \delta_1 1nZ_1 + \delta_2 \ln Z_2 + \delta_3 \ln Z_3 + \delta_4 \ln Z_4 + \delta_5 \ln Z_5 + \delta_6 \ln Z_6 \ldots\ldots\ldots\ldots\ldots\ldots..4$$

These variables are assumed to influence technical efficiency of the groundnut farmers. The gamma ($\gamma = \sigma^2$ μ/ ($\sigma 2$ μ +σ ν) which is the ratio of the variance of U σ^2 μ to the sigma squared ($\sigma^{2)}$ which is a summation of variances u and v of U and V ($\sigma^2 = \sigma^2 \mu + \sigma^2 \nu$) are also determined.

On the other hand, u_i is a non-negative truncated half normal random variable associated with farm- specific factors which lead to the ith farm not attaining maximum efficiency of production. U_i is associated with technical inefficiency of the farm and ranges between zero and one. $U_i$follows an independent and identical half-normal distributed N ($0.\delta^2 u$). N represents the number of the farms involved in the cross-sectional survey. According to Bakhsh (2007), stochastic frontier production function model is estimated using the maximum likelihood estimation procedure (MLE).

The stochastic frontier cost function is defined by:

$$C = F\,(Wi, Yi; \alpha)\ \exp ei \quad i = 1,2 \ldots.n \text{ --- } 5$$

Where,

C = Represents the minimum cost associated with groundnut production

W= Vector of input prices

Y = groundnut output

α = Vector of parameters

ei = Composite error term

Using Sheppard's Lemma we obtain

$$\frac{\partial C}{\partial Pi} = Xi\,(W, Y; \alpha) \text{ --- } 6$$

This is a system of minimum cost input demand equations (Bravo – Ureta and Evenson, 1994; Xu and Jeffrey, 1995 and Bravo-Ureta and Pinheiro, 1997). Substituting a farm's input prices and quantity of output in equation (6) yields the economically efficient input vector Xc.. With observed levels of output given, the corresponding technically and economically efficient costs of production will be equal to X_{it} P and X_{ie}, respectively. While the actual operating input combination of the farm is Xi P. The three cost measures can then be used to compute the technical (TE) and economic efficiency (EE) indices as follows;

$$TE = (X_{it}. P) / (X_i. P) \text{ ----- } 7$$

$$EE = (X_{ie}. P) / (X_i. P) \text{ ----- } 8$$

The combinations of equations (7) and (8) is used to obtain the allocative efficiency (AE) index following Farrell (1957)

$$AE = EE / TE = (X_{ie}. P) / (X_i. P) \text{ ----- } 9$$

$$Y^{*}=(X_i;\beta) - U \text{ ----- } 10$$

Where U can be estimated as

$$E(U_i / \varepsilon_i) = \frac{бλf^{*}(\varepsilon_i λ / б) - \Sigma_i λ}{1+ λ^2 1-f^{*}(\varepsilon_i λ)} \text{ ----- } 11$$

Where f*(.) and f(.) are normal density and cumulative distribution functions respectively.

$λ = б u / б v$

$\varepsilon = V_i - U_i$ and;

Y* is the desired output adjusted for statistical noise

Whenε_i, б andλ estimates are replaced in equation (9) and (10), it will provide estimates for U and V.The term V is a symmetric error,which account for random variations in output due to factors beyond the control of the farmer e.g. weather, disease outbreaks, measurementerrors, etc. The term U are non-negative random variables representing inefficiency in production relative to the stochastic frontier. The random error V_i is assumed to be independently and identically distributed as N(o, δv^2) random variables independent of the $U_i$swhichareassumed to be non-negative truncation of the N(o,δu^2)distribution (i.e. half-normal distribution) or have exponential distribution.

2.9.2 Theoretical Basis of Foster, Greer and Thorbecke(FGT) Weighted Poverty Index

This model is widely used in studies on impact of agricultural technologies adoption on poverty status of farming households (Dontsop-Nguezet*et al.*, 2011; Asfaw*et al.*, 2009; Kassie, Shiferaw, and Muricho, 2010, Omilola, 2009; Mendola, 2007; Rahman, 1999).Usually, there are three steps involved in the measurement of poverty. These are choosing a quantitative welfare indicator, choosing a means of discriminating between the poor and non-poor (through the use of a poverty line), and aggregating this information into a poverty measure for a particular population (Omonona, 2009).

The three most widely used measures of income/consumption quantitative poverty analysis are the poverty headcount ratio, the poverty gap, and the squared poverty gap or poverty severity (Omilola, 2009). This is because these three poverty indexes satisfy many of the basic desirable properties of poverty measures, particularly the property of being additively decomposable with population share-weights. These three most widely used poverty indexes are usually expressed as members of a class of measures proposed by Foster, Greer, and Thorbecke (1984).The General Foster, Greer and Thorbecke (FGT) poverty index ($P_{\alpha i}$) can be expressed as:

$$P_{ai} = \frac{1}{n}\sum_{i=1}^{q}\left(\frac{z-y_i}{z}\right)^{a} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. (12)$$

Where:

n = number of households in a group

q = the number of poor households

z = poverty line

y = the per capita expenditure (PCE) of the i^{th} household,

α = degree of poverty aversion(0, 1 and 2)

Poverty headcount index(α = 0)

$$P_0 = \frac{1}{n}\sum_{i=1}^{q}\left(\frac{z-yi}{z}\right)^{0} = \frac{q}{n} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. (13)$$

The poverty headcount index is the share of the population whose income or consumption is below the poverty line; that is, the share of the population that cannot afford to buy a basic basket of goods. The headcount ratio fails to account for the degree of poverty by ignoring the extent of the shortfall of incomes of the poor from the poverty line (Omilola, 2009). For instance, the headcount ratio will remain the same when there is a reduction in the income of all the poor without affecting the income of the rich if the poverty line is relative. In other words, the headcount ratio will be unaffected by a policy that makes the poor even poorer since it is not sensitive to distribution of income among the poor.

Poverty gap index($\alpha = 1$)

$$P_1 = \frac{1}{n}\sum_{i=1}^{q}\left(\frac{z - yi}{z}\right)^1 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. (14)$$

The poverty gap index provides information regarding how far households are from the poverty line. This measure captures the mean aggregate income or consumption shortfall relative to the poverty line across the whole population. The poverty gap measure has an advantage over the headcount ratio in the sense that it will be increased when there is income transfer from poor to non-poor, or from poor to less poor who thereby become non-poor(Omilola, 2009). Although the poverty gap index takes both the incidence and depth of poverty into account, it is insensitive to inequality among the poor.

Poverty squared gap index($\alpha = 2$)

$$P_2 = \frac{1}{n}\sum_{i=1}^{q}\left(\frac{z - yi}{z}\right)^2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. (15)$$

The poverty squared poverty gap index takes into account not only the distance separating the poor from the poverty line (the poverty gap), but also the inequality among the poor; that is, a higher weight is placed on those households further away from the poverty line. This measure takes account of the incidence of poverty, the depth of poverty, and the inequality among the poor. It rises when the number of poor people increases, or the poor get poorer, or the poorest get poorer in comparison with other poor people. We might want to prefer the squared poverty gap measure to others, but in practice it is of interest to look at all three measures. It should be noted that these poverty measures take values between 0 and 1, with numbers close to 0 indicating little poverty and those closer to 1 suggestinghighpoverty (Omilola, 2009).

Poverty Line: Poverty Line is a measure that divides the poor from non-poor using the mean per capita household expenditure (NBS, 2012). One-third of it gives (separate) the extreme or core poor from the rest of the population while two-third of the mean per capita expenditure separate the moderate poor from the rest of the population.

2.9.3 Theoretical Framework for Logit Model

Logistic regression is a popular statistical technique in which the probability of a dichotomous outcome (such as poor or non-poor) is related to a set of explanatory variables that are hypothesized to influence the outcome (Shideed and El Mourid, 2005). The preference for the probability model (logit) to the conventional linear regression models, in estimating the factors influencing the poverty status of farmers is based on the fact that, the parameter estimates from the former are asymptotically consistent and efficient. The estimation procedure also resolves the problem of heteroscedasticity. Logit model is chosen over probit model in econometric analysis primarily because of its mathematical convenience and simplicity (Green, 2008).

The application of the logit model in the estimation of the factors influencing poverty status have been widely used by researchers.Amao*et al*. (2009), used the logit modelin their studies, ‘Determinants of Poverty among Fish Farming Households in Osun State, Nigeria’ used the logit model. Eneyew*et al.*(2014) also used the logit model to determine the role ofsmall scale irrigation in poverty reduction; Aliero and Ibrahim (2012), investigated whether access to financial services reduces poverty in Nigeria, and their choice model for the research was the logit model.Achia, Wangombeand Khadioli,(2010) also used a logistic regression model to identify key determinants ofpoverty.

Going by Green (2008) and Gujarati (2003) the logit model for the factors influencing poverty status can be specified as:

$$P_i = \frac{1}{1 + e^{-z_i}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (16)$$

Where, P_i is a probability of ‘being poor’ for the i^{th} farmer and ranges from 0 to 1. e represents the base of natural logarithms and Z_i is the function of a vector of n explanatory variables and expressed.

$$Z_i = \beta_0 + \sum \beta_i X_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots .. (17)$$

Where:

β_0 = intercept

β_i= vector of unknown slope coefficients.

