EVALUATION OF THE PRODUCTION EFFICIENCY AND PROFITABILITY OF SESAME PRODUCTION IN GWER EAST AND KONSHISHA LOCAL GOVERNMENT AREAS OF BENUE STATE OF NIGERIA

BY

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

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DECLARATION

I declare that the work in this dissertation entitled "**Evaluation of the Production Efficiency and Profitability of Sesame Production in Gwer East and Konshisha Local Government Areas of Benue State of Nigeria**" has been carried out by me in the Department of Agricultural Economics and Rural Sociology. The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this dissertation was previously presented for another degree or diploma at this or any other institution.

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CERTIFICATION

This dissertation entitled '**EVALUATION OF THE PRODUCTION EFFICIENCY AND PROFITABILITY OF SESAME PRODUCTION IN GWER EAST AND KONSHISHA LOCAL GOVERNMENT AREAS OF BENUE STATE OF NIGERIA,**' by **Felix Aondona DZER** meets the regulations governing the award of the degree of Master of Science in Agricultural Economics of the Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This dissertation is dedicated to Almighty God, the Omni present, Omni potent and Omni science, who gave me the grace to painstakingly and relentlessly combine an endless flow of knowledge and ideas amidst frustrations to bring this dissertation to completion. May his holy name be exalted and glorified forever.

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ABSTRACT

This study was carried out to evaluate the production efficiency and the profitability of sesame production in Gwer East and Konshisha Local Government Areas of Benue State, Nigeria. Primary data was collected from 154 sesame farmers through the use of structured questionnaires. Purposive and random sampling techniques were used for this study. Tools used for analyses were Descriptive statistics, Net Farm Income and Stochastic Frontier Production Model. The study showed that the respondents had an average age of 36 years with 12 years of sesame farming experience. Majority of the farmers (85%) had formal education. The average household size is 37 persons which is about 81% while majority of the farmers (60%) had no extension contact during the 2014 cropping season. Majority of the sesame farmers (53%) belonged to sesame cooperative society. Majority of the farmers (82%) had no access to credit facilities. The results of the stochastic frontier revealed that farm size, seed, labour and agrochemical had a positive technical relationship with sesame output and were significant at ($p< 0.01$) level. The determinants of technical efficiency were age, sesame farming experience, education, membership of sesame cooperative society and amount of credit received. The result shows a mean technical efficiency of 0.83 with minimum and maximum technical efficiencies of 0.34 and 0.99 respectively. The elasticity of production 1.01 revealed that sesame farmers were operating at an increasing return to scale. The costs of renting of land, seeds, labour, agrochemical and sesame output had a positive relationship with the cost of sesame production and were all significant at ($p< 0.01$) level. The determinants of allocative efficiency were age, sesame farming experience, household size, extension contact, membership of sesame cooperative society and amount of credit received. Furthermore, the result shows that the sesame farmers had a mean allocative efficiency of 0.69. The minimum and maximum allocative efficiencies of 0.31 and 0.92 were obtained. The result also revealed a mean economic efficiency of 0.58. The best practice and the least economically efficient sesame farmers had economic efficiencies of 0.89 and 0.15 respectively. The profitability analysis on per hectare basis showed that a gross income of ₦ 116,720.58; total cost of production of ₦ 39,728.20; net farm income of ₦ 76,992.38 and a return per naira invested of ₦ 1.94 were realized. The major constraints to sesame production include: lack of credit facilities, poor extension service, poor storage facilities, problems of pests and diseases, lack of good road network and uneven ripening of capsules. The study concluded that sesame production is profitable by returning 94 kobo to every ₦ 1 invested, and that inefficiency exist among the sesame farmers with a maximum economic efficiency of 0.89. The study recommends sesame farmers to join cooperative society so as to enjoy the financial and socio-economic benefits that accrue from it, and the extension capabilities of agricultural institutions in Benue State be strengthened by the government to give room for effectiveness in extension delivery services.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Sesame, otherwise known as sesamum or beniseed, is one of the most ancient oilseed crops known to mankind. The crop is now grown in a wide range of environments, extending from semi-arid tropics and sub-tropics to temperate regions (Raikwar and Srivastva, 2013). The crop is believed to have originated in tropical Africa where the greatest genetic diversity exists and was later taken at a very early date to India where a secondary centre of diversity developed (Purseglove, 1996).

Sesame is one of the oldest food and cash crops in Nigeria (Nahunnaro and Tunwari, 2012). However out of the estimated 3.5 million hectares of Nigeria's arable land suitable for the growth of sesame seed, only 340,000 hectares was used for the crop in 2013 (FAOSTAT, 2013). Average actual yield of the crop is estimated to be 485.3kg/ha which is more than 4 times lower than the potential yield of 2000kg/ha and more than 2 times lower than the average yield of other seed crops such as groundnut (1271.2kg/ha) and soybeans (1000.0kg/ha) (Mkamilo and Bedigian, 2007; FAOSTAT, 2013).

Nigeria has a great market potential for sesame seed production for domestic and export markets. The production figures of the crop has been on a steady increase since 1971, reaching 72000 tonnes by 2000 and 165,000 tonnes in the year 2013 (FAOSTAT, 2013). This is in agreement with the 2008 annual report of the Central Bank of Nigeria which states that there has been a rise in production of sesame seed from 98,000,000 to 152,000,000kg from 2003 to 2007 (CBN, 2009).

Sesame is commonly grown by smallholder farmers. The major producing areas in order of priority are Nasarawa, Jigawa and Benue States. Other important areas of production are found in Yobe, Niger, Kano, Katsina, Kogi, Gombe and Plateau States (NAERLS, 2010). Benue and Nasarawa States are the major sesame producing states in Nigeria with annual outputs of not less than 40,000 metric tonnes each per annum (RMRDC, 2004).

Sesame is well suited to smallholder farming with a relatively short harvest cycle of 90 –140 days allowing other crops to be grown in the field and is often intercropped with other grains (Nigeria's Harvest, 2009; Naturland, 2002, Chemonics, 2002). This makes it favourable to Nigerian farmers and production can thus be sustained by small-scale farmers with minimum management, with an average yield of 700 kilogrammes per hectare (Nigeria's Harvest, 2009).

1.2 Problem Statement

In general, average productivity of sesame continues to be lower than expected for the last 20 years, mainly due to the continuous use of poor production technologies by farmers (Singh and Khan, 2003). The continuous use of poor production technologies by sesame farmers may not sustain soil fertility, productivity and profitability of sesame crop. Other reasons for the decline in the productivity of sesame include damage by pests and diseases, insufficient weed control, high levels of monocropping, lack of mechanisation and unrealised genetic potential (Raikwar and Srivastva, 2013).

Sesame is currently under exploited as an organic crop despite the fact that most of the tropical farmers grow the crop organically by default (Olowe *et al*., 2009). It is

reported that over 70 percent of Nigerians are poverty-striken and are living on less than US$1.00 per day, hence living below the United Nations termed poverty line (World Bank, 1996). Sesame production can lift sesame farmers not just above poverty line, but to be rich and live comfortably (Mshelia *et al*., 2012).

The use of improved production technologies of sesame offers a great scope for increasing productivity and profitability. The yield of sesame can be increased by 21-53% with adoption of improved technologies (Singh and Khan, 2003). Based on this, this study intends finding answers to the following research questions:

i. What are the socio-economic characteristics of sesame farmers in the study areas?

ii. What is the economic efficiency of sesame production?

iii. What are the determinants of efficiency in sesame production?

iv. How profitable is sesame production?

v. What are the major constraints associated with the production of sesame in the study areas?

1.3 Objectives of the study

The major objective of the study was to evaluate the production efficiency and profitability of sesame production in Gwer East and Konshisha Local Government Areas of Benue State of Nigeria. The specific objectives were to:

i. describe the socio-economic characteristics of sesame farmers in the study areas;

ii. estimate the economic efficiency of sesame production;

iii. determine the determinants of efficiency in sesame production;

iv. estimate the profitability of sesame production;

v. identify the major constraints associated with the production of sesame in the study areas.

1.4 Justification of the Study

Sesame is an important export crop of Nigeria and the country plays an important role in the global sesame trade. For example, Nigeria is the primary supplier of sesame seed to the world's largest importer, Japan (Chemonics, 2002). Thus, the potentials for sesame seeds production in Nigeria is high, since Japan, as well as Taiwan and Korea, generate global demand and offer opportunity for Nigerian growers. Nigeria has a 6% share of the $600 million global market for sesame seed (Nigeria's Harvest, 2009). In response to the growing export market demand, Nigeria's production of the crop has increased from about 15,000 metric tonnes in 1980, to about 100,000 metric tonnes in 2006 (USAID, 2009).

The realisation of the potential of sesame production for generating foreign currency for the country made increased production of the crop a prominent priority in the Agricultural Transformation Agenda of the Federal Government of Nigeria (NCRI, 2012). To this end, farmers are being encouraged to produce sesame in all agro-ecological zones of the country. Nigeria has the technology to produce significant output of sesame for export, in view of the yield potentials of the varieties released to farmers (NCRI, 2012).

The knowledge about the efficiency of sesame production is very essential as it can be used to enhance its profitability for its growers and can be used by policy makers for developing sustainable food production systems in the country. Therefore, this study is significant as it will contribute meaningfully to the body of research on efficiency and profitability of sesame production.

1.5 Hypotheses

The hypotheses that were tested in this study are as follows:

i. Determinants of efficiency do not have effects on economic efficiency of sesame production in the study areas.

ii. There is no significant difference between costs and return in sesame production in the study areas.

CHAPTER TWO

LITERATURE REVIEW

2.1 World Sesame Production and Trade

Out of the twenty two countries who are the major producers of sesame in the world (Table 1), six are in Asia, thirteen in Africa and three in Latin America (Central and South America). Myanmar, India and China are the highest producers, while Mali, Bangladesh and Paraguay, are the least producers. FAO statistics reveal that these major sesame-producing countries together account for 92.6% of the world sesame production (FAOSTAT, 2013). Nigeria currently ranks first in West Africa, fifth in Africa and eighth in the world producing about 165,000 tonnes of sesame on 340,000 hectares of land (FAOSTAT, 2013).

Sesame world production areas have remained generally stable over the years, but in some countries the crop is being marginalized (Bennet, 2011). Competition from more remunerative crops and a shortage of labour have pushed sesame to the less fertile fields and to areas of higher risk. Left unchecked, sesame production may decrease in the foreseeable future (Tunde-Akintunde and Akintunde, 2007).

World sesame trade shows that in 2011, 1,377,131 tonnes of whole sesame seeds were exported (Table 2). The market for sesame in Asia and Europe is growing at a very high rate in the last decade because the products from sesame really meet the health requirements for food in the developed world and the popular cuisine in the oriental world (Olowe *et al*., 2009). Very significant, 29% of the seed produced in the world enters international trade and the amount traded is increasing, indicating a major world market for producers (Anon, 2007) and Africans, especially Nigerian farmers can easily

take advantage of this ever increasing demand to improve on their incomes. The greatest challenge to producers is that China which as at 2000 was a major exporter has now become a major importer, importing 157,000 tonnes in 2005 (Anon, 2009). And in March, 2009 the president of China was in Africa to partner with farmers for sesame production for China market. Anon, (2009), also reported that in the last fifteen years, the amount of sesame imported has increased by 88%.

Data on sesame production and trade on regional basis in the world (Table 2) show that Asia and Africa together produces 56% and 40% of the world's sesame, respectively. About 29% of the world's production and 38% of Africa's production go on export. Nigeria became the largest supplier of sesame to the largest sesame importer, Japan in 2001 (Chemonics, 2002). Asia imports almost twice as much sesame as it exports because the seeds are consumed as a 'tahini' or crushed into toasted oil. It is suggested that Africa should step up her production to meet the ever increasing demand for sesame particularly in the Asian market. Nigerian farmers therefore need to take advantage of this demand to improve their economy.

Table 1 : World major sesame producers in 2013

S/No.	Country	Area harvested (hectares)	Production (tonnes)	Yield (tonnes/hectare)
1.	Myanmar	1590000	890000	0.5597
2.	India	1860000	636000	0.3419
3.	China	449200	588600	1.3103
4.	Sudan (former)	2157540	562000	0.2605
5.	Tanzania,United Republic of	630000	420000	0.6667
6.	Ethiopia	282950	187121	0.6613
7.	Uganda	290000	180000	0.6207
8.	Nigeria	340000	165000	0.4853
9.	Mozambique	210000	110000	0.5238
10.	Burkina Faso	160000	95000	0.5938
11.	Niger	185000	92000	0.4973
12.	Somalia	70000	70000	1.0000
13.	Guatemala	39000	54700	1.4026
14.	Thailand	70000	52000	0.7429
15.	Cameroon	70186	49130	0.7000
16.	Mexico	63642	41522	0.6524
17.	Egypt	30000	40000	1.3333
18.	Chad	97000	39000	0.4021
19.	Pakistan	84000	35000	0.4167
20.	Mali	60000	35000	0.5833
21.	Bangladesh	37000	34000	0.9189
22.	Paraguay	50000	30000	0.6000

Source : FAOSTAT, 2013

Table 2: World Regional Sesame Production, Trade and Consumption

Regional	Area harvested (hectares)	Production (tonnes)	Import (tonnes)	Export (tonnes)	Net trade	Consumption
Asia	4450807	2661596	1097458	536923	560535	3222131
Africa	3909098	1898297	63879	716430	(652551)	1245746
South America	160167	79052	7205	60098	(52893)	26159
Central America	123102	99673	38998	30076	8922	108595
North America	0	0	43661	5039	38622	38622
Caribbean	11005	4002	169	0	169	4171
Europe	290	1575	145797	28532	117265	118840
Oceania	0	0	6323	33	6290	6290
World	8654469	4744195	1403490	1377131		4770554

Source: FAOSTAT, 2011

2.2 Sesame Production in Nigeria

Sesame production in Nigeria was stimulated by the great demand for oilseed in Europe after World War II in 1947 (FIIR, 1990). The West African oilseeds mission was mandated to investigate the possibility of the production of groundnut and other oil seeds in Nigeria. Ever since then, there has been considerable growth in the cultivation of sesame beyond the traditional producing areas in the country (FIIR, 1990). Sesame, therefore, became one of the major agricultural commodities that attracted foreign exchange prior to independence.

Sesame production in Nigeria has been on the increase since 1961 because of the global demand generated by importing countries such as Japan and Korea (Chemonics, 2002).The total land area under sesame production decreased from 200,000 hectares in 1961 to 153,000 hectares in 2001 but production increased from 56,000 tonnes to

74,000 tonnes and also, yield increased from 0.280 tonnes/hectare to 0.4837 tonnes/hectares within the same period (Table 3). The area cultivated increased from 325,000 hectares in 2011 to 340,000 hectares in 2013 and production from 155,000 tonnes to 165,000 tonnes in the same period (FAOSTAT, 2013).

The current production of sesame seed is highly dependent on high marketable value and suitability of environmental conditions especially in the middle belt and northern part of the country (NAERLS, 2010). The suitability of environmental condition for sesame crop production and the presence of genetic diversity of sesame in Nigeria would give better possibility or potential for improvement (NCRI, 2002). The proximity of the country to international market and the high markets demand for Nigerian sesame seed can be considered as providing opportunities for increased production (Chemonics, 2002).

Table 3 : Sesame Production in Nigeria from 1961 to 2013

Years	**Area harvested (hectares)**	**Production (tonnes)**	**Yield (tonnes/hectares)**
1961	200000	56000	0.2800
1971	114000	32000	0.2807
1981	140000	42000	0.3000
1991	115000	46000	0.4000
2001	153000	74000	0.4837
2011	325000	155000	0.4769
2012	330000	158000	0.4788
2013	340000	165000	0.4853

Source: FAOSTAT, 2013.

2.3 Sesame Cropping Systems

Intercropping of sesame offers the possibility of yield advantage relative to sole cropping through yield stability and improved yield (Bhatti *et al*., 2006). One of the supposed advantages of this practice is that losses from insects and diseases may be reduced (Khan *et al*., 1997), most probably because the crop mixtures create a less favourable environment for certain pests of one or both of the component crops. Another benefit of intercropping is an increase in yield per area of land (Carlson, 2008). Sesame occupies the same place as a rain-fed crop in dry regions as does sorghum. It is considered a desirable preceding crop for wheat, as it does not exhaust the soil and improves the soil structure by the loosening effect of its dense root system (Onwueme and Sinha, 1991).