The relationship between $P_i$andX_i, which is non-linear, can be written as follows:

$$P_i = \frac{1}{1 + e^{\beta_0 + \beta_i X_i + \ldots\ldots\ldots + \beta_n \beta_n}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (18)$$

The slopes tell how the log-odds in favour of being poor as independent variables change. If $P_i$is the probability of 'being poor' then 1- P_i represents the probability of 'not being poor' and can be written as:

$$1 - P_i = \frac{1}{1 + e^{-z_i}} = P_i = \frac{e^{z_i}}{1 + e^{-z_i}} = P_i = \frac{1}{1 + e^{z_i}} \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots (19)$$

Dividing equation (1) by equation (4) and simplifying gives:

$$\frac{P_i}{1 - P_i} = \frac{1 + e^{z_i}}{1 + e^{-z_i}} = e^{z_i} \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots (20)$$

Equation (5) indicates simply the odd-ratio in favour of 'being poor'. It is the ratio of the probability that the farmer is 'poor' to the probability that he is 'not poor'. Finally, the logit model is obtained by taking the logarithm of equation (5) as follows.

$$l_i = \frac{P_i}{1 - P_i} = Z_i = \beta_0 + \beta_i X_i + \cdots \dots \dots \dots \dots \dots \dots \dots \dots + \beta_n X_n \dots \dots \dots \dots \dots \dots \dots (21)$$

Where l_i is log of the odds ratio, which is not only linear in X, but also linear in the parameters: Thus, if the stochastic disturbance term $u_i$is taken into account, the logistic model becomes:

$$Z_i = \beta_0 + \beta_i X_i + \cdots \dots \dots \dots \dots \dots \dots \dots \dots + \beta_n X_n + u_i \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots . (22)$$

This econometric model is estimated using the iterative Maximum Likelihood Estimation (MLE) procedure due to the nonlinearity of the logistic regression model.

The MLE procedure yields unbiased, asymptotically efficient, and normally distributed regression coefficients (parameters).

CHAPTER THREE

METHODOLOGY

3.1 Description of the Study Area

The study area is the North-West geo-political zone of Nigeria. The North West zone lies between latitudes 10°00'N and 13°54'N and longitudes 03°25'E and 11°30'E.It includes Jigawa, Katsina, Kaduna, Kano, Kebbi, Zamfara, and Sokoto states. Census reports in 2006 shows that, 35.7 million is the estimated population for the zone. The average density of the area is 103 persons per square kilometer. The projected population of the area in 2013 is about 44.1million (NPC,2006) considering the annual growth rate of 3.2%. The vegetation is typically savanna; the grass land ecology is distinguished by Sahel, Sudan and Northern Guinea Savanna. However for the sake of this study, Sokoto, Kebbi, Jigawa and Zamfarahas been considered. This is because they have partly the Sahel savanna and are part of the targeted ecological zone for IAR groundnut varieties.

3.1.1 Jigawa state

Jigawa state lies between latitude11°N and 13°N and longitudes 8°00'E and 10°35′E and shares a common border with Kano and Katsina state to the west, Bauchi state to the south-east, Yobe state to the east and Republic of Niger to the north. Its population is put at 4, 361, 002 people in 2006 (NPC,2006) and a growth rate of 3.2 percent per annum.80% of the population is found in the rural areas and is made up of mostly Hausa, Fulani and Manga (a Kanuri dialect). The climate of the state is characterized by two distinct seasons; the rainy and dry seasons.The southern part of the state has higher rainfall percentage than the northern part. High temperatures are normally recorded between the months of April and September. Agriculture is considered as the major economic activity and over most of the population is engaged in farming and animal husband,though, commerce is undertaken on small and medium scale especially in agricultural goods, livestock, and other consumer goods.The climate of the area favours the production of crops such as maize, beans, groundnut, guinea corn, millet, cotton, yam, carrot, sugarcane, tomatoes, pepper, onions garden eggplant, lettuce, amaranthus and tobacco.

3.1.2 Sokoto

Sokoto State is located in the extreme Northwestern part of Nigeria. It is located between latitudes 4°-6°40'N and longitudes 11°30'-15°50'E. The State has an estimated population of 3,696,999 (NPC, 2006).There are two distinct seasons in the state; the rainy season starts around May and last till September and the dry season from October to April. The annual rainfall is frequently erratic, poorly distributed and varies from 500mm to 1300mm (SMANR 1998). There are two temperature extremes; the hot period (March to May) which is as high as 39°C and the cold harmattan months of December to January, when cold,dust-laden winds blow from across Sahara bringing down the temperature to as low as 15°C averaging about 27°C (SMANR 1998). The climate of the state is largely controlled by two recasting air masses. The moist tropical maritime from the south which blows from the Atlantic Ocean and the tropical continental wind from the north across the Sahara, which is dry and dusty that brings the harmattan (SMANR, 2007). The rainy season is from June to October, The mean annual rainfall is 750 mm and potential evapotranspiration rate has been reported to be 102cm.

3.1.3 Kebbi

Kebbi State is located in North Western part of Nigeria. It lies between latitudes 10°and 13°N and longitudes 3° and 6°W. The state is bounded by SokotoState to the North and East, Niger State to the South, and Benin Republic to the West. The State has an estimated population of 3, 238,628. (NPC, 2006).The area falls within the dry Savanna agro ecological zone of Nigeria with an average annual rainfall of between 650mm and 1100mm, with distinct wet (May- October) and dry (November- April,) seasons. Over two thirds of the estimated populations of about 2,051,831 people are engaged in agricultural production, mainly on arable crops, alongside few cash crops with aspects of animal husbandry. The state is also divided into four Agricultural Development zones namely; Zone I (Argungu), Zone II, (Bunza), Zone III (Zuru) and Zone IV (Yauri).

3.1.4 Zamfara

The state lies between latitudes 10°50'N and 13°38'N and longitudes 4° 16'E and 7°18'E.The state is located in the Sudan savanna ecological Zone of Nigeria.It has a land area of 39,762km^2.Zamfara state shares common borders with Sokoto and the Republic of Niger to the North, Katsina and Kaduna states to the east, Niger and Kebbi states in the south (Zamfara state,2010).The state has a population of about 3,259,846 people in 2006 according to the National population commission (NPC, 2006). The climate is essentially that of tropical climate. The climate is generally characterized by alternating dry and wet seasons. The rains usually commence in May/June and end in September/October. The effective rainy season in the study area is restricted to July to mid-September (Yakubu, 2005).The mean annual rainfall ranges between 969mm and 1,086mm.

Relative humidity varies between 24% in January and rises to 85% in September. The mean annual temperature also varies from 29°C to 37°C (Zamfara state,2010). The main ethnic groups in these areas are Hausa, Beriberis, Buzzaye and Fulanis. Indeed agriculture forms the main occupation of the entire population. This constitutes the bulk of those involved in traditional farming, fishing, hunting and nomadic pastoralism.

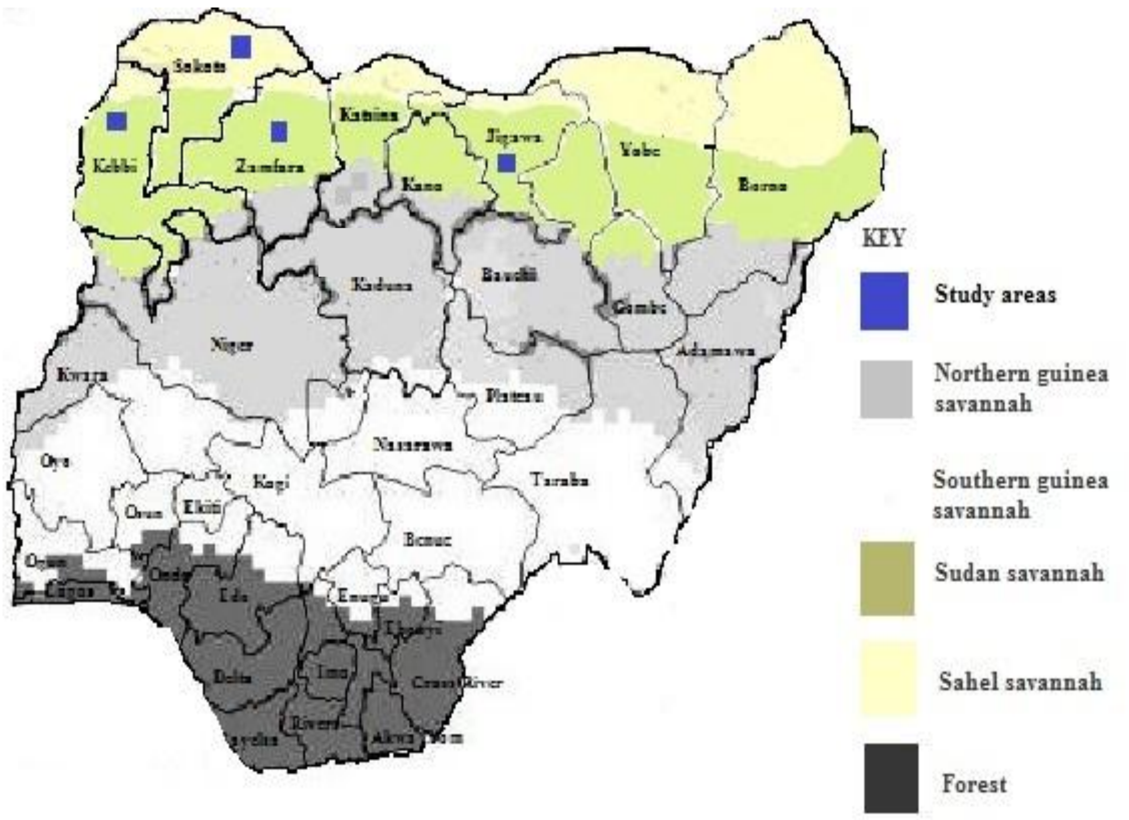

Figure 3.1: Map of Nigeria Showing the Study Area
Source: Adapted from Damisa *et al*. (2011).

3.2 Sampling procedure and Sample Size

A multi-stage sampling technique was employed in selecting the groundnut farming households in the study area (Jigawa, Zamfara, Sokoto, and Kebbi state).

The first stage was the purposive selection of two Local Government Areas fromJigawa (Gumel and Kaugama) Zamfara (Kaura Namoda and Anka), Sokoto (Wamako and Tambuwal), and Kebbi (Fakai and Arewa) states respectively. These Local Government Areas were selected on the basis of being prominent groundnutproducing areas of the

States. Secondly, one village from each of the eight selected Local Government Areas were randomly selected to give eight villages (Gumel, Kaugama,Banga, Waramu, Wamako, Tambuwal, Uchiri and Gumude). Thirdly, quota sampling method was employed in selecting 14 groundnut farming households (consisting of 7 adopters and 7 non-adopters of IAR groundnut varieties) from each Local Government to give a sample size of 56 adopters and 56 non-adopters of IAR groundnut varieties (that is, a total of 112 groundnut farming household). The use of purposive sampling was due to the unavailability of reliable sample frame for groundnut farming households in the sampled villages at the time of the survey.

Table 3.1 Distribution of sample size of the respondents

States	**L.G.A**	**Villages**	**Sample frame**	**adopters**	**Non-adopters**
Jigawa	Gumel	Gumel	NA	7	7
	Kaugama	Kaugama	NA	7	7
Zamfara	Kaura Namoda	Banga	NA	7	7
	Anka	Waramu	NA	7	7
Sokoto	Wamako	Wamako	NA	7	7
	Tambuwal	Tambuwal		7	7
Kebbi	Fakai	Uchiri	NA	7	7
	Arewa	Gumude	NA	7	7
Total				**56**	**56**

NA= Not Applicable

3.3 Method of Data Collection

Primary data was used for this study. This was obtained through the use of well-structured questionnaire administered to household heads using well trained enumerators. The data collected during the field survey included, quantity of seed, fertilizer, labour, agrochemical, cost of seed, cost of agrochemical, cost of labour, cost of land, age, marital status, household size, farm size, income, access to credit, number of extension contacts, level of education of household heads and the household size and household expenditure.

3.4 Analytical Technique

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

3.4.1 Descriptive statistics

This involves the use of frequency, percentage and mean to achieve objectives (i) (v) and (vi) of the study.

3.4.2 Stochastic Frontier Analysis

Stochastic frontier production function was used to achieve objectives (ii):

$$Y_i = f(x_i.\beta) + e_i \quad \text{.......} 23$$

$$e_i = v_i - u_i \quad \text{.......} 24$$

where:

Y_i = Quantity of output of the i^{th} farm

x_i= Vector of the inputs used by the i^{th} farm

β = A vector of the parameters to be estimated

e_i = Composed error term

v_i= Random error outside farmer's control

u_i = Technical inefficiency effects

$f(x_i, \beta)$ = A suitable function of the vector

$$\ln Y = \beta o + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_3 \ln X_3 + (V_i - U_i) \ldots\ldots 25$$

where,

ln = The natural logarithm

Y = Output of groundnut (kg)

βo = Constant term

β_1- β_5 = regression coefficients

X_1 = Farm size (ha)

X_2 = Quantity of seed (kg)

X_3 =Quantity of fertilizer (kg)

X_4 = Total labour used (man days)

X_5= Agrochemical (litres)

Vi = Random variability in the production that cannot be influenced by the farmer.

U_i = Deviation from maximum potential output attributable to technically inefficiency.

The inefficiency of production, U_i was modeled in terms of the factors that are assumed to affect the efficiency of production of farmers. Such factors are related to the socio-economic and management variables of the farmers. The determinant of technical inefficiency is defined by:

$$U_i = \delta_0 + \delta_1 1nZ_1 + \delta_2 \ln Z_2 + \delta_3 \ln Z_3 + \delta_4 \ln Z_4 + \ldots \delta_5 \ln Z_5 \ldots\ldots 26$$

where,

U_i = inefficiency effects

Z_1 = Age of farmer (years)

Z_2 = Household size (number)

Z_3 = Education (years of formal schooling)

Z_4 = farm income

Z_5 = farming experience

δ_0 = constant

δ_1-δ_9 = Parameters to be estimated.

Stochastic Frontier Cost Function

$$C = F(W_i, Y_i; \alpha) \exp e_i \quad i = 1,2 \ldots n \text{ ---} 27$$

$$\ln C = a + P_1 \ln X_1 + P_2 \ln X_2 + P_3 \ln X_3 + P_4 \ln X_4 + P_5 \ln X_5$$

Where,

C = Represents the minimum cost associated with groundnut production

W= Vector of input prices

Y = groundnut output

α = Vector of parameters

e_i = Composite error term

P_1= cost of land (in Naira)

P_2= cost of seeds (in Naira)

P_3 = cost of labour (in Naira)

P_4 = cost of fertilizer (in Naira)

P_5 = cost of agrochemicals (in Naira)

The economic efficiency was determined by the product of the technical efficiency and the allocative efficiency i.e.

EE= TE * AE

EE = Economic efficiency

TE = Technical efficiency

AE = Allocative efficiency

3.4.3 Foster-greer-thorbecke's (FGT) weighted poverty index

The Foster, Greer and Thorbecke (FGT) measures of poverty are widely used because they are consistent and additively decomposable (Foster,Greerand Thorbecke, 1984). This will be used to achieve objective (iii) of this study. Poverty head count index, poverty gap index and squared poverty gap index will be computed to measure the incidence, depth and severity of poverty among the groundnut farming households. A relative poverty line will be constructed based on the Mean Per Capita Household Expenditure (MPCHHE) of the groundnut farming households. The General Foster, Greer and Thorbecke (FGT) poverty index ($P_{\alpha i}$) can be expressed as:

$$P_{ai} = \frac{1}{n}\sum_{i=1}^{q}\left(\frac{z - y_i}{z}\right)^a \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (28)$$

Where:

$$a = 0, \qquad P_0 = \frac{1}{n}\sum_{i=1}^{q}\left(\frac{z - yi}{z}\right)^0 = \frac{q}{n} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. (29)$$

i.e poverty incidence or head count

$$a = 1, \qquad P_1 = \frac{1}{n}\sum_{i=1}^{q}\left(\frac{z - yi}{z}\right)^1 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. (30)$$

i.e poverty gap or depth

$$\alpha = 2, \qquad P_2 = \frac{1}{n}\sum_{i=1}^{q}\left(\frac{z - yi}{z}\right)^2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots . (31)$$

i.e. poverty severity

Where:

n = Number of households in a group

q = The number of poor households

z = Poverty line(2/3 Mean Per Capita Household Expenditure (MPCHHE) of the groundnut farming households)

y = The per capita expenditure (PCE) of the i^{th} household,

α = Degree of poverty aversion(0, 1 and 2)

3.4.4 Logit Regression Model

Logit regression model was used to achieve objective (iv) of this study.Poverty status was the dependent variable, and was determined by independent variables such as farm size, household size, education, access to extension services, farm income, membership of cooperative, and economic efficiency of the farmer.

The dependent variable was binary ('1' if the household is poor and '0' if the household is non-poor). Following Gujarati (2003), the probability that the i^{th}household is poor is given by:

$P_i = E(Y = 1/Xi) = 1/1 + e^{-(\beta 0 + \beta 1 \chi i)}$) ---32

For ease of exposition, the probability that a given household was poor was expressed as:

$P_i = 1/1 + e^{-z}$ ---33

Probability for not poor was 1 - P_i.. Thus,

$$P_i/1-P_i = 1 + e^{z}/1+ e^{-(zi)}$$ ---34

was the ratio of the probability that a household was poor to the probability that the household was non-poor. The natural log of Equation 34 was:

$$L_i = \ln[P_i / 1-P_i] = Z_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + ---------- + \beta_7 X_7$$ ------------------------------------35

Where P_i is a probability of being poor ranges from 0 to 1, Z_i is a function of n explanatory variables (X) which is also expressed as:

$$Z_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + ------------ + \beta_7 X_7$$ --- 36

β_0 is an intercept; β_1, β_2 ,------------- β_7 are the slopes of the equation, L_i is log of the odds ratio, which is not only linear in X_i but also linear in the parameters, X_i is vector of relevant independent variable. If the disturbance term (U_i) is introduced, the logit model becomes:

$$Z_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + ------------ + \beta_7 X_7 + U_i$$ --37

Thus:

$$Z_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + ---------- + \beta_7 X_7 + U_i$$ --38

Where:

Zi = poverty status

X_1=Farm size (hectares)

X_2 = Membership of cooperative (years)

X_3 =Household size (number)

X_4=Education (years of formal schooling)

X_5 =Access to extension services (number of contacts)

X_6 = Farm income (₦)

X_7 = Economic efficiency(%)

$\beta_1 - \beta_7$= The coefficients for the respective variables in the logit function

U_i = disturbance term

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Socio-Economic Characteristics of Groundnut Farmers

Socio-Economic Characteristics of the farmer are the social and economic attributes of farmers that affect their productivity. These characteristics include marital status, age house hold size, farm size, experience, access to credit and education.Socio-Economic Characteristics of the farmers have been broken into quantitative and qualitative in this results discussion.