Sesame is rarely grown as a sole crop. In tropical Africa it is usually sown with sorghum, millet or maize. In Uganda, it is sown among pigeon peas after the finger millet has been harvested from a mixture of pigeon peas and finger millet. It may also be intersown with maize or sorghum. In the coastal regions of Kenya, it is often sown among maize in June shortly before the cereal crop is harvested (Onwueme and Sinha, 1991).

2.4 Nutritional and Economic Importance of Sesame

The chemical composition of sesame shows that the seed is an important source of oil (44-58%), protein (18-25%), carbohydrate (~13.5%) and ash (~5%) (Borchani *et al*., 2010). Sesame seed is approximately 50 percent oil (out of which 35% is monounsaturated fatty acids and 44% polyunsaturated fatty acids) and 45 percent meal (out of which 20% is protein) (Ghandi, 2009 and Hansen, 2011).

The oil seed is renowned for its stability because it strongly resists oxidative rancidity even after long exposure to air (Global AgriSystems, 2010). The oil fraction shows a remarkable stability to oxidation. This could be attributed to endogenous antioxidants namely lignins and tocopherols (Elleuch *et al*., 2007 and Lee *et al*., 2008).

Sesame is used mainly as a food ingredient in whole, broken, crushed, shelled, powdered and paste forms. Its use is country-based. For example, in the United States of America, it is used as some form of whole seed product for the confection and baking industries. A small percentage of total production is however processed into oil, meal or flour (Hansen, 2011). In Nigeria, the seeds are consumed fresh, dried, fried or when blended with sugar. It is also used as a paste in some local soups (Fariku *et al*., 2007).

Sesame seeds are not only used for culinary purposes but also in traditional medicines for their nutritive, preventive and curative properties. Its oil seeds are sources for some phyto-nutrients such as omega-6 fatty acids, flavonoid phenolic anti-oxidants, vitamins and dietary fiber with potent anti-cancer as well as health promoting properties (Nakai *et al*., 2003). Sesame oil is an edible vegetable oil derived from sesame seeds and is used in various countries. It is used as a cooking oil in South India and Asia and often as a flavour enhancer in Chinese, Japanese, Korean, and to a lesser extent Southern Asia cuisine (Juan *et al*., 2005).

Sesame seed oil has a natural antioxidant which prevents aging and is vital for the production of liver cells (NAERLS, 2010; Weiss, 2000). The oil also contains oleic (35.9-47%), linoleic (35.6-47.6), palmitic (8.7- 13.8%), stearic (2.1-6.4%), as well as arachidic acids (0.1-0.7%) (Elleuch *et al*., 2007 and Borchani *et al*., 2010).

Sesame is an important export crop of Nigeria and the country has a substantial role in the global sesame trade. About 70% of sesame produced in the country is being traded overseas (Chemonics, 2002). Nigeria exports 80,000 tonnes of the global export of 900,000 tonnes. Major destinations for export include China, Japan, Syria, European Union, Korea, Turkey and the Middle East (Tiamiyu *et al*., 2013). Annual exports of sesame from Nigeria are valued at about US$20 million and Nigeria is the primary supplier of sesame seed to the world's largest importer, Japan (USAID, 2009).

The wide range of sesame seeds markets is a great opportunity to earn additional foreign exchange for the country if its production potentials are exploited (Tiamiyu *et al*., 2013). In response to the growing export market demand, Nigeria's production of the crop has increased from about 41,000 tonnes in 1980, to about 165,000 tonnes in 2013 (FAOSTAT, 2013).

Abdullah (2009) reported that a pilot project to increase sesame production and utilization for economic empowerment in the northern states of Nigeria jointly undertaken by the National Sesame Seeds Association of Nigeria and the First Bank of Nigeria in 2007 showed that farmers can greatly gain by engaging in sesame production. In Borno and Kebbi States where the project was tried, cooperative societies were set, using a total of 3,000 farmers who were given a loan of ₦ 160,000 million and by the end of the year when they harvested their sesame and sold it the amount realized tripled the loan. Survey have shown that it will cost about ₦ 45,000 to cultivate a hectare of sesame from land preparation to harvesting and one hectare will give about 1.2 tonnes which sells for ₦ 60,000/tonne at harvest and reaches about ₦ 150,000-₦ 200,000/tonne at some periods in the year (Abdullah, 2009). The National president of

the Sesame Seeds Association of Nigeria revealed that sesame seeds farming can provide one million jobs and earn US$1.5 Billion for the northern states of Nigeria thereby economically empowering people of the region.

2.5 Measures of Profitability

This involves estimation of costs and return of production. According to Gomez (1975), costs and return analysis is a useful tool of enterprise comparison and indicates the profit or loss recorded by enterprises.

2.5.1 Net Farm Income

Net Farm Income refers to the return to farm operators for their labour, management and capital, after all production expenses have been paid (that is, gross farm income minus production expenses) (Jasper, 2005). It includes farm income from farm productions as well as net income attributed to the rental value of farm dwellings, the value of commodities consumed on the farm, depreciation and inventory changes (Jasper, 2005). It is the difference between gross income (revenue) and total cost of production (Olukosi and Erhabor, 2005). The net farm income accounts are designed to provide an annual measure of income returned to the operators of agricultural businesses from the production of agricultural commodities. The technique emphasizes the costs (fixed and variable costs) and the return of any production enterprise. Fixed costs are cost that do not change with the level of production. An example is the cost of farm buildings. On the other hand, variable costs are costs that change in direct proportion to volume of production. An example is cost of raw materials and seeds.

2.5.2 Gross margin analysis

The gross margin analysis involves evaluating the efficiency of an individual enterprise (or farm) so that comparison can be made between enterprises or different farm plans. It is a very useful planning tool in situations where fixed capital is a negligible portion of the farming enterprise as is the case in subsistence agriculture (Olukosi and Erhabor, 2005). Gross margin (GM) by definition is the difference between the gross farm income (GI) and the total variable cost (TVC), that is GM = GI - TVC.

2.6 Resource Productivity

Agricultural productivity may be defined as the index of the ratio of the value of total farm output to the value of the total inputs used in farm production (Olayide and Heady, 1982). Since one of the chief objectives of any society is the attainment of an optimally high level of living with a given amount of effort, any increase in the productivity of resources employed in farm production amounts to progress. Increase in agricultural productivity will contribute to the well-being of the economy as a whole.

Aggregate measures of productivity in production economics analyses will add to the sum of our knowledge by (a) serving as barometers of economic progress, (b) serving as guides to adjustment of resources, (c) providing a framework for formulating and evaluating policy and (d) indicating problem areas that need further research. The final objective of the interest in productivity should be to find ways of increasing output per unit of input, and of attaining desirable inter-firm, intra-firm and inter-sector transfers of production resources, thereby providing the means for raising our economic level of living.

The input-output process of farm production, is important in at least four major problem areas. These are the distribution of income, the allocation of resources, the relation between stocks and flows, and the measurement of efficiency or productivity. In the productivity concept, a meaningful assessment will depend upon a clear and precise definition of input and output in such a way that their movements over time are not equal. In other words resource productivity is definable in terms of individual resource inputs or in terms of a combination of them. Thus, labour productivity is defined as the ratio of total output to labour inputs. Similarly, 'land,''capital,''water' and 'management' productivities can each be defined as the ratio of total output to inputs of land, capital water and management respectively (Fabricant, 1959).

Using this definition as a bench-mark, change in productivity over time will depend upon changes in both the 'included' and 'excluded' components and maximum resource productivity will imply obtaining the maximum possible output from the minimum possible set of input. In this context, optimal productivity of resources implies an efficient utilization of resources in the production process. This means that productivity and efficiency are synonymous in this context.

An increase in farm output will result from one of three forces. First it will result from an increased quantity of inputs, with no change in output per unit of input. Second it will result from increased productivity of inputs with no change or a decrease in quantity of inputs. Thirdly, it will result from a combination of changes in inputs and productivity. This situation makes the concept of efficiency a central issue in production economics (Fabricant, 1959).

2.7 Production Efficiency

Production efficiency means making rational use of resources and exploiting the full available potential (Standish, 2010). Production efficiency can also be defined as the use of economic resources that produces the maximum level of satisfaction possible with the given inputs and technology (Samuelson and Nordhaus, 2005). Efficiency is measured by comparing the actually attained or realised value of the objective function against what is obtainable at the frontier (Coelli *et al*., 2005).

Economic efficiency is decomposed into technical and allocative efficiency. A producer is said to be technically efficient if production occurs on the producer's production possibility set, and technically inefficient if production occurs on the interior of the production possibility set (Ellis, 1988). That is, technical efficiency is the extent to which the maximum possible output is achieved from a given combination of inputs (Ellis, 1988). On the other hand, a producer is said to be allocatively efficient if production occurs in a region of the production possibility set that satisfies the producer's behavioural objective (Coelli, *et al*., 2005).

Farrell (1957) distinguished between technical and allocative efficiency in production through the use of a frontier production function. He defined technical efficiency as the ability to produce maximum output from a given set of inputs. He defined allocative efficiency as the ability of a firm to use inputs in optimal proportion, given their respective prices. He defined economic efficiency as the simple product of the technical and allocative efficiencies. Alternatively, economic efficiency can be defined as the ability of a production firm or any other entity to produce a given output at minimum cost. If a firm has achieved both technically efficient and allocatively efficient levels of

production, it is economically efficient and new investment streams may be critical for any new development (Alene and Hassan, 2003).

2.8 Approaches for Measuring Production Efficiency

Data envelopment analysis and stochastic frontiers are two alternative methods for estimating frontier functions and thereby measuring efficiency of production (Coelli *et al*., 1998). Data envelopment analysis (DEA) involves the use of linear programming methods to construct a non-parametric piece-wise surface (or frontier) over the data. Efficiency measures are then calculated relative to this surface. The Data Envelopment Analysis (DEA) has no fixed functional form and does not account for noise in the data. Thus, all deviation from the frontier will be accounted for as inefficiencies (Johansson, 2005). Comprehensive reviews of the methodology are presented by Lovell (1993), Ali and Seiford (1993) and Charnes *et al*. (1994).

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 (2006), Rahman and Umar (2009), Thomas (2007), Emokaro and Ekunwe (2009) and others which derived from the error model of Aigner *et al*. (1977) and Meeusen and Van den Broeek (1977). The stochastic frontier approach is parametric and is sensitive to the choice of functional form and accounts for random errors. In this approach, all deviations from the frontier are due to random effects and inefficiency (Coelli *et al*., 2002).

2.9 Previous Empirical Studies that used the Stochastic Frontier Production Function Approach

Stochastic frontier approaches have found wide acceptance within the agricultural economics literature because of their consistency with theory, versatility and relative

ease of estimation (Kibaara, 2005). The measurement of efficiency (technical, allocative and economic) has remained an area of important research both in the developing and developed countries, where resources are meagre and opportunities for developing and adopting better technologies are dwindling (Kibaara, 2005).

Chukwuji *et al*. (2004) determined the technical efficiency of gari processors in Delta State of Nigeria using the stochastic frontier production function. He found that capital and labour were significantly related with gari processing. Age, family size, level of formal education, and gari to total revenue ratio were found to be significant determinants of technical efficiency in gari processing. The technical efficiency of gari processors ranged from 25% to 86%, with a mean level of 65%. The returns to scale estimate was 1.75 implying that the processors operate in the region of increasing returns to scale.

Rahman *et al*. (2005) estimated the technical efficiency in sorghum-based cropping systems in Soba area of Kaduna State of Nigeria and found that land, fertilizer and labour were significant and positively related with the output of sorghum in sole sorghum cropping system. For sorghum/cowpea, sorghum/groundnut,sorghum/soyabea and sorghum/millet cropping systems, land and labour were significant and positively related with the output of sorghum/cowpea, sorghum/groundnut, sorghum/soyabean and sorghum/millet. The overall technical efficiency observed in the sorghum-based cropping systems varied between 0.32 and 0.85 with average of 0.62 for sole sorghum, 0.74 for sorghum/cowpea, 0.64 for sorghum/groundnut, 0.71 for sorghum/soyabean and 0.58 for sorghum/millet respectively. Thus, in the short-run, there is tendency for increasing crop production by 38, 26, 36, 29 and 42 percent in sole sorghum,

sorghum/cowpea, sorghum/groundnut, sorghum/soyabean and sorghum/millet, respectively, by adopting the best technologies or techniques in sorghum-based cropping systems.

Udoh *et al*. (2007) estimated the technical efficiency of fluted pumpkin farmers in Uyo, Akwa Ibom State of Nigeria, using the stochastic frontier production function which incorporates a model for the technical inefficiency effects and found that land, labour, inorganic fertilizer and planting materials were positively and significantly related with the output of fluted pumpkin. The results of the technical inefficiency effects showed that extension contact and farming experience were the only significant determinants of technical inefficiency in fluted pumpkin production. The mean technical efficiency was 0.86, indicating that production level of fluted pumpkin could still be increased by 14 percent using available improved technology. The maximum and minimum technical efficiencies were 0.96 and 0.01 respectively.

Amos (2007) determined the productivity and technical efficiency of smallholder cocoa farmers in five Local Government Areas of Ondo State of Nigeria using the stochastic frontier production function. The results showed cost of fungicide and cost of processing were significantly related with cocoa output. The determinants of technical efficiency in cocoa production were age of the farmer, level of education and family size. The efficiency level ranged between 0.11 and 0.91 with a mean of 0.72. The elasticity of production showed that farmers were experiencing increasing returns to scale in cocoa production in the study area with a value of 1.26.

Kadurumba *et al*. (2009) used the translog stochastic production function to measure the

level of technical efficiency and its determinants in traditional palm oil processing in Imo State of Nigeria. The results of the translog analysis revealed that oil palm fruit, water used, amount of loan borrowed and petrol/diesel energy were significant and positively related with the output of palm oil processing, while labour was significant and negatively related with the output of palm oil processing. The determinants of technical efficiency were age, educational level, processing experience, net processing income, petrol/diesel energy, co-operative membership, credit availability, interest on loan, mill ownership and mechanization energy. The results of the determinants of technical efficiency in palm oil processing revealed that age, educational level and interest on loan were significant and negatively related with technical efficiency while processing experience, depreciation on fixed assets, net processing income, diesel energy, co-operative membership, credit availability, mill ownership and mechanization energy were positively related with technical efficiency. The results showed that the mean farm level technical efficiency was 86%, while the maximum and minimum technical efficiency indices were 97% and 61%, respectively. The results of elasticities and return to scale in palm oil processing was 4.1106 implying an increasing returns to scale.

Tanko and Opara (2010) determined the technical efficiency in maize production in Bosso local government area of Niger State of Nigeria using the stochastic frontier production function model. The results showed that farm size, labour and fertilizer were positively and significantly related with output of maize. The results of the determinants of technical efficiency showed that education, farming experience and credit were the significant determinants of technical efficiency of maize farmers. The results also revealed a mean technical efficiency of 0.87 and the maximum and minimum technical

efficiencies of 0.98 and 0.43 respectively.

Amodu (2010) determined the technical efficiency of part-time farming in Idah local government area of Kogi State of Nigeria using stochastic frontier production function model. He found that farm size, labour and planting materials were significant and positively related with part-time farming. The determinants of technical inefficiency in part-time farming were found to be age, education and farming experience. The results showed that age and household are negatively related with technical inefficiency while education and farming experience has positive relationship with technical inefficiency. The mean technical efficiency was 65%, and the maximum and minimum technical efficiency indices were 99.8% and 24.8%, respectively. The return to scale was 0.954 indicating a decreasing return to scale. The Maximum Likelihood Estimates of the stochastic frontier cost function revealed that costs of land preparation, labour, planting materials, fertilizer and other variable expenses were significantly related with cost of part-time farming. The determinants of allocative inefficiency were age and education. The mean, maximum and minimum allocative inefficiencies were 100%. The mean economic efficiency was 65%, and the maximum and minimum economic efficiency indices were 99.8% and 24.8%, respectively.

Abu *et al*. (2012) carried out a study on the profit efficiency among sesame farmers in Nasarawa State of Nigeria using stochastic frontier production function model. He found that labour, seed and fertilizer were significant and positively related with the output of sesame. The determinants of technical inefficiency of sesame farmers were age, farming experience, off sesame farm income, educational status, training and access to credit. The mean technical efficiency of sesame farmers was 0.66, and the

maximum and minimum technical efficiencies were 0.90 and 0.10 respectively. The return to scale was 0.45 indicating decreasing return to scale. The results of the Maximum likelihood estimates of the Cobb-douglas stochastic frontier cost function model showed that costs of seed, fertilizer, labour, chemical and transport were significant and positively related with the cost of sesame production in the study area. The determinants of allocative inefficiency were age, farming experience, off sesame farm income, educational status, household size, access to credit and occupational status. The mean allocative efficiency of sesame farmers was 1.419, and the maximum and minimum allocative efficiencies were 12.89 and 1.03 respectively.

2.10 Constraints of Sesame Production

The major constraints of sesame production in Nigeria include:

2.10.1 Inadequacy of fertilizer - One of the factors affecting sesame production in Nigeria is inadequacy of fertilizer (Adebisi *et al*., 2005). Alege *et al*. (2009) reported that chemical fertilizers are useful for soil fertility improvement but are scarce, expensive and a threat to the environments.

2.10.2 Problem of weed - In Nigeria, over 65% yield losses in sesame in Jigawa, Katsina, Benue and Nasarawa States have been attributed to weeds on farmers' fields (Busari *et al*., 1998). Considering the growing potentials of the export and domestic market demand for sesame seeds, this level of loss is very high. The effects of weeds on sesame establishment and growth have been well-documented. Balyan (1993) reported weed-induced reductions of sesame yield up to 65% and a need for a critical weed-free period up to 50 days after planting.

2.10.3 Poor access to credit - One of major constraints for small-scale farmers in the adoption of agricultural technologies is poor access to credit. Limited cash resources

generally hinder the purchase of high-yielding seed varieties and chemical fertilizers at the beginning of the sesame planting season (Zerfu *et al*., 2010). Presently, the position of farmers is that without credit, they may not be able to adopt new methods and techniques which are required to increase sesame production and productivity, upon which the development of the economy depends. According to Adegeye and Dittoh (1985), credit is needed to break the poverty cycle among the farmers since low income implies low productivity.

2.10.4 Poor extension services - Extension service provision in developing economies like Nigeria remains low for both women and men farmers (Meinzen-Dick *et al*., 2010). Poor extension services result in reduced adoption of agricultural technologies for sesame production, low farm productivity and reduced household incomes (Anderson a nd Feder, 2007).

2.10.5 Poor management practices - In Nigeria, the low sesame yield is partly attributed to improper agronomic practices such as inappropriate fertilizer levels, dependence on lower-yielding cultivars and poor planting systems (NARO, 1999). It has been shown that increased seed yields can be enhanced significantly by improving these management practices. In Nigeria, the productivity of sesame is 485.3kg/ha which is lower than the potential yield of 2000kg/ha indicating that there is room for greater improvement in productivity (Mkamilo and Bedigian, 2007).

2.10.6 Problem of diseases - Sesame is highly susceptible to diseases (Tripathi *et al*., 1992). Among the thirty two most important diseases, fusarium wilt (*Fusarium oxysporium*) takes a heavy toll on the crop every year in Nigeria. Root and stem rot caused by *Macrophomina phaseolina* is also a very serious and destructive disease, which is present in all sesame-growing areas (Tripathi *et al*., 1992). According to Ssekabembe *et al*. (2001), very few farmers control diseases and pests, even though

they are aware of their existence. Engoru *et al*. (2001) indicated that of the farmers who experience pest and disease problems, about 60% completely ignore the situation. Therefore, diseases contribute to lower sesame yields in Nigeria, and hence the need for effective and affordable control measures, which are still inadequate.

2.10.7 Problem of pests- Insect pests cause drastic reduction in the yield of sesame. Depending on the weather and time of the year, the sesame plant is constantly attacked by a wide range of insect pests (NCRI, 2002). These pests range from species that defoliate the plant to those attacking flower heads and young fruits. Research by NCRI (2002) has shown that in most sesame production zones, pod-sucking bugs cause severe damage to the crop. The principal insect pests of sesame in Africa are the leaf-roller (*Antigastra catalaunalis*) and the sesame gall-fly (*Asphondyla* sesame) (Onwueme and Sinha, 1991).

2.10.8 Indeterminate growth habit - One of the major problems associated with sesame production is the uneven ripening of capsules (Wasana, 1997). At present, all commercial sesame cultivars in Nigeria and other countries are indeterminate, producing leaves, flowers and capsules as long as the weather conditions and soil moisture permit. Thus, some yield is lost either because the early-produced capsules shatter before harvesting or because late-produced capsules are immature at harvest time (Ashri, 1989). Vanisri *et al*. (1994) have indicated that the number of capsules per plant is the most important yield-contributing character in sesame. Hence, there is need to breed for cultivars with determinate growth and more number of capsules in order to reduce the above problem.

CHAPTER THREE

METHODOLOGY

3.1 The Study Areas

The study was conducted in two local government areas of Benue State namely: Gwer East and Konshisha. Benue State is located in the North Central Nigeria, approximately between latitudes 6.3^{o} N to 8.1^{o} N and longitudes 8°E to 10^{o} E (BNARDA, 2000). According to 2006 National Population Commission (NPC) census results, Benue State had a population of 4,219,244 people. Based on the annual population growth rate of 3.2 per cent estimated by National Population Commission in 2014, Benue State has a population of 5,472,659 people. Benue State is divided into three agricultural zones, namely northern, eastern and central agricultural zones, with headquarters at Guma, Vandeikya and Oju respectively. Gwer East and Konshisha Local Government Areas are located in the northern and eastern agricultural zones.

Gwer East has its headquarters in the town of Aliade. It has an area of 2,294km^2 and a population of 163,647 people at the 2006 population census and 210,546 people in 2014, based on the 3.2 percent population growth rate. It has three districts, which are: Jiriv, Ngyohov and Yonov. Gwer East has seventeen council wards and it shares boundary with seven other local government areas. Konshisha has its headquarters in the town of Tse-Agberagba. It has an area of 1,673km^2 and a population of 225,672 people at the 2006 population census and 290,346 people in 2014. It has two districts and eleven council wards. It shares boundary with three other local government areas and Cross River State.

The northern agricultural zone lies between latitudes 6°50’ North and longitudes 7°50’

to 10° East and covers an estimated land area of about 10,318.2 square kilometres and the eastern agricultural zone lies between latitudes 6°5' to 7°2' North and longitudes 8°4' to 10° East and covers an estimated land area of about 10,089 square kilometres (BNARDA, 2000). The northern zone comprises seven Local Government Areas namely: Buruku, Gboko, Guma, Gwer East, Gwer West, Makurdi and Tarka and the eastern zone comprises seven Local Government Areas namely: Katsina-Ala, Konshisha, Kwande, Logo, Ukum, Ushongo and Vandeikya.

Benue State has a tropical climate with two distinct seasons (rainy and dry seasons). The rainy season commences from April to October, while the dry season starts from November to March. According to BNARDA (2000), the daily mean temperature during the rainy season is 28°C while in the dry season, the average temperature is 35°C.

The major occupation of the people in the state is agriculture. The major agricultural crops produced include cassava, rice, sesame, maize, yam, soya bean, sorghum, sweet potatoes, groundnut, cocoyam, cowpea, plantain, banana and oranges. The livestock reared include goat, pigs, sheep and cattle (BNARDA, 2000). A small proportion of the people engage in trading, while others are in the civil service, but are still engage in some farming activities.

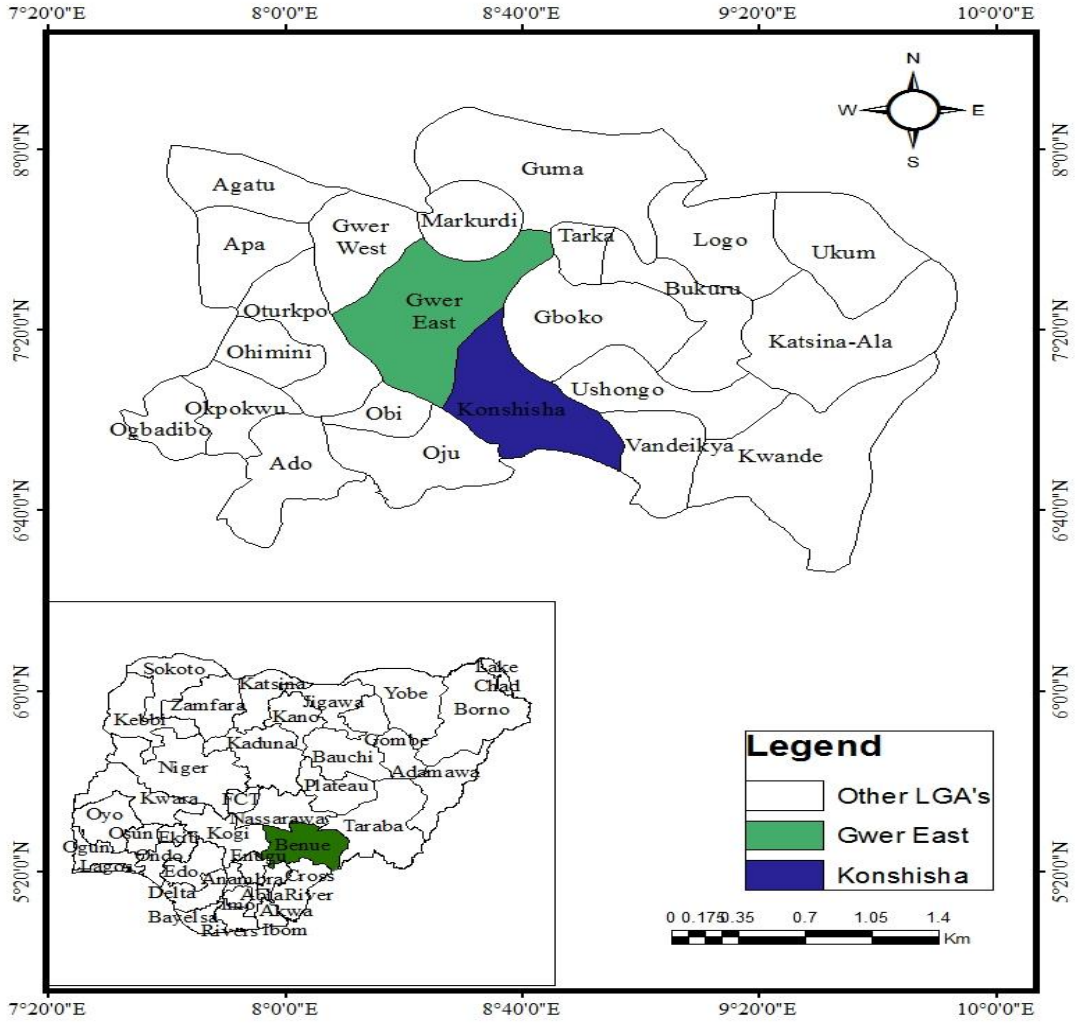


Figure 1: Map of Benue State showing the Study Areas

3.2 Sampling Technique and Sample Size

Multi-stage sampling was used for this study. The first stage involved the purposive selection of Gwer East and Konshisha Local Government Areas from the northern and eastern agricultural zones respectively, considering their position as the highest sesame-producing LGAs in Benue state. Secondly, all the three districts in Gwer East LGA and the two districts in Konshisha LGA were used. Thirdly, since Gwer East (90 villages) has more number of villages than Konshisha (60 villages), five villages were proportionally selected from the three districts of Gwer East LGA and three villages from the two districts of Konshisha LGA. Fourthly, from the population of sesame

farmers in each of the selected villages in the two Local Government Areas estimated with the help of village extension agents of Benue State Agricultural and Rural Development Authority (BNARDA) during a reconnaissance survey, fifty percent of the sesame farmers in each village was randomly selected to give a sample size of one hundred and fifty four sesame farmers (Table 4).

Table 4: Distribution of sesame farmers in the study areas.

Local Government Areas	Districts/ (villages)	Villages selected	Population of sesame farmers estimated	Number of sesame farmers selected
Gwer East	Jiriv (37)	Taraku	34	17
		Dagi	28	14
	Ngyohov (17)	Aliade	46	23
	Yonov (36)	Ikpayongo	42	21
		Mbaayande	30	15
Konshisha	Mbavaa (44)	Awajir	43	21
		Mbaikyu	39	19
	Shangev-Tiev(16)	Tse-Agberagba	48	24
Total 2	5 (150)	8	310	154

3.3 Method of Data Collection

The study made use of primary data. Data for the 2014 sesame cropping season was collected with the aid of structured questionnaires. The data generated include:

(i) the socio-economic characteristics of the farmers such as age, sesame farming experience, household size, farm size, educational level, extension contact, amount of credit received, and membership of farmers' cooperative societies.

(ii) the input data which are farm size cultivated for sesame (hectares), quantity and cost of seed, labour, fertilizer and agrochemicals, number and cost of simple farm tools such as sprayers, cutlasses and hoes.

(iii) the output data which are the total quantity and value of the sesame produced, including value of sesame consumed at home and given out as gifts.

3.4 Analytical Techniques

The following analytical tools were used to achieve the objectives of the study:

i. Descriptive statistics

ii. Net farm income

iii. Stochastic frontier production function

3.4.1 Descriptive Statistics

Descriptive statistics was used to achieve objectives i and v of the study. It involves the use of percentages, averages and frequency distributions.

3.4.2 Net Farm Income

Net farm income will be used to achieve objective iv. It will be used to estimate the costs, return and net profit of sesame production. The model used for estimating the net farm income is represented by :

NFI= TR-TC 1

Where:

NFI= Net farm income (₦)

TR= Total revenue (₦)

TC= Total cost of production (₦)

The fixed inputs such as simple farm tools and equipments are not normally used up in a production cycle. They will be depreciated using the straight line method of depreciation given by:

$$D = \frac{P-S}{N} \quad \text{.....2}$$

Where:

D = Depreciation (₦)

P = Purchase value of fixed input (₦)

S = Salvage value of input (₦)

N = number of years of life of asset (years)

The return per naira invested (RNI) will be obtained by dividing the net farm income (NFI) by the total cost (TC). Therefore, $RNI = \frac{NFI}{TC}$ 3

Where:

RNI = return per naira invested

NFI = net farm income

TC = total cost

3.4.3 Stochastic Frontier Production Function

The stochastic frontier production function was used to achieve objectives ii and iii. The stochastic frontier model for estimating the technical efficiency of the sesame farms is specified in the log form of the Cobb-Douglas frontier production function as:

$$\ln Y = \beta_0 + \beta_1 \ln X_1 i + \beta_2 \ln X_2 i + \beta_3 \ln X_3 i + \beta_4 \ln X_4 i + (Vi - Ui) \text{ …….……4}$$

Where:

ln = the natural logarithm

Y = output of sesame (kg)

β_0 = constant term

β_1- β_5 = regression coefficients

X_1 = farm size (hectares)

X_2 = quantity of seed (kg)

X_3 = labour used (man-days)

X_4 = quantity of agrochemicals (litres)

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

Ui = deviation from maximum potential output attributable to technical inefficiency.

The determinants of technical inefficiency were estimated using:

$U_i = \delta_0 + \delta_1 1nZ_1 + \delta_2 lnZ_2 + \delta_3 lnZ_3 + \delta_4 lnZ_4 + \delta_5 lnZ_5 + \delta_6 lnZ_6 + \delta_7 lnZ_7$…….....……5

Where:

Ui = technical inefficiency of the ith farmer

δ_0 = constant

δ_1- δ_7 = parameters to be estimated.

Z_1 = age of farmer (years)

Z_2 = sesame farming experience (years)

Z_3 = formal education (years)

Z_4 = household size (number of persons in the household)

Z_5 = extension contact (number of times of contact)

Z_6 = membership of cooperative societies (years)

Z_7 = amount of credit received (in naira and kind)

The explicit form of the stochastic frontier cost function is specified as:

$lnC = \beta_0 + \beta_1 lnX_1 i + \beta_2 lnX_2 i + \beta_3 lnX_3 i + \beta_4 lnX_4 i + (Vi + Ui)$ …….....6

Where:

ln = the natural logarithm

C = Cost of production of sesame (₦)

β_0 = constant term

β_1- β_4 = regression coefficients

X_1 = cost of farm (rent) (₦)

X_2 = cost of seed (₦)

X_3 = cost of labour (₦)

X_4 = cost of agrochemicals (₦)

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

U_i = deviation from the production cost frontier attributable to technical inefficiency.