Table 4.1 Socio-Economic Characteristics of Groundnut Farmers(Quantitative) (adopters)

Variable	Minimum	Maximum	Mean	Total	Std. Error
Age	20	65	47.39	56	1.24
Household size	1	27	12.57	56	0.88
Farm size	0.5	5.0	3.63	56	0.19
Experience	5	40	18.88	56	1.23
Credit	0	0	0	56	0

Table 4.2 Socio-Economic Characteristics of Groundnut Farmers(Quantitative)(Non-Adopters)

Variable	Minimum	Maximum	Mean	Total	Std. Error
Age	20	80	45.05	56	1.99
Householdsize	2	30	11.66	56	0.94
Farm size	0.5	5	2.20	56	0.17
Experience	3	50	18.80	56	1.77
Credit	0	0	0	56	0

4.1.1 Age distribution of groundnut farmers

Age is the measure of a farmer's life from birth till date. It is usually measured in years. Table 4.1 shows that the average age of adopters was found to be approximately 47.39 years with minimum of 20 years and maximum of 65 years, while the average age of non-adopters was found to be approximately 45.05 years with minimum of 20 years and maximum of 80 years as shown in Table 4.2. It can be deduced from the mean ages of the adopters and non-adopters that, the farmers are active and can participate adequately in farming activities. Yusuf (2005) reported that age can influence agricultural practices. And the findings are also consistent with that of Nwankwo*et al.* (2009) who reported that the most active farmers' age group engaged in agricultural production is within 31-50 years.

4.1.2 Household size of groundnut farmers

Table 4.2 shows the distribution of farmers by household size. The maximum family size observed was 27 persons with a minimum of 1 person for adopters. The maximum family size observed for non-adopters was 30 persons with a minimum of 1 person . This implies that the farmers in the study area might have advantage of family labour availability if many household members participate in farms. However, the implication of large household size is that it will increase household consumption expenditure which would compete with production for limited financial resources within the household. According to Okoruwa and Ogundele (2006) large family size does not necessarily translate to higher use of family labour because some of the young able bodied family member may prefer other jobs than farming. This finding is also in line with Solomon (2008) and Banmeke (2003), which indicates that large household size assist more on farm and other household activities.

4.1.3 Distribution of groundnut farmers according to farm size

Farm size refers to the land area that was used for groundnut production. The maximum farm size observed for the adopters was 5 hectares with a minimum of 0.5 hectares and average of 3.63 hectares (see Table 4.1), while the maximum farm size observed for the non-adopters was 5 hectares with a minimum of 0.5 hectares and average of 2.20 hectares (see Table 4.2). In agriculture, the size of farm land determines the scale of operation of farmers. Farm land is considered to be animportant factor of production. There is a positive relationship between farm size and productivity. The larger the farm size of the household, the higher the expected level of groundnut production. From the result, the adopters have a higher mean farm size and are expected to have a higher level of groundnut production.

4.1.4 Farming experience of farmers

Farming experience of farmers refers to the cumulative period over the years past that a farmer has been in groundnut production actively. From Table 4.1 The results shows that the maximum farming experience observed was 40 years with a minimum of 5 year for the adopters and The average farming experience was 18.88 years for adopters;while for the non-adopters, in Table 4.2 the maximum farming experience observed was 50 years with a minimum of 3 year. The average farming experience was 18.80 years. This mean farming experience shows that adopters should be able to make sound decisions as regards resources allocation and management of their farms(possibly) better than the non-adopters.Ajani (2000) reported on productivity in food farming in northern area of Oyo State that years of farming experience increased agricultural productivity among farming households in Nigeria.

4.1.5 Credit obtain by farmers

The results in Table 4.1 and Table 4.2 revealed that adopters and non-adopters had no access to credit to finance their production activities This suggests that the farmers may have used their personal saving to purchase farm inputs and adopt farm innovations. This absence of access to credit could be attributed to the fact that government seldom grants financial credit to large number of farmers. Ekong (2003) asserts that credit is a very strong factor that is needed to acquire or develop any enterprise; its availability could determine the extent of production capacity.

4.2 Educational level of the farmers

Education level may be defined as the extent to which a farmer is schooled. The table 4.4 below shows the extent of education that the farmers have attained.

Table 4.4: Farmers level of education

Education	Adopter	Non-Adopter
No formal education	15(26.8)*	29 (51.8)*
Primary	9(17.9)*	9(16.1)*
Secondary	6(25.0)*	6(10.7)*
Tertiary	12(28.6)*	12(21.4)*
Total	**56(100.0)***	**56(100.0)***

*Figures in parentheses are the percentages.

The result in Table 4.4 revealed that about 27% of adopters had no formal education while about 52% of non-adopters had no formal education; about 17.9% of the adopters had only primary education while 16.1% of the non-adopters had only primary education. About 25% had secondary education for adopters while about 11 of the non-adopters had secondary education. Furthermore 28.6 % had tertiary education amongst the adopter while about 21.4% had tertiary education amongst the non-adopter. However, altogether about 72.2% of the adopters are literate while 48.2% of the non-adopters are literate. Formal education is believed to have a positive implication on efficient use of productive resources. Formal education is expected to influence decision making and adoption of innovation by farmers, which may bring about increase in productivity.

4.3 Efficiency of IAR Groundnut Production

4.3.1 Estimation of the Technical Efficiency of IAR Groundnut

The ML estimates and efficiency determinants of the specified frontier are presented in Table 4.5. The study revealed that the log likelihood function for adopters was --62.7. The log likelihood function implies that inefficiency exist in the data set. The log likelihood ratio value represents the value that maximizes the joint densities in the estimated model. Thus, the functional form that is, Cobb-Douglas used in this estimation is an adequate representation of the data. The value of gamma (γ) is estimated to be 53% and it was highly significant at ($p<0.01$) level of probability. This is consistent with the theory that true γ-value should be greater than zero. This implies that 53% of random variation in the yield of the farmers was due to the farmers' inefficiency in their respective sites. Since these factors are under the control of the farmer, reducing the influence of the effect of γ will greatly enhance the technical efficiency of the farmers and improve their yield. The value of sigma squared ($\boldsymbol{\sigma^2}$) was significantly different from zero level of probability. This indicates a good fit and correctness of the specified distributional assumptions of the composite error terms while the gamma γ indicates the systematic influences that are unexplained by the production function and the dominant sources of random error. This means that the inefficiency effects make significant contribution to the technical inefficiencies of adopters IAR groundnut varieties.

On the other hand (non-adopters), the value of gamma (γ) is estimated to be 20.0% and it was highly significant at ($p<0.01$) level of probability. This is consistent with the theory that true γ-value should be greater than zero. This implies that 20.0% of random variation in the yield of the farmers was due to the farmers' inefficiency in their respective sites. Since these factors are under the control of the farmer, reducing the influence of the effect of γ will enhance the technical efficiency of the farmers and improve their yield. The value of sigma squared ($\boldsymbol{\sigma^2}$) was significantly different from zero level of probability. This indicates a good fit and correctness of the specified distributional assumptions of the composite error terms while the gamma γ indicates the systematic influences that are unexplained by the production function and the dominant sources of random error. This means that the inefficiency effects make significant contribution to the technical inefficiencies of non-adopters IAR groundnut varieties.

The estimated coefficients of parameters of production functions such as seed and agrochemical were significant at ($p<0.01$) level of probability respectively and hence play a major role in the adopters groundnut production in the study area. While for the non-adopters the estimated coefficients of parameters of production functions such as farm size and agrochemical were positive and significant at ($p<0.01$) and ($p<0.05$) level of probability respectively and hence play a major role in the non-adopters groundnut production in the study area.

For the adopters of IAR groundnut varieties the estimated coefficient for seed was 1.04 which is positive and statistically significant at ($p<0.01$) level. The estimated 1.04 coefficient of seed implies that increasing seed by 1kg will increase groundnut output by a magnitude of 1.04 kg. The significance of seed is due to the fact that seed is the reason to expect an output. If correct seed rates and quality seeds are not used, output will be low even if other inputs are in abundance. This is in line with the findings of Shehu *et al* (2010) who observed that the estimated coefficient of seed was positive as expected and significant at ($p<0.01$) level and implies that the more seed is applied the better the output of groundnut. This result also agrees with that of Okoruwa and Ogundele (2006) who reported a positive relationship between seed and output of rice farmers in the study on technical efficiency differential in rice production technologies in Nigeria.

The estimated coefficient for agrochemical was -0.64 which is negative and statistically significant at ($p<0.01$) level of probability. This implies that an increase in agrochemical usageby 1 liter will decrease groundnut output by -0.64. This relationship was unexpected. This relationship may be due to over-utilization ofagrochemicals or wrong method of agrochemical application. The a priori expectation was a positive relationship between groundnut output and agrochemical usage.

For non-adopters it was found that the estimated coefficient for farm size was 0.58 which is positive and statistically significant at ($p<0.10$) level. The estimated 0.58 coefficient of farm size implies that increasing farm size by 1 hectare will lead to an increase groundnut output by 0.58 kg. The significance of farm size is however, due to the fact that farm size determines to a large extent the output obtained. This is in line with findings of Bayacag (2001), who revealed that there is a positive and significant relationship between farm size and farmers' efficiency in production.