3.5 Economic Efficiency

The product of allocative and technical efficiencies provides a measure of economic efficiency, that is,

EE = TE×AE 7

Where: EE= Economic efficiency, TE= Technical efficiency and AE= Allocative efficiency

3.6 Definition, Operationalisation and Rationalisation of variables

i. **Age** – This is the number of years a sesame farmer has lived from birth up to the time of study. This was measured in years. Age is expected to be positively related with technical inefficiency. The reason is that the older a farmer is, the fewer the number of farm practices he adopts and the weaker he becomes. Older

farmers seem to be somewhat less inclined to adopt new farm practices than younger ones, which increases their technical inefficiency (Voh, 1979).

ii. **Farming experience** – This is the length of time the farmer has been in sesame farming. This was measured in years. Farming experience is expected to have a negative relationship with technical inefficiency. The reason is that farming experience enables the farmer to set realistic target and to make effective farm management decisions with regard to good agronomic practices and wise choice of input combinations or resource allocation, which reduces technical inefficiency (Tanko and Opara, 2010).

iii. **Formal education level** – This is the number of years a respondent has spent in formal school. This was measured as: no formal education=0; primary school education=1; secondary school education=2; and tertiary education=3. Formal education is expected to be negatively related with technical inefficiency. The reason is that education enhances a farmer's ability to seek and make good use of information about production inputs (Kepede, 2001).

iv. **Household size** – This is the number of persons eating from the same pot under the care of the respondent as at the time of study . This was measured as the total number of persons in the household. Household size is expected to have a positive relationship with technical inefficiency. The reason is that rural households generally are known to be poor, thus the little they may have in terms of financial resources may not go far enough to purchase farm inputs after the other commitments of the household have been taken care of. This tends to increase technical inefficiency (Voh, 1979).

v. **Extension contact** – This is the frequency of visits by extension agents to the respondent and vice-versa. This was measured by the number of visits to or received by the sesame farmer in 2014. Extension contact is expected to be negatively related with technical inefficiency. The reason is that extension workers teach farmers proper use of improved technologies, which reduces their technical inefficiency (Njoku, 1991).

vi. **Cooperative membership** – This is the number of years that the farmer has spent in sesame cooperative society. This was measured in years of his/her membership of the society. Membership of cooperatives is expected to have a negative relationship with technical inefficiency. This is because membership of cooperatives enhances access to information, material inputs and their use which reduces technical inefficiency (Njoku, 1991).

vii. **Amount of credit** – This is the amount of credit received by the respondent in cash or kind for sesame production for the year 2014. This was measured or quantified in naira. This variable is expected to be negatively related with technical inefficiency. The reason is that availability of credit enables farmers to purchase and use improved inputs and practices which reduces their technical inefficiency (Njoku, 1991).

viii. **Farm size** – This refers to the total amount of land under sesame cultivation during the 2014 cropping season. This was measured in hectares. Farm size is expected to be positively related with sesame output. The reason being that large farm holdings tend to increase the output of sesame (El-Greedly *et al.*, 2005).

ix. **Seed** – This is the total quantity of sesame seeds that was sown by the respondent in 2014. This was measured in kilogrammes. Seed is expected to

have a positive relationship with the output of sesame. The reason is that the more improved seed of sesame a farmer uses the higher will be his output (Singh and Khan, 2003).

x. **Labour** – This is the number of manpower or labourers that were engaged during the course of sesame production in 2014. This was measured in man-days (1 man-day=8 hours). This variable is expected to be positively related with the output of sesame. This is because the more labour a sesame farmer employs the more plots of farmland he is likely to cultivate and the higher is likely to be the output of his sesame under very good agronomic practices (Umoh, 2006).

xi. **Agrochemical** – This is the amount of herbicide that was used for sesame production in 2014. This was measured in litres. This variable is expected to be positively related with the output of sesame. This is because agrochemicals help in the control of weeds, pests and diseases which are capable of reducing the yield of sesame.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Socio-economic Characteristics of Sesame Farmers in Gwer East and Konshisha Local Government Areas

The socio-economic variables examined in the study are: Age, sesame farming experience, formal educational status, household size, extension contact, membership of sesame co-operative society and amount of credit received by sesame farmers. The socio-economic characteristics of sesame farmers in the study areas is presented in table 5.

4.1.1 Age structure of sesame farmers

The result of the socio-economic characteristics of sesame farmers in the study areas revealed that 96.76 percent of the sesame farmers in the study areas were within their active age of 20 – 49 years with a mean age of 36 years. This implies that the sesame farmers are strong and active and can participate immensely in sesame production. This result agrees with the findings of Yusuf *et al.* (2008) that most farmers are within their active years and can make positive contribution to agricultural production.

4.1.2 Farming experience of sesame farmers

The study revealed that 51.30 percent of the sesame farmers had 11 – 12 years of sesame farming experience with a mean sesame farming experience of 12 years. These implies that majority of the sesame farmers are experienced farmers, as such will have high output of sesame. The reason is that farming experience enables the farmer to set realistic target and to make effective farm management decisions with regard to good agronomic practices and wise choice of input combinations or resource allocation, which reduces technical inefficiency (Tanko and Opara, 2010).

4.1.3 Educational level of sesame farmers

Education is an important socio-economic variable that influences a farmer's decision-making and level of adoption of innovations. Table 5 below shows that 14.94 percent of the sesame farmers had no formal education; 14.94 percent had primary education; 32.47 percent had secondary education; and 37.66 percent had tertiary education. This is an indication that majority (85.06 percent) of the sesame farmers are educated. Consequently, they could access information necessary to help them improve on their farming activities. Level of education of the sesame farmers' household is important in determining the household's ability to access, process and implement information on agricultural technologies (Zbinden and Lee, 2005)

4.1.4 Household size

The distribution of sesame farmers by household size revealed that majority (38.31 percent) of the sesame farmers had a household size of between 6 – 10 persons; 29.22 percent had a household size of 11 – 15 persons; and 11.69 percent had a household size of 16 – 20. The average household size was 10 persons implying a reasonably high number of family labour for the accomplishment of farm activities. The finding of this study agrees with Oluwatayo *et al.* (2008) that there is a positive and significant relationship between household size and farmers efficiency in production.

4.1.5 Number of extension visits of sesame farmers per year

The study shows that 59.74 percent of the sesame farmers had no extension contact, while 40.26 percent had extension contacts. Of the 40.26 percent, 22.08 percent had extension contacts of 1 – 5 times in the last sesame cropping season, while 18.18 percent had extension contacts of 6 – 10 times. This could be attributed to poor

extension service in the study areas. Good extension service enhances farmers adoption and usage of improved technologies.

4.1.6 Membership of sesame cooperative society

The distribution of sesame farmers by membership of sesame cooperative society indicates that 47.40 percent of the sesame farmer did not belong to sesame cooperative society, while 52.6 percent belonged, with an average of 5 years of membership. This implies that majority (52.6 percent) of the sesame farmers enjoyed the benefits of membership of sesame cooperative society such as having access to credit for sesame production; market outlets for sesame; marketing information and information on new technologies.

4.1.7 Amount of credit received by sesame farmers

The result also shows that 18.18 percent had no access to credit while 81.82 percent had access to credit varying from ₦ 1,000 to ₦ 160,000 with an average credit of ₦ 35,756. This implies that majority of the sesame farmers had credit to facilitate their sesame farm operations. The importance of credit for stimulating agricultural production, particularly at the small-scale level with enormous unrealized production potentials, cannot be over-emphasized. Odoemenem *et al.* (2005), observed that credit finances investments, help the rural poor to produce for the market, generate cash surpluses and accumulate savings, which will be the basis for future income growth or a protection against sudden reversals in household income and food security.

Table 5: Distribution of the respondents according to their socio-economic characteristics

Variable	Frequency (N=154)	Percentage (%)
Age (years)		
10 – 19	1	0.65
20 – 29	38	24.68
30 – 39	49	31.82
40 – 49	62	40.26
50 – 59	4	2.60
Mean	**36**	
Farming experience (years)		
01 – 10	70	45.46
11 – 20	79	51.30
21 – 30	5	3.25
Mean	**12**	
Educational status		
No formal education	23	14.94
Primary education	23	14.94
Secondary education	50	32.47
Tertiary education	58	37.66
Household size (number of people)		
1 – 5	30	19.48
6 – 10	59	38.31
11 – 15	45	29.22
16 – 20	18	11.69
21 – 25	2	1.30
Mean	**10**	
Extension visits per year		
No visit	92	59.74
1 – 5	34	22.08
6 – 10	28	18.18
Mean	**2**	
Sesame Cooperative Society Membership (years)		
Non membership	73	47.40
1 – 5	18	11.69
6 – 10	43	27.92
11 – 15	10	6.50
16 – 20	10	6.50
Mean	**5**	
Amount of credit received (naira)		
No credit	28	18.18
1000 – 40000	66	42.86
41000 – 80000	57	37.01
81000 – 120000	1	0.65
121000 – 160000	2	1.30
Mean	**35756**	

4.2 Efficiency of Sesame Production

4.2.1 Estimation of the Technical Efficiency of Sesame farmers

This section analyses the results of the production function and the technical inefficiency models of the stochastic frontier analysis. The stochastic frontier model specified was estimated by the maximum likelihood (ML) method using FRONTIER 4.1 software developed by Coelli (1995). The stochastic frontier production function estimates and the inefficiency determinants of the specified frontier are presented in Table 6. The study revealed that the generalized log likelihood function was 85.665. The log likelihood function implies that inefficiency exist in the data set. The value of gamma (γ) is estimated to be 0.29 and it was highly significant at $p< 0.01$ level. This implies that 29% of variation in the output of the sesame farmers from the frontier was due to the farmers' technical inefficiencies in their respective farms and not as a result of random variability. Since the factors responsible for the sesame farmers' technical inefficiencies are under their control, reducing their effects will greatly enhance their technical efficiencies and improve their outputs. The value of sigma-squared ($\boldsymbol{\sigma^2}$) was significantly different from zero level of probability. Sigma was 0.22 which represents good fit and correctness of the distributional form assumed for the composite error term.

The study revealed that the estimated coefficients of parameters of the production function were positive and farm size, seed and labour were significant at $p<0.01$ level. The estimated coefficient of farm size was 0.7596 which implies that increasing farm size by 1 unit will amount to 0.76 increase in the output of sesame. Furthermore, the result showed that farm size is the most important factor increasing the quantity of output of sesame as every unit increment in farm size used by sesame farmers will increase the quantity of sesame output by 0.76. This result is in harmony with that of

(Ogundari and Ojo, 2006) that revealed farm size to be significantly related to technical efficiency.

The coefficient of seed was positive and significant at $p<0.01$ level. The estimated coefficient of seed was 0.1124 implying that for every 1 unit increment in sesame seed, the output of sesame will be increased by 0.11. This is in agreement with the findings of Shehu *et al* (2010) who observed that the estimated coefficient of seed and labour inputs were positive as expected and significant at $p<0.01$ level, implying that the more seed is applied and the more labour employed the better the output of sesame

The elasticity of production with respect to labour was 0.1387 which is positive and significant at $p<0.01$ level. This implies that when 1 unit of labour is increased, sesame output will be increased by 0.14. This is in line with the study by Umoh (2006) which shows the importance of labour in farming, particularly in developing countries where mechanization is rare on small scale farms. The estimated coefficient of agrochemical was 0.0025 which is positive and not significant at $p<0.01$, $p<0.05$ or $p<0.1$ level. This is an indication that agrochemical did not contribute significantly to the output of sesame during the 2014 sesame cropping season.

Table 6: Maximum Likelihood Estimates Results of Stochastic Frontier Production Function (Technical Efficiency) of Sesame Production

Variable	parameters	coefficient	standard-error	t-ratio
Production function				
Constant	β_0	5.7576	0.09145	62.956*
Farm size	β_1	0.7596	0.04673	16.256*
Seed	β_2	0.1124	0.03963	2.837*
Labour	β_3	0.1387	0.02465	5.628*
Agrochemical	β_4	0.0025	0.00193	1.294
Inefficiency variables				
Constant	Z_0	0.7618	0.41925	1.817***
Age	Z_1	-0.0727	0.04124	-1.762***
Farming experience	Z_2	0.1737	0.08475	2.049**
Education	Z_3	-0.2525	0.14653	-1.723***
Household size	Z_4	-0.0607	0.03754	-1.617
Extension contacts	Z_5	-0.1106	0.07347	-1.505
Cooperative society	Z_6	-0.0567	0.02991	-1.897***
Amount of credit	Z_7	0.0001	0.00006	1.697***
Diagnostic statistics				
sigma-squared	(σ^2)	0.2166	0.11984	1.807***
Gamma	(γ)	0.2927	0.00015	200.39*
Log likelihood function	*L/f*	85.665		
LR test	101.403			
Total number of observation	154			
Mean efficiency	0.83			

Significance level: *= p<0.01; **= p<0.05; ***= p<0.1

The result of the inefficiency model of the Maximum Likelihood estimates of the stochastic frontier production function is contained in table 6. The estimated coefficients with negative signs attached indicate that they reduce technical inefficiency among the sesame farmers, while positive signs indicate that the coefficients increase technical inefficiency or reduce technical efficiency. The results showed that age, farming experience, education, membership of sesame cooperative society and credit were the determinants of technical inefficiency among the sesame farmers. Age, level of education and membership of sesame cooperative society were negatively related with technical inefficiency, while sesame farming experience and amount of credit received were positively related with technical inefficiency. The estimated coefficient of age was

-0.0727 which is significant at $p<0.1$ level. The negative coefficient of age implies that the older a farmer is, the lower will be the level of technical inefficiency or the higher will be his technical efficiency in sesame production. This can be attributed to the fact that the older a farmer is, the more familiar he becomes with farming practices that enhance efficiency. This result is in contrast with Kolawole and Ojo (2007) who in their study of small scale farmers in Nigeria found age to be positively related to inefficiency.

The coefficient of farming experience was 0.1737 and significant at $p<0.05$ level of significance. This implies that the more experienced a sesame farmer is, the higher will be his level of technical inefficiency. This is probably due to the fact that sesame farmers with long years of experience are used to obsolete methods of farming, traditional tools and species which do not encourage high output. This finding is at variance with that of Adebayo (2006) which revealed that farming experience in pastoral farming has positive impact and is statistically significant. On the other hand, this finding is congruent with that of Onu *et al.*(2000) whose result showed a negative relationship between farming experience and technical efficiency in cotton production in Nigeria.

Level of education has an estimated coefficient of -0.2525 and significant at $p<0.1$ level. This indicates that education impacts positively on the technical efficiency of sesame farmers. That is to say, the more educated a sesame farmer is, the higher is likely to be his technical efficiency. Education enhances farmer's ability to derive, decode and evaluate useful information as well as improving labour quality. This result concur with that of Onyenweaku *et al.*(2005) that showed a positive relationship

between education and technical efficiency in yam production in Nasarawa state, Nigeria.

Household size has a negative coefficient of -0.0607 and is not significant. This implies that the larger the household of a sesame farmer, the lower will be the level of technical inefficiency. This could be due to the fact that large household size make sufficient availability of labour for farm production. This is in harmony with findings of Bayacag (2001), who revealed that there is a positive and significant relationship between household size and farmers' efficiency in production.

The coefficient of extension contact is -0.1106 which is not significant. The implication of the negative coefficient of extension contact is that it impacts positively on the technical efficiency of the sesame farmers. In other words, the more extension contacts a sesame farmer gets, the higher will be his level of technical efficiency or the lower his level of technical inefficiency. Extension contact is positively related to technical efficiency in accordance with the a priori expectation that extension contact leads to more efficient transmission of information to farmers as well as enhancing the adoption of innovation. This result is in consonance with that of Onyenweaku *et al.*(2005) that revealed that there is a positive relationship between extension contact and technical efficiency in yam production in Nasarawa state, Nigeria.

Membership of sesame cooperative society has negative coefficient of -0.0567 and is significant at $p<0.1$ level. This implies that membership of sesame cooperative society contributes towards increase in the technical efficiency of the sesame farmers. Members of sesame cooperative society have more access to agricultural information, credit and

other production inputs as well as more enhanced ability to adopt information. This finding is consistent with that of Onyenweaku and Nwaru (2005) that membership of cooperative society enhances technical efficiency of farmers.