The estimated coefficient for agrochemical was 0.65 which is positive and statistically significant at ($p<0.01$) level. The estimated 0.65 coefficient of agrochemical implies that increasing agrochemical by 1 litre will increase groundnut output by 0.65 kg. This finding agrees with the findings of Ajibefun(2002) who reported that the coefficient of agrochemical was positive in a study on the determinants of technical efficiency of small scale farmers in Nigeria.

Table 4.5: Maximum Likelihood Estimation Results of Stochastic Frontier Production Function

Variable	Adopter	Non-adopter
Constant (β_0)	5.02	4.28
	(4.65***)	(19.31***)
Farm size (X_1)	0.26	0.58
	(0.97)	(2.00**)
Seed (X_2)	1.04	-0.06
	(4.36***)	(-0.09)
Fertilizer (X_3)	0.08	0.08
	(0.51)	(-1.30)
Chemical (X_4)	-0.64	0.65
	(-5.59***)	(11.65***)
Labour(X_5)	-0.142	-0.04
	(-0.78)	(-0.078)
Variance Parameters		
Sigma squared (σ^2)	0.97	0.17
	(2.40**)	(5.85***)
Gamma (γ)	0.53	0.20
	(2.44**)	(3.12***)
LR test	0.15	20.72
log likelihood function	-62.7	-70.53

Figures in parentheses are t-ratio; figures not in parentheses are coefficients

$\sigma^2 = \sigma_v^2 + \sigma_u^2$, $\gamma = \sigma_u^2 / \sigma^2$

**** Significant at 1% , ** Significant at 5% , * significant at 10%*

4.3.2 Estimated Stochastic Frontier Cost Functions

The Maximum Likelihood (ML) estimates of the stochastic frontier cost parameters for IAR groundnut adopters and non-adopters are presented in Table 4.6. For the adopters, the sigma ($\sigma^2 = 0.02$) and the gamma (γ=0.43) are significant at 1% level of probability. The significant value of the sigma square (σ^2) indicate the goodness of fit and correctness of the specified assumption of the composite error terms distribution (Idiong, 2005). The gamma ($\gamma = 0.43$) shows that 43% of the variability in the output of groundnut farmers that are unexplained by the function is due to allocative inefficiency. While for the non-adopters the sigma (σ^2=0.82) and the gamma (γ=0.57) are significant at ($p<0.01$) level of probability. The significant value of the sigma square (σ^2) indicate the goodness of fit and correctness of the specified assumption of the composite error terms distribution (Idiong, 2005). The gamma ($\gamma = 0.57$) shows that 57% of the variability in the output of groundnut farmers that are unexplained by the function is due to allocative inefficiency.

The results of the estimated coefficients of the parameters of the cost functionfor IAR groundnut farmers are positive. The cost variables, farm land and agrochemical are significant at (0.01) level. Seed is significant at ($p<0.05$) and labour is significant at ($p<0.10$).

The coefficient of the cost of farm land was positive and statistically significant at ($p<0.01$). This implies that farm land is important in groundnut farming. This indicating that if there is an increase in cost of land, the total cost of production will increase.

The estimated coefficient of the variable labour was positively signed and statistically significant at ($p<0.10$) level indicating that if there is an increase in labour cost the total cost of groundnut production will increase. The result of this research also agrees with the findings of Ogundari, Ojo, and Ajibefun, (2006), where they reported direct effect of labour cost in their study on economies of scale and cost efficiency in small scale maize production in Nigeria.

The estimated coefficient of the variable cost of agrochemical was positive and statistically significant at 1% level indicating that if there is an increase in agrochemical cost the total cost of groundnut production will increase.This is in line with the finding of Ani, Umeh and Weye, (2013) in the study of profitability and economic efficiency of groundnut production in Benue state, Nigeria.

On the other hand, the results of stochastic frontier cost function for non-adopters are also shown in Table 4.6. The estimated coefficients of the parameters of the cost function are positive. The cost variables farmland, seed, fertilizer and labour are significant at ($p<0.01$) level.

The coefficient of the cost of farm land was positive and statistically significant at ($p<0.01$). This implies that farm land is important in groundnut farming. This indicating that if there is an increase in cost of land, the total cost of production will increase.

The estimated coefficient of the variable seed was positively signed and statistically significant at ($p<0.01$) level indicating that if there is an increase in seed cost the total cost of groundnut production will increase. This result corroborate with that of Ohajianya *et al.*,(2010) who found a positive relationship between total cost of production and cost of seed.

The estimated coefficient of the variable labour was positive and statistically significant at ($p<0.01$) level indicating that if there is an increase in labour cost the total cost of groundnut production will increase. The result of this research also agrees with the findings of Ogundari, Ojo, and Ajibefun, (2006), where they reported direct effect of labour cost in their study on economies of scale and cost efficiency in small scale maize production in Nigeria. This result also agrees with the finding of Bifarin*et al.*,(2010) who reported a positive and significant influence of labour cost on total cost of production.

Table 4.6: Maximum Likelihood Estimation Results of Stochastic Frontier Cost Function

Variable	**Adopter**	**Non-adopter**
Constant (β_0)	4.97	2.30
	(8.89***)	(5.41***)
Cost of farm land (X_1)	0.50	0.63
	(9.07***)	(4.31***)
Cost of seed (X_2)	0.05	0.55
	(2.49**)	(4.1***)
Cost of fertilizer (X_3)	-0.07	0.16
	(1.08)	(3.40***)
Cost of labour (X_4)	0.08	0.241
	(1.68*)	(3.43***)
Cost of agro chemicals (X_5)	0.11	0.01
	(3.13***)	(0.19)
DiagnosticParameters		
Sigma squared (σ^2)	0.02	0.82
	(3.01***)	(4.77***)
Gamma (γ)	0.43	0.57
	(3.44***)	(53.08***)
LR test	5.98	12.59
log likelihood function	16.07	24.80

Figures in parentheses are t-ratio ;figures not in parentheses are coefficients

`$\sigma^2 = \sigma_v^2 + \sigma_u^2$, $\gamma = \sigma_u^2 / \sigma^2$

**** Significant at 1% , ** Significant at 5% , * significant at 10%*

4.3.3 Frequency Distribution of Technical Efficiency Estimates of IAR Groundnut Varieties Adopters and Non-adopters

The frequency distribution of the technical efficiency estimates for IAR groundnut adopters in the study area as obtained from the stochastic frontier model presented in Table 4.. The mean technical efficiency is 0.62. It was observed from the study that over 78% of the farmers had technical efficiency (TE) of 0.51 and above while about 22% of the farmers operate at less than 0.51 efficiency level. The farmer with the best and least practice had a technical efficiency of 0.88 and 0.01 respectively. This implies that on the average, output fall by 38% from the maximum possible level due to inefficiency.

The study also suggest that for the average farmer in the study area to achieve technical efficiency of his most efficient counterpart, he could realize about 30 percent (1-0.62/0.88*100) cost savings while on the other hand, the least technically efficient farmers will have about 99 percent (1-0.01/0.88*100) cost savings to become the most efficient farmer.

On the other hand the frequency distribution of the technical efficiency estimates for non-adopters in the study area as obtained from the stochastic frontier model presented in Table 4.7. The mean technical efficiency is 0.57. It was observed from the study that about 55% of the farmers had technical efficiency (TE) of 0.51 and above while 45% of the farmers operate at less than 0.51 efficiency level. The farmer with the best and least practice had a technical efficiency of 1.00 and 0.33 respectively. This implies that on the average, output fall by 43% from the maximum possible level due to inefficiency.

The study also suggest that for the average farmer in the study area to achieve technical efficiency of his most efficient counterpart, he could realize about 43 percent (1-0.57/1.00*100) cost savings while on the other hand, the least technically efficient farmers will have about 67 percent (1-0.33/1.00*100) cost savings to become the most efficient farmer.

Table 4.7: Frequency Distribution of Technical Efficiency Estimates

Efficiency range	Adopters	Percentage(%)	Non-adopter	Percentage(%)
<0.41	5	8.93	13	23.21
0.41-0.50	7	12.50	12	21.43
0.51-0.60	11	19.64	16	28.57
0.61-0.70	15	26.79	1	1.79
0.71-0.80	10	17.86	3	5.36
0.81-0.90	8	14.29	4	7.14
0.91-1.00	0	0.00	7	12.50
Total	56	100.00	56	100.00
Mean	0.62			0.57
Minimum	0.01			0.33
Maximum	0.88			1.00

4.3.4 Frequency Distribution of Allocative Efficiency Estimates of Adopters and Non-adopters of IAR Groundnut Varieties

The allocative efficiency estimates presented in Table 4.8, indicate that allocative efficiency estimates of adopters ranged from 0.85 to 1.00; the mean allocative efficiency was 0.82. The result indicates that average groundnut farmer in the state would enjoy cost saving of about 4 (1-0.96/1.00*100) percent if he or she attains the level of the most efficient farmer among the respondents. The most allocative inefficient farmer will have an efficiency gain of about 15 (1-0.85/1.00*100) percent in groundnut production if he or she is to attain the efficiency level of most allocative efficient farmer in the state.

On the other hand,allocative efficiency estimates of non-adopters ranged from 0.31 to 0.98; the mean allocative efficiency was 0.75. The result indicates that average groundnut farmer in the state would enjoy cost saving of about 26 (1-0.75/0.98*100) percent if he or she attains the level of the most efficient farmer among the respondents. The most allocative inefficient farmer will have an efficiency gain of about 70(1-0.31/0.98*100) percent in groundnut production if he or she is to attain the efficiency level of most allocative efficient farmer in the state.

Table 4.8: Frequency Distribution of Allocative Efficiency Estimates

Efficiency range	**Adopters**	**Percentage(%)**	**Non-Adopter**	**Percentage(%)**
<0.81	-	-	26	46.43
0.81-0.90	6	12	9	16.07
0.91-1.00	49	88	21	37.50
Total	56	100	56	100.00
Mean	0.96			0.75
Minimum	0.85			0.31
Maximum	1			0.98

4.3.5 Frequency Distribution of Economic Efficiency Estimates of Adopters and Non-adopters of IAR Groundnut Varieties

The frequency distribution of the economic efficiency estimates for adopters of IAR groundnut varieties in the study area as obtained from the stochastic frontier model is presented in Table 4.9. It was observed from the study that 21.43% of the farmers had economic efficiency (EE) of less than 0.51 while 78.57% of the farmers operate above 0.51 efficiency level. The mean economic efficiency of the adopters in the study area was 0.59. The farmer with the best and least practice had economic efficiencies of 0.86 and 0.01 respectively. This implies that on the average, output fall by 41% from the maximum possible level due to inefficiency.

The study also suggest that for the average farmer in the study area to achieve economic efficiency of his most efficient counterpart, he could realize about 31 percent (1-0.59/0.86*100) cost savings while on the other hand, the least economic efficient farmers will have about 100 percent cost savings to become the most efficient farmer. However, the average economic efficiency of the IAR groundnut farmers was 59 percent. This indicates that groundnut farms were economically efficient.

The frequency distribution of the economic efficiency estimates for non-adopters of IAR groundnut varieties in the study area as obtained from the stochastic frontier model is presented in Table 4.9 It was observed from the study that about 39.29% of the farmers had economic efficiency (EE) of 0.51 and above while 60.71% of the farmers operate at less than 0.51 efficiency level. The mean economic efficiency of the adopters in the study area was 0.43. The farmer with the best and least practice had economic efficiencies of 0.98 and 0.11 respectively. This implies that on the average, output fall by 57% from the maximum possible level due to inefficiency.

The study also suggest that for the average farmer in the study area to achieve economic efficiency of his most efficient counterpart, he could realize about 56 percent (1-0.43/0.98*100) cost savings while on the other hand, the least economic efficient farmers will have about 100 percent cost savings to become the most efficient farmer. However, the average economic efficiency of the IAR groundnut farmers was 43 percent. This indicates that groundnut farms were relatively economically inefficient.

Table 4.9: Frequency Distribution of Economic Efficiency Estimates

Efficiency range	Adopters	Percentage(%)	Non-adopter	Percentage(%)
<0.21	1	1.79	5	8.93
0.21-0.30	2	3.57	11	19.64
0.31-0.40	2	3.57	9	16.07
0.41-0.50	7	12.50	9	16.07
0.51-0.60	13	23.21	7	12.50
0.61-0.70	19	33.93	2	3.57
0.71-0.80	7	12.50	5	8.93
0.81-0.90	5	8.93	3	5.36
0.91-1.00	-	-	5	8.93
Total	56		56	
Mean	0.59		0.43	
Minimum	0.01		0.11	
Maximum	0.86		0.98	

4.3.6 Socio-economic factors influencing technical inefficiency of adopters and non-adopters of IAR groundnut varieties

The estimated result of the inefficiency model is contained in Table 4.10. Generally, a negative sign on a parameter means that the variable reduces technical inefficiency, while a positive sign increases technical inefficiency. The results shows that for the adopters, household size and income have a negative sign and statistically significant at ($p<0.05$) and ($p<0.01$)level of probability respectively, and therefore reduce technical inefficiency.

The results shows that, household size have a regression coefficient of -0.14 and statistically significant at ($p<0.01$) level of probability, and therefore reduce technical inefficiency. This means that a unit increase in the household size will reduce technical inefficiency and ultimately increase groundnut output by 0.14kg

The results shows that income level, have a regression coefficient of 0.03 and statistically significant at ($p<0.01$) level of probability, and therefore reduce technical inefficiency. This means that a naira increase in the income of the house hold head will reduce technical inefficiency and ultimately increase groundnut output by 0.03kg

Conversely, the estimated result of the inefficiency model for non-adopters is contained in table 4.10. Generally, a negative sign on a parameter means that the variable reduces technical inefficiency, while a positive sign increases technical inefficiency. The results shows that income level, have a regression coefficient of 0.05and statistically significant at ($p<0.01$) level of probability, and therefore reduce technical inefficiency. This means that a naira increase in the income of the house hold head will reduce technical inefficiency and ultimately increase groundnut output by 0.05kg

Table 4.10: Determinants of technical inefficiency

Variable	Adopter	Non-adopter
Constant	-1.70	2.31
	(-1.67*)	(5.33***)
Age	0.036	-0.003
	(0.09)	(-0.30)
Household size	-0.14	0.10
	(-1.83*)	(0.16)
Education	0.15	0.13
	(0.29)	(0.01)
Income	-0.03	-0.05
	(-5.19***)	(-3.15***)
Experience	-0.10	-0.01
	(-0.31)	(-1.50)
Marital status	1.08	-0.50
	(1.12)	(-0.26)

Figures in parentheses are t-ratio ; figures not in parentheses are coefficients

4.4 Poverty level of groundnut farmers

The result of the poverty profile and indices of adopters and non-adopters of IAR groundnut varieties in the study area is presented in Table 4.11 .From the estimates of FGT weighted class of poverty indices, the proportion of non-poor groundnut farmers who adopted IAR groundnut varieties was found to be 71.23% while the proportion of non-poor groundnut farmers who did not adopt IAR groundnut varieties was estimated to be 49.04% using an estimated poverty line of ₦45,964.88; this indicates that the proportion of non-poor groundnut farmers who adopted IAR groundnut varieties

(71.23%) was higher than that of non-poor farmers who did not adopt IAR groundnut varieties (49.04%). Furthermore, the proportion of moderate poor groundnut farmers who adopted IAR groundnut varieties was found to be 23.76% while the proportion of non-poor groundnut farmers who did not adopt IAR groundnut varieties was estimated to be 40.38%. More so, the proportion of core poor groundnut farmers who adopted IAR groundnut varieties was found to be 4.95% while the proportion of non-poor groundnut farmers who did not adopt IAR groundnut varieties was estimated to be 10.58%.

The poverty incidence on adopters of IAR groundnut varieties was 29% while that of the non-adopters was 51%. This implies that the share of the population of adopters that cultivate IAR groundnut varieties whose income and consumption falls below the poverty line is lower than that of non-adopters of IAR groundnut varieties indicating that the proportion of adopters of IAR groundnut varieties that cannot afford to buy a basic basket of goods to meet the consumption needs of their households is lower than that of the non-adopters of IAR groundnut varieties. This finding is in line with Awotide *et al*. (2012) who discovered that the incidence of poverty was higher among the non-adopters (51%) than the adopters (46%) of improved rice varieties in Nigeria. The poverty gap index for adopters IAR groundnut varieties who are poor (0.31) was lower than the non-adopters (0.34). This indicates that non-adopters IAR groundnut varieties are farther away from the poverty line than their counterparts and the implication is that it is easier for the adopters of IAR groundnut varieties to move above the poverty line than the non-adopters who are far away from the poverty line. Also, the poverty severity among those who adopted IAR groundnut varieties given by the estimated severity of poverty (0.09) was equally lower than those who did not adopt the varieties (0.11).This shows that the proportion of poor farmers who adopted IAR groundnut varieties are better-off, as their poverty severity is lower than the poor farmers who did not adopt IAR groundnut varieties. Hence, from the poverty profile of the adopters and non-adopters of IAR groundnut varieties, it can be deduced that the adopters of IAR groundnut varieties had a lower poverty status than the non-adopters of IAR groundnut varieties and this implies that adopter of IAR groundnut varieties enjoys the dividends of the varieties which is in line with Kassie*et al*.(2010) who also found that adoption of improved groundnut varieties contributed to rural poverty alleviation in Uganda.

Table 4.11: Household poverty profile and indices among the respondents

Poverty Profile	**Adopter**	**Non-adopter**
Non-poor	72(71.29)*	51(49.04)*
Moderate-poor	24(23.76)*	42(40.38)*
Core-poor	5(4.95)*	11(10.58)*
FGT poverty indices		
Poverty incidence(head count)	0.29	0.51
Poverty depth(gap)	0.31	0.34
Poverty severity	0.09	0.11
Mean PCE	82728.99	55563.19
Min PCE	12400	10504.35
Max PCE	323600	213000

Poverty line (2/3) = 45,964.88; *Figures in parenthesis are percentages

4.5 Factors influencing Poverty status of IAR groundnut farmers

Table 4.12 showsfactors influencing poverty status of IAR groundnut farmers. The result of the logit regression of the determinants of poverty status for adopters of IAR groundnut varieties shows that a number of socioeconomic variables significantly influenced the poverty status of the respondents in the study area. The factors include household-size,farm income and economic efficiency The negative coefficients of some of the variables suggest that there is likelihood that the adopters poverty level will be reduced as they increase.

For adopters, farm-size has a negative coefficient but not statistically significant. Education has a positive coefficient and is insignificant. Household size has a regression coefficient of -0.1242and statistically significant at ($p<0.01$). The negative and significant coefficient of household size, suggest the high likelihood, that in such a household, poverty level will be reduced as the household size increases. This is because it is expected that the members of the household would supply their labour if not free but at a cheap rate to the farmer.

Household income has a regression coefficient of -0.085 and statistically significant at ($p<0.10$). The odd ratio of -0.085 indicates that a unit increase in household income would decrease the probability of poverty by -0.085.