The coefficient of the amount of credit received is 0.0001 which is positive and significant at $p<0.1$ level. The implication of this is that the higher the amount of credit a sesame farmer receives, the more technically inefficient he becomes. This may be due to the fact that credit received by some sesame farmers in the study areas is used for some other purposes other than sesame production, such household upkeep, production of other crops, settlement of bills (medical, electricity, rent). Credit is an important part of agricultural production, the absence of which poses severe constraints to agricultural development in low-income countries, like Nigeria. This result is at variance with that of Onyenweaku and Nwaru (2005) who found a positive relationship between credit and technical inefficiency.

4.2.2 Elasticity of Production and Return to Scale

The elasticities of production and return to scale of sesame production in the study areas is presented in table 7. The elasticity of production is the degree of responsiveness of output to changes (increase or decrease) in inputs. The individual coefficients of farm size, seed, labour and agrochemical with respect to the output of sesame derived from the Cobb-Douglas stochastic frontier production function represent the elasticities of the variables. The sum of these coefficients indicates the nature of return to scale (Koutsoyannis, 1977). The elasticities of the variables with respect to sesame output are: farm size (0.76); seed (0.11); labour (0.14) and agrochemical (0.003). The result also revealed that farm size was the most significant and influential factor in sesame

production in the study areas. The sum of the individual elasticities of the variables is 1.01 indicating that the sesame farmers in the study areas are operating at an increasing return to scale. This implies that if all the productive resources are increased in the same proportion, the output of sesame will increase more than proportionate.

Table 7: Elasticities of Production and Return to Scale (RTS)

Variables	**Elasticities**
Farm	0.760
Seed	0.110
Labour	0.140
Agrochemical	0.003
RTS	**1.013**

4.2.3 Estimation of the Stochastic Frontier Cost Function

This section analyses the results of the cost function and the allocative inefficiency models of the stochastic frontier analysis. The Maximum Likelihood (ML) estimates of the stochastic frontier cost model of sesame farmers in the study areas is presented in Table 8. The diagnostic statistics estimates for sigma-squared and gamma are 0.15720 and 0.81247 respectively, and they are significant at $p<0.01$ level. The sigma-squared indicates the goodness of fit and correctness of the distributional form assumed for the composite error term while the gamma indicates the systematic influences that are unexplained by the cost function and the dominant sources of random error. The estimated sigma-squared parameter of 0.15720 indicates that about 15% variation in the cost of sesame production of the sesame farmers is attributed to factors beyond the farmers' control such as weather fluctuation, luck, pest and disease outbreak e.t.c. On the other hand, the estimated gamma parameter of 0.81247 indicates the presence of allocative inefficiency effects in sesame production and implies that about 81% variation in the cost of production of sesame was due to the differences in the allocative efficiencies of the sesame famers. On a general note, a positively signed variable coefficient indicates that the coefficient contributes to increasing allocative inefficiency,

while a negatively signed coefficient implies that the variable contributes to reducing allocative inefficiency or increasing allocative efficiency.

The result revealed that the costs of all independent variables conform with a priori expectation as all the estimated coefficients of the costs of farm size, seed, labour and agrochemical were all positive implying conformity with the assumption that the cost function monotonically increases with the input prices. The coefficients of the variables were significant at $p<0.01$ level, except agrochemical that was not significant. This implies that costs of farm size, seed and labour exert significant positive influence on the cost of production of sesame in the study areas. The result showed that the coefficient of the cost of farm size is 0.29121 and significant at $p<0.01$ level. This implies that a 1 unit increase in the cost of farm size will raise the cost of sesame production by 0.29.

Table 8: Maximum Likelihood Estimates Results of Stochastic Frontier Cost Function (Allocative Efficiency) of Sesame Production

Variables	Parameters	Coefficients	Standard errors	T- Values
Cost model				
Constant	β_0	8.92577	0.14448	61.7752*
Farm size	β_1	0.29121	0.07663	3.8001*
Seed	β_2	0.34762	0.08545	4.068*
Labour	β_3	0.46426	0.04726	9.8243*
Agrochemical	β_4	0.00267	0.00448	0.5965
Inefficiency model				
Constant	Z_0	1.53424	0.28753	5.3359*
Age	Z_1	-0.11001	0.01244	-8.8407*
Farming experience	Z_2	-0.07032	0.02121	-3.3156*
Education	Z_3	-0.01307	0.10925	-0.1197
Household size	Z_4	0.15311	0.01831	8.3611*
Extension contact	Z_5	-0.21464	0.03679	-5.8349*
Cooperative society	Z_6	0.12411	0.02109	5.8844*
Amount of credit	Z_7	0.00005	0.00002	2.048**
Diagnostic statistics				
Sigma-squared	($\sigma 2$)	0.15720	0.02084	7.5424*
Gamma	(γ)	0.81247	0.04586	17.7152*
Log likelihood function	*L/f*	34.3432		
LR test	52.8198			
Total number of observation	154			
Mean efficiency	0.69			

Significance level : * = p<0.01; ** = p<0.05.

The coefficient of seed is 0.34762 and significant at p<0.01 level. The implication of this is that 1 unit increase in the cost of seed will give rise to 0.34 increase in the cost of sesame production. The cost of labour has a coefficient of 0.46426 and significant at p<0.01 level. This implies that 1 unit increment in cost of labour will increase the cost of sesame production by 0.46. The significant influence of seed cost and labour cost is in agreement with the findings of Okoh (2009), similarly found seed and labour cost as determinant of allocative efficiency in the Fadama production of tomato in Benue State. The cost elasticity of sesame production with respect to agrochemical is 0.00267, but not significant. This is an indication that 100 unit increase in the cost of agrochemical will result to 0.27 increase in the cost of sesame production.

The inefficiency model of the stochastic frontier cost function revealed that age, farm experience, household size, extension contact, membership of sesame cooperative society and amount of credit received were the determinants of allocative efficiency among the sesame farmers. The coefficients of the variables were all significant at $p<0.01$ level, with exception of amount of credit received that is significant at $p<0.05$ significance level and education that is not significant. This implies that level of education did not determine the allocative efficiency of sesame farmers in the study areas.

The coefficient of age is -0.11001, indicating that the older a farmer is, the more allocatively efficient he will be. This may be due to the fact that older farmers have more life experience which informed their effective decision of optimal combination of resource inputs leading to the reduction in allocative inefficiency. This contradicts the findings of Kolawole and Ojo (2007), who in their study of the economic efficiency of small scale food production in Nigeria found age to be positively related to allocative inefficiency. Farming experience has an estimated coefficient of -0.07032. This implies that the more experienced a sesame farmer is, the lower will be his allocative inefficiency. This can be attributed to a farmer's familiarity with choices of input combination which result to him making the best allocatively efficient choice among alternative input combination.

The coefficient of level of education is -0.01307. This implies that the more educated a sesame farmer is, the more allocatively efficient he is. This is as a result of a sesame farmer's ability to make wise choices as regards to inputs combination owing to his knowledge of costs of inputs. Education enhances a farmer's ability to seek and make

good use of information about production inputs (Kepede, 2001). However, this variable is not significant in enhancing the allocative efficiency or reducing the allocative inefficiency of sesame farmers.

Household size has an estimated coefficient of 0.15311. The implication of this result is that larger sesame households are more allocatively inefficient than small sesame household size. That is to say, the smaller a sesame household, the more efficient it will be in the allocation of productive resources. This may be due to the fact that larger sesame households have more mouths to feed than small sesame households, as a result of this, the ability to make appropriate choices between alternative farm inputs is constrained by the shortage of financial resources. The coefficient of extension contact is -0.21464. This is an indication that extension contact contributed towards reducing allocative inefficiencies among the sesame farmers. This may be due to the fact that good extension contact exposes the farmers to information on input prices which in turn facilitates their choices of rational input combination to reduce allocative inefficiency.

The estimated coefficient of membership of sesame cooperative society is 0.12411 and is significant at $p<0.01$ level. This implies that sesame farmers that belong to sesame cooperative society had more allocative inefficiencies than those that did not belong to any sesame cooperative society. This can be attributed to the fact that membership of sesame cooperative society expose members to expensive agricultural innovations which tend to affect the rationality of their decision as regards to resource input purchase and combination. This finding is contrary to the one obtained by Fleming *et al* (2004).

Amount of credit received has a coefficient of 0.00005. The implication of this is that the more credit a sesame farmer receives, the more allocatively inefficient he becomes. This may be due to the fact that credit received by sesame farmers is misused or misallocated in the purchase of farm inputs. This result is corroborated by one of Okike *et al.* (2000) that showed that receiving credit contributed to farmers' economic inefficiency. They contended that this could be the result of disbursement of credit in cash rather than in kind and loan misapplication endangered by resource poverty.

4.2.4 Frequency Distribution of TE, AE and EE Estimates of Sesame Farmers

This section examines the frequency distribution of the technical, allocative and economic efficiencies of the sesame farmers in the study areas.

4.2.4.1 Frequency Distribution of Technical Efficiency (TE) Estimates of Sesame Farmers

Technical efficiency is the extent to which the maximum possible output is achieved from a given combination of inputs (Ellis, 1988). The frequency distribution of the technical efficiency estimates of sesame farmers in the study areas derived from the stochastic frontier production function model is presented in Table 9. The study revealed that 91% of the sesame farmers had technical efficiency (TE) of 0.61 and above while 9% of the farmers operate at less than 0.61 efficiency level. The sesame farmers with the best and least practices had technical efficiencies of 0.98 and 0.34 respectively. This implies that on the average, sesame output fall by 2% from the maximum possible level of 1.00 due to technical inefficiencies. The result also showed a mean technical efficiency of 0.83. This means that majority of the sesame farmers operated closer to their production frontier. Also, this implies that on the average, sesame farmers are able to obtain 83% potential output from a given mix of productive resources. In a short-run, there is scope for increasing sesame output by 17% by

adopting the techniques and technologies employed by the best sesame farmers. The study further revealed that for the average sesame farmer in the study areas to become the most efficient sesame farmer, he will need to realize about 15%[1-(0.83/0.98)*100] cost savings, while on the other hand, the least technically efficient sesame farmer will need about 65% [1-(0.34/0.98)*100] cost savings to become the most technically efficient sesame farmer.

4.2.4.2 Frequency Distribution of Allocative Efficiency Estimates of Sesame Farmers

Allocative efficiency refers to the ability to of a firm to use inputs in optimal proportion, given their respective prices (Farrell, 1957). The frequency distribution of the allocative efficiency estimates of sesame farmers in the study areas is also in Table 9. The result revealed that 79% of the sesame farmers had allocative efficiency (AE) of 0.61 and above while 21% of the farmers operate at less than 0.61 allocative efficiency level. This implies that the greater majority of sesame farmers were fairly allocatively efficient as 79% of them attained efficiency level greater than 0.60. In other words, the clustering of allocative efficiencies in the region of 0.61 – 1.00 efficiency range implies that the sesame farmers are fairly efficient. That is, the farmers are fairly efficient in producing sesame at a given level of output using the cost minimizing input ratio as about 79% of the sesame farmers have allocative efficiencies of 0.61 and above. The estimated allocative efficiencies differ substantially among the sesame farmers ranging between the minimum value of 0.31 and maximum value of 0.92. This means that the most allocatively efficient sesame farmers operated closer to their cost frontier or minimum cost of 1.00. The mean allocative efficiency was 0.69. This implies that if the average sesame farmer in the study area was to achieve allocative efficiency level of his most efficient counterpart, then the average sesame farmer will realize 25% cost saving

i.e. [1-(0.69/0.92)*100]. A similar calculation for the most allocatively inefficient sesame farmer reveals cost saving of 66% [1-(0.31/0.92) x100].

4.2.4.3 Frequency Distribution of Economic Efficiency Estimates of Sesame Farmers

Economic efficiency can be defined as the ability of a production firm to produce a given output at minimum cost. The frequency distribution of the economic efficiency estimates of sesame farmers in the study areas (Table 9) revealed that 45% of the sesame farmers had economic efficiency (EE) of 0.61 and above while the remaining 55% of the sesame farmers operated at less than 0.61 efficiency level. The mean economic efficiency of the sesame farmers in the study areas was 0.58. This implies that on the average, there was a fall in the sesame output level by 42% from the maximum feasible level due to economic inefficiency. The sesame farmer with the best and least practice had economic efficiencies of 0.89 and 0.15 respectively. In the same vein, the study also revealed that for the average sesame farmer in the study area to achieve economic efficiency of his most efficient counterpart, he will have to realise about 35% [1-(0.58/0.89)*100] cost savings while on the other hand, the least economically efficient sesame farmers will have to realise about 83% [1-(0.15/0.89)*100] cost savings to become the most economically efficient sesame farmer. However, the result indicates that the highest number of sesame farmers have economic efficiencies between 0.41-0.60, representing about 41% of the 154 sesame farmers. This is an indication that the sesame farmers were fairly economically efficient in producing sesame at a minimum cost for a given level of technology. This is corroborated by the low average economic efficiency level of 58%.

Table 9: Frequency Distribution of Technical, Allocative and Economic Estimates from the Stochastic Frontier Model

Efficiency level	Technical efficiency		Allocative efficiency		Economic efficiency	
	Frequency	%	Frequency	%	Frequency	%
0.01 – 0.20	0	0	0	0	2	1.30
0.21 – 0.40	2	1.30	5	3.25	20	12.99
0.41 – 0.60	11	7.14	28	18.18	63	40.91
0.61 – 0.80	32	20.78	61	39.61	56	36.36
0.81 – 1.00	109	70.78	60	38.96	13	8.44
Total	154	100	154	100	154	100
Mean	0.83		0.69		0.58	
Minimum	0.34		0.31		0.15	
Maximum	0.98		0.92		0.89	

4.3 Costs and Return of Sesame Production in the Study Areas

4.3.1 Cost of sesame production in the study areas.

The quantity of sesame seeds used for the 2014 cropping season was 4.06kg/ha with an average market price of ₦ 1,019 per kg. This result to an average sesame seed cost of ₦ 4,137.14 per hectare. Labour costs consist of cost of land tillage, planting, weeding, agrochemical application, harvesting, threshing and bagging. The family labour supplied for sesame production was computed on the basis of opportunity cost in man-days. The wage rate varied according to the nature of farm operations performed. An average wage rate of ₦ 3,126 per man-day and 8.34 man-days per hectare was obtained, giving the average labour cost per hectare to be ₦ 26,070.84, which constitutes 81.43% of the variable cost of production and 65.62% of the total cost of production. The quantity of agrochemical used was 1.7 litres per hectare of farmland, with an average market price of ₦ 1,064 per litre, resulting to average agrochemical cost per hectare of ₦ 1,808.80. The cost of fixed inputs (cost of renting land and depreciation of tools) incurred on sesame production was ₦ 7,711.42. This constitutes 19.41% of the total cost of production.

4.3.2 Returns to investment in sesame production in the study areas

The quantity of sesame obtained was 427.83kg per hectare of farmland, with an average market value of ₦ 272.82 per kg. This results to average sesame output value per hectare of ₦ 116,720.58. The total cost of sesame production (TVC + TFC) per hectare was ₦ 39,728.20. The net farm income was therefore ₦ 76,992.38. The average rate of return on investment (i.e return per naira invested) was ₦ 1.94, indicating that for every ₦ 1 invested in sesame production in the study areas, a gain of 94 kobo was made. However, it can be extrapolated that sesame production in the study areas was profitable. This finding is in agreement with that of Tiamiyu *et al.* (2013) who found that sesame production is profitable in Nigeria.