The result of the analysis shows that three of the five socio-economic factors,that was entered into the logit regression model has a significant effect on their poverty status. Thus the null hypothesis that,socio-economic factors has no significant effect on the poverty status of adopters of IAR groundnut varietiesis rejected and the alternative is accepted.Therefore,socio-economic factors has a significant effect on their poverty status.

Economic efficiency of adopters has a regression coefficient of -0.603 and statistically significant at ($p<0.01$). The odd ratio implies that a unit increase in the farmers' efficiency would decrease probability of poverty by -0.603. Thus the null hypothesis that economic efficiency has no significant effect on the poverty status of adopters of IAR groundnut varietiesis rejected and the alternative is accepted.Thus, economic efficiency has a significant effect on the poverty statusof adopters of IAR groundnut varieties. This result is consistent with other related studies on the impact of agricultural technologies on poverty (Mendola, 2007; Mignouna*et al*., 2011; Omilola, 2009).

Conversely, the estimated result of the logit model for non-adopters is contained in table 4.18 show that farm size and economic efficiency are significant at ($p<0.10$). Farm size of non-adopters had a regression coefficient of -0.603 and statistically significant at ($p<0.01$). The odd ratio implies that a unit increase in the farmers'farm size would decrease probability of poverty by -0.1588.Economic efficiency of non-adopters has a regression coefficient of -0.948 and statistically significant at ($p<0.10$). The odd ratio implies that a unit increase in the farmers' efficiency would decrease probability of poverty by -0.948.

Table 4.12: Factors influencing Poverty status of IAR groundnut adopters

Variables	Adopters	Non-adopters
Farm size	-0.1975	-0.158826
	(-1.49)	(-1.95*)
Household size	-0.1242	-.452894
	(-2.8***)	(0.277)
Education	0.0698	-.0312394
	(1.35)	(0.500)
Farm income	-0.085	-0.025
	(-1.95*)	(1.59)
Economic efficiency	-0.6033	-0.948149
	(-2.75***)	(-1.95*)
Constant	6.4611	4.038689
	(3.32***)	(1.66*)
LR $chi^2(7)$	31.23	58.47
Prob> chi^2	0.0001	0.0001
Log likelihood	-44.9382	-42.833501
Pseudo R^2	0.2579	0.4057

*NB: * P<0.1, ** P<0.05 and *** P<0.01*

4.6 Implication of Increasing Efficiency of Groundnut Farmers onPoverty Alleviation

The logit regression model result as presented earlier in Table 4.12 tells that there is an inverse relationship between economic efficiency and poverty status. The results presented in Table 4.13 shows that, adopters of IAR developed groundnut variety has higher economic efficiency (59%) than the non-adopter (43%). Furthermore, the poverty head-count of the adopters was 29% while that of the non-adopter was 51%. Thus, poverty head-count of the adopters was lower than that of the non-adopters, suggesting that economic efficiency is inversely related to poverty.This implies that an increase in economic efficiency by adopters in groundnut production will lead to a decrease in their poverty status as suggested by the logit regression model result presented in Table 4.12This relationship is likely because it is expected that a rational combination of the farmers lean resources ultimately results to greater output, so much so, that if the groundnut output is commercialized, they have an edge over their counterpart. This finding agrees with Asogwa*et al.*(2012), that poverty reduction among the farming households is linked with improving farm efficiency.This result is also consistent with other related studies on the impact of agricultural technologies on poverty (Mendola, 2007; Mignouna*et al.*, 2011; Omilola, 2009).

Table 4.13:Efficiency and Poverty Nexus

	Economic efficiency	Poverty headcount
Adopters	59%	0.29
Non-adopters	43%	0.51

4.7 Constraints Faced by Groundnut Farmers

4.7.1 Constraints faced by adopters of IAR groundnut varieties in the study area

The problems faced by adopters of IAR groundnut varietiesin the study area were ranked according to their magnitude as stated by the farmers (Table 4.14). The problem of pest and disease was the most constraint with 55.45% of the respondent reporting this case. Pest and disease were responsible for pre-harvest and post-harvest losses by these producers.

About 20% of the groundnut farmers indicated inadequacy of capital. It ranked second. This affects groundnut production in the study area, because the meager savings the farmers might have made or the funds generated from relatives is insufficient to satisfy various activities in groundnut production. Inadequate rainfall ranks third in constrains suffered by farmers. About 12 percent of the farmers raised this issue. This issue has being generally noticed in the savanna and is to some extent outside the control of man. 10 percent of the farmers complained of high cost of inputs. High cost of inputs ranked fourth in constraints faced by farmers of IAR groundnut varieties.

About 8% of the groundnut farmer indicate cost of labour as constraints in the study area. This was the fifth in the ranking. According to the farmers, during active period of production-every household would have been engaged in his family farm work. The demand for labour gets very high and expensive during the peak period of land clearing, ridging, harvesting, processing and weeding, these ultimately leads to the high cost of labour in the study area .

Table 4.14: Constraints faced by adopters of IAR Groundnut Varieties

Constraints	**Frequency**	**Percentage**	**Rank**
Pest and disease	31	55.45	1
Inadequate credit	11	19.80	2
Inadequate rainfall	7	11.88	3
High cost of inputs	6	9.90	4
High cost of labour	4	7.92	5

***** Multiple response was allowed

4.7.2Constraints faced by non-adopters of IAR groundnut farmers in the study area

The problems faced by Non-adopters ofIAR groundnut farmers in the study area were ranked according to their magnitude as stated by the farmers (Table 4.14). The problem of pest and disease was the most severe constraint of groundnut producers with about 53% of the respondent attesting to this claim. Pest and disease were responsible for pre-harvest and post-harvest losses by groundnut producers.

About 36% of the groundnut farmers indicated inadequacy of capital and credit facilities which rank second. This affects groundnut production in the study area, because the meager savings the farmers might have made or the funds generated from relatives is not sufficient to satisfy various activities in groundnut production.Most of the farmers also complained of not having enough money to purchase chemicals to combat these diseases, although the economic advantage of spraying could lead to increase yield thereby justify the costs they invested. About 31% of the groundnut farmer indicate short of labour as constraints in the study area. According to the farmers, during active period of production-every household would have been engaged in his family farm work. The demand for labour is normally very high and expensive during the peak period of land clearing, ridging, harvesting, processing and weeding, these led to labour shortage in groundnut farming in the study area .

High cost of fertilizer rank fourth as perceived to be least serious constraint with about 13% of the farmers attesting to this fact.According to the respondents fertilizer is made available when farmers are far into the production period, sometimes at the middle of the raining season.

Table 4.15: Constraints associated with IAR groundnut production

Variable	**Frequency**	**Percentage**	**Rank**
Pest and disease	30	52.7	1
Inadequate credit	20	36.3	2
High cost of labour	17	30.6	3
Hight cost of fertilizer	7	13.1	4

***** Multiple response was allowed

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

This study was carried out to analyze the implication ofincreasing groundnut farmers' efficiency on the poverty status of the farmers adopting IAR groundnut varieties in the North West Zone of Nigeria. Two Local Government Areas from Jigawa (Gumel and Kaugama), Zamfara (Kaura-Namoda and Anka), Sokoto (Wamako and Tambuwal) and Kebbi (Fakai and Arewa) states respectively were purposively chosen based on being prominent groundnut producing areas of the states. Next, was a multistage sampling of 112 groundnut farming households from the eight selected local government areas; and to achieve this broad objective, the study came up with six main objectives. These were to: describe the socio-economic characteristics of farmers who adopt IAR groundnut varieties in the study area, determine the economic efficiency of groundnut production by farmers cultivating IAR groundnut varieties, determine the poverty status of the groundnut farmers cultivating IAR groundnut, estimate the factors influencing poverty status of IAR groundnut farmers varieties, examine the implication of increasing efficiency of groundnut farmers who are cultivating IAR groundnut varieties to poverty alleviation and to identify the constraints faced by famers of IAR groundnut varieties in the study area.

Primary data was collected from 112 respondents using structured questionnaires. The statistical tools used to analyze the data were descriptive statistics, stochastic production frontier function model, Foster-Greer-Thorbeckes' weighted poverty index and logit regression.To enrich the quality of this research adoptersand non-adopters of the IAR groundnut varieties were analyzed in tandem.

The study also revealed that the average age of adopters was found to be approximately 47 years while the average age of non-adopters was found to be approximately 45 years. Majority of the adopters and non-adopters had household size that ranged from 5-27 persons. 73 percent of the adopters are literate while 48% percent of the non-adopters are literate. The maximum farming experience observed was 40 years with a minimum of 5 year for the adopters; while for the non-adopters the maximum farming experience observed was 50 years with a minimum of 3 year. The average farm size observed for the adopters was of 3.36 hectares while for the non-adopters 2.20 hectares.

The estimated coefficients of parameters of the production function for adopters such as seed and agrochemicals were positive and both significant at 1% level of probability respectively; while the estimated coefficients of parameters of the production function for non-adopters such as farm size and agrochemicals were positive and both significant at 5% and 1% level of probability respectively. The frequency distribution of the technical efficiency estimates for IAR groundnut adopters in the study area shows that the mean technical efficiency is 0.62 while the frequency distribution of the technical efficiency estimates for non-adopters in the study area shows that the mean technical efficiency is 0.57.

The mean allocative efficiency for the adopters was 0.96 whilethe non-adopters had 0.75. The mean economic efficiency of the adopters in the study area was 0.59. This indicates that groundnut farms were economically efficient; conversely, for the non-adopters, It was observed that, the mean economic efficiency of the non-adopters in the study area was 0.43. This is not a favorable efficiency level especially when compared with the adopters.

From the estimates of FGT weighted class of poverty indices, the proportion of non-poor groundnut farmers who adopted IAR groundnut varieties was found to be 71.23% while the proportion of non-poor groundnut farmers who did not adopt IAR groundnut varieties was estimated to be 49.04% using an estimated poverty line of ₦45,964.88; The poverty incidence on adopters of IAR groundnut varieties was 28.77% while that of the non-adopters was 50.96%. The poverty gap index indicated that non-adopters IAR groundnut varieties are farther away from the poverty line than their counterpart. Also, the poverty severity among those who adopted IAR groundnut varieties given by the estimated severity of poverty shows that the proportion of poor farmers who adopted IAR groundnut varieties are better-off, as their poverty severity is lower than the poor farmers who did not adopt IAR groundnut varieties.

From the logit regression model for factors affecting the poverty status of adopters of IAR groundnut varieties, Economic efficiency of adopters had a regression coefficient of -0.6033 and statistically significant at ($p<0.01$). The logit regression analysis shows that there is the high likelihood that poverty level will be reduced as adopters of IAR groundnut varieties increase their level of efficiency through feasible means.

Finally, among the constraints identified in the study area, the problem of pest and disease, inadequacy of capital and credit facilities, inadequate rainfall, high cost of inputs and high cost of labour.

The efficiency and poverty nexus as described showed that an increase in economic efficiency by adopters of IAR developed groundnut varieties in groundnut production will lead to a decrease in the farmers' poverty status.

5.2 Conclusion

This study has revealed that IAR groundnut farmers are not fully economically efficient andtherefore there is allowance of efficiency improvementby addressing some important policy variables thatnegatively and positively influenced farmers' levels ofefficiency in the study area. The evidence from this study also suggests that the IAR groundnut contributed to poverty reduction in the area. It is seen from the estimates of FGT weighted class of poverty indices that adopters of IAR developed groundnut varieties are better-off in terms of their poverty status compared to the non-adopters; non-adopters have the likelihood to improve their poverty status by adopting IAR developed groundnut varieties.

5.3 Contribution of the study to knowledge

1. It was discovered that IAR groundnut farmers were relatively economically efficient in the study area having compared their level with their counterparts who do not adopt IAR groundnut varieties.

2. The study revealed that only about 29% of IAR groundnut farmers are poor as compared to 51% of their counterparts who do not adopt IAR groundnut varieties.

3. It is seen in the study that there is a relationship between the economic efficiency of farmers that adopt IAR groundnut varieties and their poverty status. A unit change in the level of the farmers' economic efficiency has a likelihood to influence their poverty status.

5.4 Recommendations

From the following findings of this study, the following recommendations, among others are put forward:

i. It is recommended that stakeholders should encourage groundnut farmers to adopt IAR developed groundnut varieties as adopters of these varieties appear to be having a relatively favorable poverty status.

ii. The research shows that an increase in the economic efficiency of adopters of IAR developed groundnut varieties has high likelihood to reduce poverty status. This can be achieved through improved extension services and policies that encourage the supply of sufficient and affordable labour for groundnut production.

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APPENDIX 1

QUESTIONNAIRE

DEPARTMENT OF AGRICULTURAL ECONOMICS AND RURAL SOCIOLOGY,
AHMADU BELLO UNIVERSITY, ZAIRA.

FARMERS RESEARCH QUESTIONNAIRE

TOPIC: "ANALYSIS OF IAR DEVELOPED GROUNDNUT VARIETIES FARMER EFFICIENCY FOR POVERTY ALLEVIATION IN NORTH WESTERN NIGERIA"

Agro-Ecological Zone ………………………………………………………….....

1. Name of respondent…………………………………………………………………...
2. Phone number of respondent………………………………………………………….
3. Village/local government area/state…………………………………………………...
4. Marital status…………………………………………………………………………..
5. Age of respondent……………………………………………………………………..
6. Household size………………………………………………………………………...
7. Level of education:No formal education ( ) Primary ( ) Secondary ( ) Tertiary ( ) Others ( )
8. Total number of years spent in school………………..
9. What is your total land size ………………….. Ha
10. How long have you been in groundnut production…………………………………………
11. Name the various IAR groundnut varieties you know……………………………………………………………...…………………
    ………………………………………………………………………………………………
12. Which varieties do you plant?
    …………………………………………………………………………………………………
    …………………………………………………………………………………………………
    ……………………………………………………………………………………

13. Estimate the percentage of farmers that planted the type of IAR groundnut variety that you planted……………………………………………………………………………………

14. Do you belong to any farming organization? (Name the organization if yes)……………………..

15. How many times did

a. You visit any extension agent to seek for advice on groundnut production…………………

b. Any extension agent visited you to give advice on groundnut production………………..

c. You attend farmer field school on groundnut production…………………………………

d. You attend any workshop/conference or film shows on groundnut production…………

16. Did you have access to credit in the last cropping season? Yes ( ) No ( )

17. If yes, what was the total amount obtained ₦…………………….

Plot	Name of crop planted	Plot Size (Ha)	Seed (Kg)	Fertilizer (Brand)/(Kg)	Manure (Kg)	Agrochemicals (*l*)	Output (Kg)
1.							
2.							
3.							
4.							

18. Quantity of input applied and output realized

Plot	Land preparation and planting		Weeding		Inorganic fertilizer application		Organic fertilizer application		Pesticide application		Harvesting	
	Family labour	Hired labour	Family labour	Hired labour	Family labour	Hired labour	Family labour	Hired labour	Family labour	Hired labour	Family labour	Hired labour
1												
2												
3												
4												

19. Kindly indicate the hours of labour you employed in each farming activity in the cultivation of groundnut during the last cropping season.

20. Cost of inputs applied

Plot	Name of Crop Planted	Seed(₦)	Fertilizer (Brand)/(Kg)	Manure (₦)	Labour (₦)	Cost of land	Agrochemicals (₦)
1.							
2.							
3.							
4.							

21. How many bags (100kg bag) did you sell last season? .... bags
22. How much was the price per bag? ₦..
23. What was your annual income from all sources last season? ₦..
24. How much do you spend on feeding per week? ....
25. What percentage of the income from groundnut production adds to your general income and food security…………………………………………………………………………
26. How many times do you feed per day? …………………………………………………….
27. How many months are you food secured? …………………………………………………
28. List the problems you faced in the production of the groundnut in the last production season …………………………………………………………………………………………………… ………………………………………………………………………………………

29. Kindly provide information on your households food and non-food consumption expenditure.

Item		Amount(₦)
Food	Monthly expenditure	
House rent	Monthly expenditure	
Electricity/water bills	Monthly expenditure	
School expenses (school fees, textbooks, writing materials e.t.c)	Annual expenditure	
Medical expenses	Annual expenditure	
Clothing expenses	Annual expenditure	
Communication expenses (G.S.M calls, recharge cards e.t.c)	Monthly expenditure	
Transportation expenses	Monthly expenditure	
Social expenses (wedding, naming ceremony e.t.c)	Annual expenditure	
Religion (offerings, contributions e.t.c)	Monthly expenditure	
Others………………………………		

APPENDIX2

Results of technical, allocative and economic efficiency for adopters of IAR developed groundnut Varieties

Technical efficiency	Allocative efficiency	Economic Efficiency
0.56758	0.901601	0.511733
0.35599	0.971915	0.345992
0.56234	0.727582	0.409148
0.419356	0.960344	0.402726
0.387941	0.918947	0.356497
0.331509	0.851088	0.282143
0.447912	0.74617	0.334218
0.554102	0.836189	0.463334
0.524513	0.904672	0.474512
0.542276	0.952931	0.516752
0.479456	0.947854	0.454454
0.415207	0.940303	0.39042
0.541022	0.934227	0.505437
0.540247	0.781719	0.422321
0.354241	0.639537	0.22655
0.720769	0.771653	0.556183
0.436756	0.622082	0.271698
0.815157	0.781021	0.636655
0.350987	0.834901	0.29304
0.359625	0.573683	0.206311
0.378437	0.591823	0.223968
0.384543	0.98209	0.377656
0.584634	0.548717	0.320798
0.416952	0.903177	0.376581
0.380248	0.442916	0.168418
0.447724	0.832684	0.372813
0.388296	0.942998	0.366162
0.809316	0.774989	0.627211
0.345093	0.897083	0.309577
0.461852	0.982653	0.45384
0.530966	0.787144	0.417947
0.466827	0.747127	0.348779
0.342573	0.954077	0.326841
0.570081	0.814669	0.464427
0.644155	0.946944	0.609979
0.583585	0.783291	0.457116
0.582328	0.59359	0.345664
0.563043	0.656309	0.36953
0.752758	0.307051	0.231135
0.909239	0.604435	0.549576

0.527607	0.675336	0.356312
0.471996	0.737526	0.348109
0.560828	0.718607	0.403015
0.863568	0.509024	0.439577
0.969799	0.828778	0.803748
0.777865	0.586565	0.456269
0.469038	0.532771	0.24989
0.833362	0.669522	0.557954
0.965839	0.923179	0.891643
0.572278	0.9626	0.550875
1	0.841245	0.841245
0.908658	0.965345	0.877169
0.978796	0.906857	0.887628
0.981757	0.970288	0.952586
0.368349	0.972812	0.358335
0.411293	0.863915	0.355322