Table 10: Costs and returns per hectare of sesame production

Variable	**Average Quantity/ hectare**	**Value (₦)/hectare**	**Percentage to total cost**
Gross Income(GI)		**116,720.58**	
Variable Inputs			
Seed	4.05	4,137.14	10.41
Labour	8.33	26,070.84	65.62
Agrochemical	1.70	1,808.80	4.55
Total Variable Cost(TVC)		**32,016.78**	
Fixed inputs			
Cost of renting land		5,764.54	14.51
Depreciation of tools (hoes, cutlasses and wheelbarrow)		1,946.88	4.90
Total Fixed Cost(TFC)		**7,711.42**	
Total Cost (TVC+TFC)		**39,728.20**	**100.00**
Net Farm Income (NFI)=(GI – TC)		76,992.38	
Return per Naira Invested (RNI)=(NFI/TC)		1.94	

4.4.0 Constraints associated with sesame production in the study areas

The constraints faced by sesame farmers in the study areas is presented in Table 11. The result revealed that lack of credit facilities is the predominant problem affecting sesame farmers constituting about 79.22%. Credit is needed to purchase farm inputs such as seeds, fertilizer, feeds, labour and to transport farm produce from the farm to the market or home. Lack of credit hinders the purchase of these farm inputs and this impose limitation on agricultural production. The sesame farmers affected by this problem resorted to borrowing from sesame cooperative society, friends and using money from other farms to finance their sesame production.

The second most pressing constraint is poor extension service which accounts for about 58.44% of the problems militating against sesame farmers. Poor extension services demote the adoption of agricultural innovations and techniques which promote agricultural production. The coping strategy adopted to curtail this problem included the consultation of successful farmers and members of sesame cooperative society. About 56.49% of the sesame farmers had poor storage facilities to be their problem in sesame production. Poor storage facilities in some cases lead to post-harvest loses of farm produce which in turn reduces the income of the farmer. In order to cope with this problem, the sesame farmers used plastic bags, drums, jute sacks and close basin to store their produce.

The problems of pests and diseases ranked 4^{th} and 5^{th} thereby constituting 51.95% and 46.75% of the overall problems of the sesame farmers. With the view to curtail these problems, the farmers consulted agrochemical dealers, changed seed varieties and selected seed that were disease-resistant.

Hierarchically, lack of good road network is the 6th pressing problems of the sesame farmers. Lack of good road network obstruct the free movement of farm produce from the farm to the market or home, and also farm inputs from the market or home to the farm. This problem accounted for 40.91% of the sesame farmers problems. The sesame farmers affected by this problem resorted to using carts, motorcycles, bicycles and wheelbarrow to transport their goods. Uneven ripening of capsules of sesame plants accounted for 9.09% of the problems affecting the sesame farmers. The farmers hit by this problem resorted to selecting virile sesame stands for onward sowing and early planting as a coping strategy.

Table 11: Constraints associated with sesame production in the study areas

Constraints	**Frequency**	**Percentage**	**Rank**	**Coping strategies**
Lack of credit facilities	122	79.22	1st	Borrow from cooperative society, money from other farms
Poor extension service	90	58.44	2nd	Consult successful sesame farmers, cooperative society
Poor storage facilities	87	56.49	3rd	Use plastic bags, drums, jute sacks, close basin
Problems of pests	80	51.95	4th	Consult agrochemical dealers, change seed varieties
Problems of diseases	72	46.75	5th	Select seeds that are disease-resistant
Lack of good road network	63	40.91	6th	Use carts, motorcycles, bicycle, wheelbarrow
Uneven ripening of capsules	14	9.09	7th	Select virile stands for onward sowing
Total	**528***			

***** = Multiple responses

4.5 Test of hypotheses

This section presents the results of the regression analysis and t-test carried out to test the hypotheses of the study.

4.5.1 Test of hypothesis I

The result of the regression analysis carried out to test the first hypothesis of the study is presented in Table 12. From the result, age, farming experience, level of formal education, extension contact and membership of sesame co-operative society were found to be statistically significant. Consequently, the hypothesis which states that determinants of efficiency do not have effects on economic efficiency of sesame production in the study areas is rejected.

Table 12: Result of the regression analysis

Variables	Coefficients	Standard Error	T Stat
Intercept	-374.5499028	219.0818279	-1.70963473
Age	31.1905008	8.360368374	3.730756757*
Farm Exp	-49.14309686	13.2491722	-3.7091447*
Formal Ed	146.1580667	55.00357192	2.657246822*
HH Size	19.93564324	13.540662	1.472279808
Ext Cont	32.56575042	20.49079539	1.58928679***
Coop Soc	35.69354531	12.80464868	2.787545851*
Credit Amt	-0.000488896	0.001833039	-0.26671338

Significance level: *= p<0.01;= p<0.1**

4.5.2 Test of hypothesis II

The result of the t-test carried out to test hypothesis II of the study is presented in Table 13. Since the t-statistic value of 15.13 is greater than the t critical two-tail value of 1.98, thus the hypothesis that: there is no significant difference between costs and returns in sesame production is rejected.

Table 13: Result of t-test for hypothesis II

	Total Revenue	**Total Cost**
Mean	232272.7273	75201.2987
Variance	32263153892	2860018038
Observations	154	154
Pearson Correlation	0.964741006	
Hypothesized Mean Difference	0	
df	153	
t Stat	15.1338852	
P(T<=t) one-tail	1.64116E-32	
t Critical one-tail	1.654873847	
P(T<=t) two-tail	3.28233E-32	
t Critical two-tail	1.975590281	

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

This study appraised the production efficiency and profitability of sesame farmers in Gwer East and Konshisha Local Government Areas of Benue State of Nigeria. Eight villages were proportionally selected from the two local government areas and 154 sesame farmers were also randomly selected from these villages. Primary data was used for this study and it was collected from 154 sesame farmers using structured questionnaires. The statistical tools used to analyze the data were descriptive statistics, net farm income and stochastic frontier production function model.

The result of the socio-economic characteristics of sesame farmers revealed that (40%) of the farmers were within the age range of 40-49 years; about 51% of the farmers have 11-20 years of sesame farming experience; the majority of the farmers (85%) had formal education; about 81% had household size that ranged from 6-25 persons; majority of the farmers (59.74%) had no any form of extension contact during the 2014 sesame cropping season; majority of the farmers (53%) belonged to sesame cooperative society; and the average amount of credit received by a sesame farmer was ₦ 35,756.

The results of the stochastic frontier production revealed that farm size, seed, labour and agrochemical had a positive relationship with sesame output and were significant at $p<0.01$ level with exception of agrochemical that was not significant. The determinants of technical efficiency were age, sesame farming experience, education, membership of sesame cooperative society and amount of credit received. Age, education and membership of sesame cooperative society were positively related to technical

efficiency, while sesame farming experience and amount of credit received were negatively related to technical efficiency. The result shows that a mean technical efficiency of 0.83 was obtained. The minimum and maximum technical efficiencies were 0.34 and 0.99 respectively. The elasticity of production revealed that the sesame farmers were operating at an increasing return to scale with a value of 1.01.

The results of the stochastic frontier cost function revealed that the costs of renting of land, seeds, labour and agrochemical had a positive relationship with the cost of sesame production and were all significant at $p<0.01$ level. The determinants of allocative efficiency were age, sesame farming experience, household size, extension contact, membership of sesame cooperative society and amount of credit received. Age, sesame farming experience and extension contact were positively related to allocative efficiency, while household size, membership of sesame cooperative society and amount of credit received were negatively related to allocative efficiency. Furthermore, sesame farmers had a mean allocative efficiency of 0.69. The minimum and maximum allocative efficiencies of 0.31 and 0.92 were obtained. The result also revealed a mean economic efficiency of 0.58. The best practice and the least economically efficient sesame farmers had economic efficiencies of 0.89 and 0.15 respectively.

The result of the profitability analysis on per hectare basis showed that a gross income (GI) of ₦ 116,720.58; total cost of production of ₦ 39,728.20; net farm income of ₦ 76,992.38 and a return per naira invested of ₦ 1.94 were realized. The major constraints militating against sesame production included: lack of credit facilities; poor extension service; poor storage facilities; problems of pests and diseases; lack of good road network and uneven ripening of capsules.

5.2 Conclusion

Base on the findings of this study, it can be inferred that sesame production in the study areas is lucrative by returning 94 kobo to every ₦ 1.00 invested. On account of the profitability and economic importance of sesame, its production should be encouraged in the study areas so as to increase the farm income of the sesame farmers. The sum of the partial output elasticities with respect to all the inputs indicates increasing returns to scale in sesame production among the farmers. Consequently, the output level of sesame can be raised if the use of inputs such as farm size, seed and labour influencing the sesame output can be increased.

The presence of inefficiency in sesame production in the study areas as revealed by the efficiency distribution is an indication that opportunity still exist for sesame farmers to increase technical efficiency and reduce allocative inefficiency if the farmers utilize available resources optimally. This can be achieved through improved farmer-specific factors that were found influencing technical and allocative efficiencies among the sesame farmers.

5.3 Recommendations

Based on the outcome of this research, the following recommendations are made:

i. Sesame farmers should join cooperatives in order to pool together their financial resources with a view to get loan and enjoy other benefits of cooperative membership such as availability of market outlets for sesame sales; marketing information and improved sesame seeds for planting.

ii. The agricultural extension units of the Federal University of Agriculture,

Makurdi and the Benue State Agricultural and Rural Development Authority (BNARDA), Makurdi should be strengthened and made effective in order to promote extension services with the view to disseminate agricultural innovations to sesame farmers in the study areas.

iii. All bad feeder roads in the sesame-producing areas should repaired and new ones should be constructed where needed to link points of production to points of sale and or consumption. This will help to curtail post-harvest loses.

iv. Sesame farmers should increase their hectarage of land for sesame production since farm size was the most influential factor in sesame production in the study areas.

v. Benue State Government should make available at subsidized rate modern storage facilities in order to curtail loses due to pests during storage and sesame glut that may lead to a fall in the price of sesame.

5.4 Contribution of the Study to Knowledge

i. The study revealed that sesame production in the study areas is profitable with net farm income of ₦ 76,992.38 and an average rate of return to investment of ₦ 1.94.

ii. The study also discovered that sesame farms were fairly economically efficient having a mean economic efficiency of 0.58, with mean technical and allocative efficiencies of 0.83 and 0.69 respectively.

iii. The return to scale estimate in sesame production among the sesame farmers was 1.013 which indicates an increasing returns to scale.

iv. The study discovered lack of credit facilities and poor extension service as the major constraints associated with sesame production in the study areas.

REFERENCES

Abdullah, N. M. (2009). Nigeria: Sesame seeds farming can provide 1 million jobs and US$1.5 billion for northern states. *Sesame Pilot Project Report, 2007*. Published by National Sesame Seed Association of Nigeria, Abuja, Nigeria.

Abu, G. A., Ater, P. I., and Abah, D. (2012). Profit efficiency among sesame farmers in Nasarawa State, Nigeria. *Current Research Journal of Social Sciences,* 4(4): 261-268.

Adebayo, E.F. (2006). *Resource used efficiency and multiple objectives of dairy pastoralists in Adamawa State, Nigeria* (Unpublished doctoral dissertation) Department of Agricultural Economics, University of Ibadan, Nigeria.

Adebisi, M.A., Ajala, M.O., Ojo, D.K and Salau, A.W. (2005). Influence of population density and season on seed yield and its components in Nigerian sesame genotypes. *Journal of Tropical Agriculture,* 43(2):13-18.

Adegeye, A.J. and Dittoh, J.S. (1985). *Essentials of Agricultural Economics,* Impact Publishers, Ibadan, Nigeria, pp. 25.

Aigner, D.C., Lovell, K., and Schmidt, P. (1977). Formulation and estimation of stochastic frontier production function models. *Journal of Econometrics,* 6: 21-37.

Alege, G.O., Akinyele, B.O and Agianaku, E. (2009). Effects of nutrient sources on the vegetative and pod attributes of sesame in Anyigba, Nigeria. *Applied Tropical Agriculture,* 1:60 - 63.

Alene, D.A. and Hassan, R.M. (2003). Measuring the impact of Ethiopia's New Extension Programme on the Productive Efficiency of Farmers. Paper presented at the 25th International Conference of Agricultural Economist, Durban, South Africa.

Ali, A. and Seiford, L. (1993). The mathematical programming approach to efficiency analysis. In: Fried, H., Lovell, K., and Schmidt, S. (Eds.), *The Measurement of Productive Efficiency,* Oxford University Press, New York.

Amodu, M.Y. (2010). *Economic analysis of part-time farming in Idah, Local Government Area of Kogi State, Nigeria* (Unpublished master's thesis) Department of Agricultural Economics and Rural Sociology, Ahmadu Bello University, Zaria, Nigeria.

Amos, T. T. (2007). An analysis of productivity and technical efficiency of smallholder cocoa farmers in Nigeria. *Journal of* Social *Science,* 15(2): 127-133.

Anderson, J.R. and Feder, G. (2007). Agricultural Extension. In: Evenson, R. and Pingali, P. (Eds.). *Handbook of Agricultural Economics*. Agriculture and Rural Development Department, World Bank, Washington, District Centre. 3(44): 2344 – 2367. DOI: 10.1016/S1574-0072(06)03044-1.

Anon (2007): Sesame markets: uses of sesame around the world. *American Sesame Growers Association*. Available at http://www.sesamegrowers.org/usesofsesame.htm. Accessed 6/11/2009.

Anon (2009). Small seed provides large income. *USAID/MARKETS: Nigeria's Harvest markets*. Agbiz update, October 21, 2009.

Ashri, A. (1989). Simsim. In: Robbelen, G., Downey, R.K. and Ashri, A. (Eds.). *Oil Crops of the World*, McGrow- Hill publishing company, pp. 375-387.

Balyan, R. (1993). Integrated weed management in oilseed crops in India. *Indian Society of Weed Science*, 1: 317-323.

Bayacag, P.G. (2001). *Farm environment, farm Knowledge and technical efficiency: An Investigation among upland corn farmers in Bukidnon, Philippines* (Unpublished doctoral dissertation). University of the Philippines, Los Banos, Laguna, Philippines.

Bennet, M. (2011). *Sesame seed: A handbook for farmers and investors*. Retrieved from www.agmrc.org/media/cm/sesame_38F4324EE52CB.pdf 29/08/11

Bhatti, I.A., Ahmad, R., Jabbar, A., Nazir, M.S., and Mahmood, T. (2006). Competitive behaviour of component crops in different sesame-legume intercropping systems. *International Journal of Agriculture and Biology*, 8(2): 165-167.

Benue State Agricultural and Rural Development Authority (BNARDA). (2000). Agricultural production recommendation for Benue. *Extension bulletin* 3:1-20.

Borchani, C., Besbes S., Blecker, C. H. and Attia, H. (2010). Chemical characteristics and oxidative stability of sesame seed, sesame paste, and olive oils. *Journal of Agriculture, Science and Technology*, 12: 585-596

Busari, L.D., Olowe, V.I.O., Yusuf, I.A., and Idowu, A.A. (1998). Research on beniseed agronomy in Nigeria. *Proceedings First National Workshop on Beniseed in Nigeria*, pp.75 – 85.

Carlson, J.D. (2008). Intercropping with maize in Sub-arid Regions. In: *Community Planning and Analysis, Technical Brief*, April 16, pp.6.

Central Bank of Nigeria (CBN). (2009). *Annual report and statement of account for the year ended 31st December 2008*, pp. 142 -145.

Charnes, A., Cooper, W., Lewin, A.Y., and Seiford, L.M. (1994). *Data Envelopment Analysis: Theory, methodology and applications*, Kluwer Academic Publishers, Boston, p. 87.

Chemonics International Inc. (2002). *Overview of the Nigerian Sesame Industry*. The United States Agency for International Development (USAID)/Nigeria RAISE IQC Contract No. PCE-I-00-99-00003-00

Chukwuji, C.O., Ike, P.C., and Inoni. O.E. (2004). Determinants of technical efficiency of gari processors in Delta State, Nigeria. A Paper presented at the annual conference of Nigerian Agricultural Economics Association on 'Agricultural Marketing and Commercialisation for Sustainable Development' at Ahmadu Bello University , Zaria, November, 2004.

Coelli, T.J. (1995a). Estimators and hypothesis test for a stochastic frontier function: A Monte Carlo Analysis. *Journal of productivity analysis,* 6:247-268

Coelli, T., Rao, D. S. P., and Battese, G. E. (1998). *An Introduction to Efficiency and Productivity Analysis*, Kluwer Academic Publishers, Boston/Dordrecht/London. Pp. 225-235.

Coelli, T., Rahman, S. and Thirtle, C. (2002). Technical, allocative, cost and scale efficiencies in Bangladesh rice cultivation: A non parametric Approach. *Journal of Agricultural Economics,* 53:607-626.

Coelli, T., Rao, D.S.P., O'Donnell, C.J and Battese, G.E. (2005*). An Introduction to Efficiency and Productivity Analysis*, Springer Science and Business Media, New York, p. 343

Elleuch, M., Besbes, S., Roiseux, O., Blecker, C. and Attia, H. (2007). Quality characteristics of sesame seeds and by-products. *Food Chemistry,* 103(2): 641 – 650.

El-Greedly, A., Nadia, H.M. and Mekki, B.B. (2005). Growth, yield and endogenous hormones of two sesame (*Sesamum indicum* L.) cultivars as influenced by stigmasterol. *Journal of Applied Sciences Research,* 1(1): 63 – 66.

Ellis, F. (1988). *Peasant Economics: Farm Households and Agrarian Development,* Cambridge University Press, Cambridge, pp. 155-157.

Engoru P. and Bashaasha, B. (2001). Constraints to the effective production and marketing of simsim: A case study of Soroti, Uganda. *African Crop Science Conference Proceedings,* 5: 715 – 722.

Fabricant, S. (1959). *Basic Fact on Productivity Change.* National Bureau of Economic Research, New York, Occasional Paper 63, p. 49.

Farell, M.J. (1957). The measurement of production efficiency. *Journal of the Royal Statistical Society Service A(general.),* 25: 3-81.

Fariku, S., Ndonya, A.E., and Bitrus, P.Y. (2007). Biofuel characteristics of beniseed (*Sesanum indicum*) Oil. *African Journal of Biotechnology,* 6(21): 2442-2443

Food and Agricultural Organisation Statistics (FAOSTAT).(2013). Food and Agricultural Organisation of the United Nations Statistics Division Database. Faostat.fao.org/site/567/desktopdefault.aspx. Assessed on 6/09/2014.

Federal Institute for Industrial Research (FIIR), (1990). *Report on Survey of Selected Agricultural Raw Material in Nigeria*, p.58

Fleming, E.P., Fleming, P., Rogers, H., Griffiten, G. and Johnston, D.(2004). Animal efficiency in an intensive beef production. *Genetic Breeding Unit*, University of New England, Armidale, NSW, Australia.

Gandhi, A.P. (2009). Simplified process for the production of sesame seed (*Sesamum indicum* L) butter and its nutritional profile. *Asian Journal of Food and Agro-Industry*. 2(1):24-27.

Global AgriSystems. (2010). *Dehulled and roasted sesame seed oil processing unit*. Retrieved from http://mpstateagro.nic.in/Project%20Reports%20pdf/Dehulled%20and%20Roaed%20S esame%20Seed%20Oil%20Processing%20Unit.pdf. 18/08/11.

Gomez, O.(1975). *Economic of Agricultural Production and Resource Use*, Prentice Engle Wood, New York, p. 428.

Hansen, R. (2011). *Sesame Profile*. Retrieved from http://www.agmrc.org/commodities__products/grains__oilseeds/sesame_profile.cfm. 19/08/11

Jasper, W. (2005). Report for Congress : Agriculture : *A Glossary of Terms, Programmes and Laws*. 2005 Edition.

Juan, X., Chen, S.,and Qiuhui H. (2005). Antioxidant activity of brown pigment and extracts from black sesame seed (*Sesamum indicum* L.). *Food Chemistry*, 91(1): 79-83.

Johansson, L. (2005). *Mathematical programme for sector analysis: Some applications, evaluations and methodological proposals.* (doctoral dissertation) Department of Economics, Swedish University of Agricultural Science, Uppsala, Sweden.

Kadurumba, C., Ezeh C. I., Mbanasor J. A. (2009). Technical efficiency of traditional palm oil processing in Imo state, Nigeria. *Farm Management Association of Nigeria Journal*, 10(2): p.98.

Kepede, T.A.(2001). *Farm household technical efficiency: A stochastic frontier analysis of rice producers in Mardi watershed in the western development region of Nepal*. (Unpublished master's thesis) Department of Economics and Social Sciences, Agricultural University of Norway, Norway, p. 57.

Khan, S.A. and Saeed, M. (1997). Competitive relationships of component crops in different wheat-based intercropping systems, *Journal of Applied Pharmaceutical Science*, 7(2): 37-39.

Kibaara, B.W. (2005). *Technical efficiency in Kenya's maize production: An application of the stochastic frontier approach*. (Unpublished master's thesis) Department of Agricultural and Resources Economics, Colorado State University, Fort Collins, Colorado.

Kolawale, O. and Ojo, S.O. (2007). Economic efficiency of small scale food crop production in Nigeria: A stochastic frontier approach. *Journal of social science,* 14(2):123-130.

Koutsoyannis, A.(1977). *Theory of Econometrics: An Introductory Exposition of Econometrics Methods.* London Macmillan Press Ltd, p.381, ISBN13: 9780333223796.

Lee, J.Y., Lee, Y.S., and Choe, E.O. (2008). Effects of sesamol, sesamin and sesamolin extracted from roasted sesame oil on the thermal oxidation of methyllinoleate. *Food Science and Technology,* 42: 1871-1875.

Lovell, K.,(1993). Production Frontiers and Productive Efficiency. In: Fried, H., Lovell, K. and Schmidt, S. (Eds.). *The Measurement of Productive Efficiency,* Oxford University Press, Oxford.

Meinzen-Dick, R ., Quisumbing, A ., Behrman, J., Biermayr-Jenzano, P., Wilde, V ., Noordeloos, M ., Ragasa, C. and Beintema,N.**(**2010). *Engendering* A*gricultural Research*, IFPRI Discussion Paper No. 973. Washington, DC, IFPRI.

Meeusen, W. and Vanden Broeck, J. (1977). Efficiency estimation from Cobb-Douglas production functions with composed error. *International Economic Review,* 18: 435-444.

Mkamilo, G. S. and Bedigian, D. (2007). *Sesamum indicum* L. In: Vander Vossen, H.A.M and Mkamilo, G.S (Eds.). *Vegetable Oils 14: Plant Resources of Tropical Africa (PROTA),*pp. 153-158.

Mshelia, J. S., Sajo A. A., and Gungula, D. T., (2012). Sesame production as panacea for poverty alleviation in Nigeria. *Journal of Agriculture and Veterinary Sciences*, 4:16, p.16

National Agricultural Extension and Research Liaison Services (NAERLS).(2010). Beniseed production and utilisation in Nigeria. *Extension Bulletin No. 154, Horticulture Series No. 5* Available at www.naerls.gov.ng/extmat/bulletins/Beniseed.pdf

Nahunnaro, H. and Tunwari, B.A. (2012). Natural selection of four sesame resistant cultivars against cercospora leaf spot disease (*Cercospora sesame* Zimm) in the Nigerian southern and northern guinea savannahs. *World Journal of Agricultural Sciences,* 8(5): 540-546.

Nakai, M., Harada, M., and Nakahara, K. (2003). Novel antioxidative metabolites in rat liver with ingested sesamin. *Journal of Agricultural and Food Chemistry*, 51(6): 1666-1670

National Agricultural Research Organisation (NARO). (1999). Entebbe. *Annual Report*, 1999, p.189.

National Population Commission (NPC). (2006), *Federal Republic of Nigeria Official Gazette*, 94(24): p.B1 82.

Naturland. (2002). *Organic farming in the tropics and subtropics: Sesame*.. Available from www.naturland.de/fileadmin/MDB/documents/Publication/English/sesame.pdf

National Cereals Research Institute (NCRI).(2002). *Guide to beniseed (sesame) production*. Oil seed research programmes, p.125.

National Cereals Research Institute (NCRI).(2012). Modern agronomic practices in sesame production; In: Shokalu. O. (Ed.). *Training Manual for Sesame Stakeholders in Nigeria*. Federal Ministry of Agriculture/NCRI, Nigeria, p. 183.

Nigeria's Harvest (2009). *Small seed provides large income*. Available from http://www.nigeriamarkets.org/files/Nigeria%27s_Harvest_Vol_5_Exporting_Nigerian_Sesame.pdf

Njoku, J.E. (1991). Factors influencing the adoption of improved oil palm production technologies by smallholders in Imo State of Nigeria. In: Olukosi, J.O., Ogungbile, A.O. and Kalu, B.A. (Eds.). *Appropriate Agricultural Technologies for Resource-poor Farmers.* Proceedings of the National Farming Systems Research Network Workshop held in Calabar, Cross River State, Nigeria. August 14-16.

Odoemenem, I.U., Ezike, R.N.N and Alimba, J.O. (2005). Assessment of agricultural credit availability to small-scale farmers in Benue State. *Journal of Agricultural Science and Technology*, 15 (2): p. 59.

Ogundari, K., Ojo, S.O. and Ajibefun, I.A. (2006). Economies of scale and cost efficiency in small scale maize production: Empirical evidence from Nigeria. *Journal of social science,* 13(2): 131-136

Okike, I., Jabbor, M.A., Manyons, V., Smith, J.W., Akinwumi, J.A., and Ehui, S.K. (2000). Agriculture intensification and efficiency in the West African savannahs: Evidence from Northern Nigeria. *Socio-economics and Policy Research Working Paper* 33, International Livestock Research Institute (ILRI), Nairobi, Kenya, p. 54.

Okoh, C.O., (2009). Resource use efficiency in tomato production in the Fadama: Implication for poverty reduction in Benue State, Nigeria. (Unpublished master's thesis). Department of Agricultural Economics, University of Agriculture Makurdi, Benue State, Nigeria.

Olayide, S.O. and Heady, E.O. (1982). *Introduction to Agricultural Production Economics*. Ibadan University Press, Ibadan, Nigeria, pp. 24-117.

Olowe, V.I.O., Adeyemo, Y.A. and Adeniregun, O.O. (2009). *Sesame: the under exploited organic oilseed crop*. Available from www.unep-unctad.org/.../23-sesame%20the%20under exploited%20organic%20oil%20seed%20crop%20paper%201pdf

Olukosi, J.O. and Erhabor, P.O. (2005). *Agricultural Farm Management Principles and Application.* Agitab publications Zaria, Nigeria, p. 46.

Oluwatayo, A.B. Sekumade O. and Adesoji, S.A. (2008). Resource use efficiency of maize farmers in rural Nigeria: Evidence from Ekiti State, Nigeria. *World Journal of Agricultural Science,* 4(1): 91-99.

Onu, J.K., Amaza, P.S. and Okunmadewa, F.Y. (2000). *Determinants of Agriculture and Social Research,* 6(1): 9-16

Onwueme, I.C. and Sinha, T.D. (1991). *Field Crop Production in Tropical Africa.* Technical Centre for Agricultural and Rural Co-operation (CTA). The Netherlands.1-319.

Onyenweaku, C.E., Igwe, K.C., and Mbanasor, J.A.,(2005). Application of a stochastic frontier production function to the measurement of technical efficiency in yam production in Nasarawa State, Nigeria. *Journal of Sustainable Tropical Agricultural Research,* 13: 20-25.

Onyenweaku, C.E., and Nwaru, J.C. (2005). Application of a stochastic frontier production function to the measurement of technical efficiency in food crop production in Imo State, Nigeria. *The Nigerian Agricultural Journal*, 36(1): 1-12.

Purseglove, J.W. (1996) . *Tropical Crops Dicotyledons*. Longman, London, 1: p. 435.

Rahman, S. A., Ajayi, F. A., and Gabriel, J. (2005). Technical efficiency in sorghum-based cropping systems in Soba area of Kaduna state, Nigeria. *Journal of Research in Science and Management,* 3(1):100-104.

Raikwar, R. S., and Srivastva, P. (2013). Productivity enhancement of sesame (*Sesame indicum L.*) through improved production technologies. *African Journal of Agricultural Research,* 8(47): 6073-6078.

Raw Materials Research and Development Council (RMRDC) (2004). *Report on survey of agro-raw materials in Nigeria: Beniseed,* 1st Ed. Publisher: Raw Materials Research and Development Council Garki-Abuja, 1-87.

Singh, R. and Khan, M.A. (2003). Response of clusterbean varieties to fertility levels and cropping systems under arid conditions. In: Henry, A., Kumar, D. and Singh, N. B. (Eds.). *Advances in Arid Legume Research*. Scientific Publishers and Indian Society of Arid Legumes, Jodhpur, pp. 225-228.

Samuelson, P.A and Nordhaus, W.D (2005). *Economics*. Tata McGraw-Hill Publishing Company Limited, New Delhi, India, p. 108.

Shehu, J.F., Iyortyer, J.I., Mshelia, S.I. and Jongur, A.A.U. (2010). Determinants of yam production and technical efficiency among yam farmers in Benue State, Nigeria. *Journal of Social Science*, 24(2):143-148.

Ssekabembe, C.K., Osiru, D.S.O., Ogenga-Latigo, M.W., Nantongo, S. and Okidi, J. (2001). Some aspects of simsim production in northern and eastern Uganda. *African Crop Science Conference Proceedings,* 5: 689-697.

Standish, B. (2010). *Economics: Principles and Practice*. South Africa: Pearson Education, pp. 13-15.

Tanko, L. and Opara, C. (2010). Measurement of the technical efficiency in maize production in Bosso Local Government Area, Niger state. In: *Restrategizing Nigerian Agriculture in Rapidly Changing Climatic Conditions For Sustainable Food Security*: *Proceedings of the 44th Annual Conference of Agricultural Society of Nigeria*, Ladoke Akintola University of Technology, October 18-22.

Tiamiyu, S. A., Adagba, M. A., Ibrahim, P. A. and Shaahu, A. (2013). Profitability of sesame production and marketing in Nigeria. *Advanced Journal of Agricultural Research*, 1(6): 88-94.

Tripathi, N.N. and Galhotra, P.P. (1992). Qualitative effect of root-exudates on the pathogenesis of *Fusarium oxysporium* f.sp. *Simsim* (Jacz) Castellani. *Simsim and Safflower Newsletter*, p. 92.

Tunde-Akintunde, T.Y., and Akintunde, B.O. (2007). Effect of moisture content and variety on selected properties of beniseed. *Agricultural Engineering International: The CIGR Ejournal*. Manuscript FP 07 021. Vol. IX.

Udoh, E.J and Etim, N.A. (2007). Measuring farm level technical efficiency of fluted pumpkin production in Uyo, Nigeria. In: *Reviving Agriculture For Sustainable National Growth and Stable Democracy: Proceedings of the 41st Conference of the Agricultural Society of Nigeria*, Institute for Agricultural Research, Ahmadu Bello University, Zaria, October 22-26.

Umoh, G.S. (2006). Resource-use efficiency in urban farming: An Application of stochastic frontier production function. *International Journal of Agriculture and Biology*, 8(1):38-44.

United State Department of Agriculture (USDA).(1990). *1990 Fact Book of Agriculture*. Miscellaneous Publication No. 1063, Washington, District Centre.

United States Agency for International Development (USAID).(2009). Markets maximizing agricultural revenues and key enterprises in targeted sites. *Package of Practices for Sesame Production,* p. 29.

Vanisri, S., Raghunatham, G., Ranganatha, A.R.G. and Sarma, P.S. (1994). Studies on character association and path analysis in sesame (*Sesamum indicum* L.). *Journal of Research:APAU*, 22: 92-96.

Voh, J. P. (1979). An exploratory study of factors associated with adoption of recommended farm practices among Giwa farmers. *Samaru Miscellaneous Paper No.73*. Institute for Agricultural Research, Ahmadu Bello University, Zaria, Nigeria.

Wasana W. (1997). Evaluation of stem growth termination in simsim. *Simsim and Safflower Newsletter*, 12: 51-54.

Weiss, E.A. (2000). *Oil Seed Crop.* 2nd Edition, Blackwell Longman Group Ltd. USA.

World Bank (1996). Nigeria poverty in the midst of plenty: The challenges of growth with inclusion. *A World Bank Poverty Assessment Report* No. 14733. UNI.

Yusuf, O. (2005). *Economics analysis of 'Egusi' melon production in Okehi Local Government Area of Kogi State* (Master's thesis Department of Agricultural Economics and Rural Sociology, Ahmadu Bello University, Zaria, Nigeria), pp. 40-41.

Yusuf, O.S., Sanni, A., Ojuekaiye, E.O., Ugbabe, O.O.(2008). Profitability of 'Egusi' melon (*Citrullus Lanatus Thunb. Mansf*) production under sole and mixed cropping systems in Kogi State, Nigeria. *ARPN Journal of Agricultural and Biological Science*, 3: 14-18.

Zbinden, S. and Lee, D.R (2005). Paying for environmental services: An analysis of participation in Costa Rica's PSA program. *World Development,* 33: 255-272.

Zerfu, D. and Larson, D. F. (2010). Incomplete markets and fertilizer use: Evidence from Ethiopia. *Policy Research Working Paper* 5235. The World Bank, Washington District Center.

APPENDIX I

EVALUATION OF THE PRODUCTION EFFICIENCY AND PROFITABILITY OF SESAME PRODUCTION IN GWER EAST AND KONSHISHA LOCAL GOVERNMENT AREAS OF BENUE STATE OF NIGERIA

This questionnaire is intended to be used by a student of the Department of Agricultural Economics and Rural sociology, Ahmadu Bello University, Zaria. Please, fill as appropriate. All information will be treated with confidentiality and strictly for the purpose of research on the above topic. Thank you for your co-operation.

A. SOCIO –ECONOMIC CHARACTERISTICS OF SESAME FARMERS

1. Name of farmer……

2. Sex: Male ( ) Female ( )

3. Age (years)……

4. How long have you been in sesame farming? (Years of experience)……

5. Marital status: Married ( ) Single ( )

6. Household size (All the people living with you in your household)…….

   (a) No of Adult Males ( ) (b) No of Adult females ( ) (c) Children ( ) (d) Dependents ( )

7. Level of Education:

   (a) No Formal Education ( ) (b) Primary school Education ( ) (c) Secondary School Education ( )(d) Tertiary Education ( ) (e) Others(indicate)……

8. Do you belong to any co-operative society? Yes ( ) No ( )

9. If yes, (Years of participation) ----------

10. What benefits did you derive as a member?.....
.....……

11. Did you borrow capital for sesame farming ? Yes ( ) No ( )

12. If yes, how much did you borrow to finance sesame production in 2014 ? (Fill the table for the sources and amount of money borrowed)

Source of loan	Amount borrowed (₦)	Interest rate(%)(if any)
1.		
2.		
3.		
4.		
5.		

13. Have you been visited by an extension agent? Yes ( ) No ( )

14. If yes, how many times in the last one year ?.....

15. Did the extension visit(s) contribute to the success of your sesame farming ? Yes ( ) No ( )

16. If yes, how……
……

B. INFORMATION ON INPUTS FOR SESAME PRODUCTION

(1) Farm size (Hectares)

(a) How many farm plots did you grow sesame in the last production season? ..... Indicate the sizes of the plots in the table below.

Plot No.	Plot size (hectares)	Cost (₦)
1.		
2.		
3.		
4.		
5.		

NB : Inherited land should be assigned cost and indicated appropriately

(2)Seed (Kg)

Plot No.	Seed type: improved/local varieties	Quantity of seed(kg)	Cost(₦)
1.			
2.			
3.			
4.			
5.			

(3)Fertilizer.

Plot No.	Fertilizer type	Quantity(kg)	Cost(₦)
1.			
2.			
3.			
4.			
5.			

(4) Agrochemical.

Plot No.	Agrochemical type	Quantity(litres)	Cost(₦)
1.			
2.			
3.			
4.			
5.			

(5) Labour input

(a) Land preparation

Plot No.	Hired labour			Family labour		
	No of labourers	No of hours	Cost(₦)	No. of labourers	No. of hours	Cost(₦)
1.						
2.						
3.						
4.						
5.						

(b)Planting

Plot No.	Hired labour			Family labour		
	No of labourers	No of hours	Cost(₦)	No. of labourers	No. of hours	Cost(₦)
1.						
2.						
3.						
4.						
5.						

(c) Fertilizer Application

Plot No.	Hired labour			Family labour		
	No of labourers	No of hours	Cost(₦)	No. of labourers	No. of hours	Cost(₦)
1.						
2.						
3.						
4.						
5.						

(e) First Weeding

Plot No.	Hired labour			Family labour		
	No of labourers	No of hours	Cost(₦)	No of labourers	No of hours	Cost(₦)
1.						
2.						
3.						
4.						

(f) Second Weeding

Plot No.	Hired labour			Family labour		
	No of labourers	No of hours	Cost(₦)	No of labourers	No of hours	Cost(₦)
1.						
2.						
3.						
4.						
5.						

(g) Agrochemical application

Plot No.	Hired labour			Family labour		
	No of labourers	No of hours	Cost(₦)	No of labourers	No of hours	Cost(₦)
1.						
2.						
3.						
4.						
5.						

(h) Harvesting and threshing

Plot No.	Hired labour			Family labour		
	No of labourers	No of hours	Cost(₦)	No of labourers	No of hours	Cost(₦)
1.						
2.						
3.						
4.						
5.						

(6) Simple farm tools and equipments

S/no	Simple farm tools	Number of	Purchase cost	Salvage value
1.				
2.				
3.				
4.				
5.				

(C) INFORMATION ON SESAME OUTPUT

Plot No.	Total quantity of sesame produced (bags)	Total quantity sold	Price per bag(₦)
1.			
2.			
3.			
4.			
5.			

(D) CONSTRAINTS OF SESAME PRODUCTION

S/No.	Constraints	Tick as appropriate	Coping strategy, if any
1.	Lack of credit facilities		
2.	Inadequate fertilizer		
3.	Poor extension service		
4.	Problem of pests		
5.	Problem of diseases		
6.	Lack of good road network		
7.	Poor storage facilities		
8.	Uneven ripening of capsules		
9.	Inadequate family labour		
10.	High cost of hired labour		
11.	Inadequate marketing channels		
12.	Others (indicate)		

E. GENERAL SUGGESTIONS FOR THE IMPROVEMENT OF SESAME PRODUCTION IN THE STUDY AREAS.

……
……
……
……
……
……

APPENDIX II

RESULT OF THE TECHNICAL EFFICIENCY OF SESAME FARMERS IN THE STUDY AREAS

Farmer	Year	Tech efficiency			
1	1	9.86E-01	41	1	9.53E-01
2	1	8.69E-01	42	1	7.91E-01
3	1	9.60E-01	43	1	8.33E-01
4	1	9.66E-01	44	1	6.46E-01
5	1	9.46E-01	45	1	8.16E-01
6	1	8.54E-01	46	1	9.54E-01
7	1	9.61E-01	47	1	7.29E-01
8	1	9.52E-01	48	1	9.65E-01
9	1	6.56E-01	49	1	8.09E-01
10	1	6.60E-01	50	1	9.66E-01
11	1	6.83E-01	51	1	8.95E-01
12	1	7.78E-01	52	1	7.49E-01
13	1	9.28E-01	53	1	9.58E-01
14	1	6.13E-01	54	1	7.26E-01
15	1	8.26E-01	55	1	7.67E-01
16	1	6.46E-01	56	1	9.33E-01
17	1	9.39E-01	57	1	8.88E-01
18	1	9.50E-01	58	1	8.23E-01
19	1	9.31E-01	59	1	9.49E-01
20	1	8.68E-01	60	1	9.74E-01
21	1	9.78E-01	61	1	9.47E-01
22	1	9.60E-01	62	1	9.19E-01
23	1	9.51E-01	63	1	8.91E-01
24	1	9.59E-01	64	1	8.26E-01
25	1	9.46E-01	65	1	5.26E-01
26	1	9.76E-01	66	1	6.79E-01
27	1	9.75E-01	67	1	9.17E-01
28	1	9.60E-01	68	1	6.15E-01
29	1	9.78E-01	69	1	9.76E-01
30	1	9.87E-01	70	1	8.78E-01
31	1	7.59E-01	71	1	5.78E-01
32	1	6.25E-01	72	1	9.32E-01
33	1	9.63E-01	73	1	9.76E-01
34	1	8.50E-01	74	1	8.82E-01
35	1	9.79E-01	75	1	8.24E-01
36	1	8.95E-01	76	1	4.74E-01
37	1	6.43E-01	77	1	8.73E-01
38	1	9.53E-01	78	1	9.17E-01
39	1	9.13E-01	79	1	9.52E-01
40	1	8.88E-01	80	1	8.34E-01

81	1	8.90E-01	122	1	9.53E-01
82	1	3.40E-01	123	1	9.76E-01
83	1	8.23E-01	124	1	8.23E-01
84	1	8.81E-01	125	1	4.13E-01
85	1	8.44E-01	126	1	8.23E-01
86	1	7.61E-01	127	1	9.49E-01
87	1	7.17E-01	128	1	9.17E-01
88	1	9.13E-01	129	1	9.49E-01
89	1	4.14E-01	130	1	9.17E-01
90	1	9.76E-01	131	1	9.17E-01
91	1	4.98E-01	132	1	9.55E-01
92	1	8.81E-01	133	1	9.49E-01
93	1	6.65E-01	134	1	6.63E-01
94	1	7.26E-01	135	1	9.49E-01
95	1	9.48E-01	136	1	9.49E-01
96	1	9.17E-01	137	1	9.33E-01
97	1	9.77E-01	138	1	8.55E-01
98	1	9.22E-01	139	1	9.33E-01
99	1	5.59E-01	140	1	5.27E-01
100	1	9.61E-01	141	1	9.17E-01
101	1	8.25E-01	142	1	9.76E-01
102	1	8.23E-01	143	1	7.04E-01
103	1	7.40E-01	144	1	8.23E-01
104	1	7.92E-01	145	1	9.52E-01
105	1	7.88E-01	146	1	8.34E-01
106	1	5.14E-01	147	1	3.40E-01
107	1	8.30E-01	148	1	8.23E-01
108	1	9.68E-01	149	1	8.81E-01
109	1	5.13E-01	150	1	8.44E-01
110	1	6.27E-01	151	1	7.61E-01
111	1	9.33E-01	152	1	7.17E-01
112	1	9.37E-01	153	1	9.13E-01
113	1	8.19E-01	154	1	4.14E-01
114	1	8.98E-01	**Total**		**1.28E+02**
115	1	9.33E-01	**Mean**		**8.34E-01**
116	1	9.49E-01	**Minimum**		**3.40E-01**
117	1	8.05E-01	**Maximum**		**9.87E-01**
118	1	7.75E-01			
119	1	7.25E-01			
120	1	7.20E-01			
121	1	9.76E-01			

APPENDIX III

RESULT OF THE ALLOCATIVE EFFICIENCY OF SESAME FARMERS IN THE STUDY AREAS

Farmer	Year	Cost efficiency			
1	1	6.19E-01	41	1	8.20E-01
2	1	7.06E-01	42	1	6.10E-01
3	1	6.15E-01	43	1	7.04E-01
4	1	8.08E-01	44	1	7.07E-01
5	1	9.22E-01	45	1	5.19E-01
6	1	9.08E-01	46	1	8.17E-01
7	1	5.23E-01	47	1	7.06E-01
8	1	6.17E-01	48	1	6.12E-01
9	1	4.20E-01	49	1	6.25E-01
10	1	6.35E-01	50	1	4.17E-01
11	1	7.09E-01	51	1	4.06E-01
12	1	8.09E-01	52	1	6.07E-01
13	1	9.14E-01	53	1	4.27E-01
14	1	9.05E-01	54	1	3.05E-01
15	1	9.17E-01	55	1	6.25E-01
16	1	3.09E-01	56	1	5.25E-01
17	1	5.24E-01	57	1	8.04E-01
18	1	3.07E-01	58	1	7.15E-01
19	1	7.13E-01	59	1	5.34E-01
20	1	7.07E-01	60	1	8.08E-01
21	1	7.05E-01	61	1	9.16E-01
22	1	5.20E-01	62	1	9.12E-01
23	1	5.09E-01	63	1	7.06E-01
24	1	5.16E-01	64	1	4.61E-01
25	1	6.07E-01	65	1	8.10E-01
26	1	9.11E-01	66	1	9.18E-01
27	1	7.35E-01	67	1	8.10E-01
28	1	7.15E-01	68	1	9.11E-01
29	1	7.12E-01	69	1	8.11E-01
30	1	6.10E-01	70	1	6.15E-01
31	1	5.10E-01	71	1	8.04E-01
32	1	8.08E-01	72	1	5.15E-01
33	1	8.14E-01	73	1	4.06E-01
34	1	9.10E-01	74	1	7.12E-01
35	1	8.15E-01	75	1	6.08E-01
36	1	9.11E-01	76	1	3.07E-01
37	1	9.08E-01	77	1	7.05E-01
38	1	7.12E-01	78	1	6.07E-01
39	1	6.11E-01	79	1	8.06E-01
40	1	8.07E-01	80	1	8.07E-01

81	1	7.07E-01	120	1	7.04E-01
82	1	6.04E-01	121	1	5.06E-01
83	1	5.06E-01	122	1	6.06E-01
84	1	4.09E-01	123	1	9.06E-01
85	1	8.05E-01	124	1	9.06E-01
86	1	7.41E-01	125	1	6.06E-01
87	1	6.05E-01	126	1	8.06E-01
88	1	8.03E-01	127	1	9.06E-01
89	1	7.09E-01	128	1	9.06E-01
90	1	8.04E-01	129	1	8.06E-01
91	1	8.10E-01	130	1	9.06E-01
92	1	9.04E-01	131	1	8.06E-01
93	1	7.03E-01	132	1	7.06E-01
94	1	6.04E-01	133	1	7.06E-01
95	1	5.05E-01	134	1	8.06E-01
96	1	6.05E-01	135	1	8.06E-01
97	1	9.06E-01	136	1	9.04E-01
98	1	7.06E-01	137	1	8.04E-01
99	1	7.16E-01	138	1	8.34E-01
100	1	9.08E-01	139	1	5.44E-01
101	1	8.07E-01	140	1	7.34E-01
102	1	8.04E-01	141	1	5.24E-01
103	1	7.21E-01	142	1	6.24E-01
104	1	6.23E-01	143	1	6.14E-01
105	1	5.05E-01	144	1	8.24E-01
106	1	6.10E-01	145	1	8.04E-01
107	1	5.07E-01	146	1	6.07E-01
108	1	5.16E-01	147	1	7.07E-01
109	1	4.05E-01	148	1	7.07E-01
110	1	7.07E-01	149	1	9.07E-01
111	1	6.13E-01	150	1	7.07E-01
112	1	3.14E-01	151	1	9.10E-01
113	1	4.28E-01	152	1	6.10E-01
114	1	8.04E-01	153	1	8.10E-01
115	1	6.07E-01	154	1	9.10E-01
116	1	5.04E-01	**Total**		**1.07E+02**
117	1	9.08E-01	**Mean**		**6.94E-01**
118	1	9.08E-01	**Minimum**		**3.05E-01**
119	1	6.10E-01	**Maximum**		**9.22E-01**

APPENDIX IV

RESULT OF THE ECONOMIC EFFICIENCY OF SESAME FARMERS IN THE STUDY AREAS

Farmer	Year	Econ efficiency
1	1	6.10E-01
2	1	6.13E-01
3	1	5.90E-01
4	1	7.80E-01
5	1	8.72E-01
6	1	7.75E-01
7	1	5.02E-01
8	1	5.88E-01
9	1	2.76E-01
10	1	4.19E-01
11	1	4.84E-01
12	1	6.29E-01
13	1	8.48E-01
14	1	5.55E-01
15	1	7.57E-01
16	1	2.00E-01
17	1	4.92E-01
18	1	2.92E-01
19	1	6.64E-01
20	1	6.14E-01
21	1	6.89E-01
22	1	4.99E-01
23	1	4.84E-01
24	1	4.95E-01
25	1	5.74E-01
26	1	8.89E-01
27	1	7.17E-01
28	1	6.86E-01
29	1	6.97E-01
30	1	6.02E-01
31	1	3.87E-01
32	1	5.04E-01
33	1	7.84E-01
34	1	7.74E-01
35	1	7.97E-01
36	1	8.15E-01
37	1	5.83E-01
38	1	6.79E-01
39	1	5.58E-01
40	1	7.17E-01
41	1	7.81E-01
42	1	4.83E-01
43	1	5.86E-01
44	1	4.57E-01
45	1	4.24E-01
46	1	7.79E-01
47	1	5.15E-01
48	1	5.91E-01
49	1	5.05E-01
50	1	4.03E-01
51	1	3.63E-01
52	1	4.55E-01
53	1	4.09E-01
54	1	2.22E-01
55	1	4.79E-01
56	1	4.90E-01
57	1	7.14E-01
58	1	5.88E-01
59	1	5.07E-01
60	1	7.87E-01
61	1	8.68E-01
62	1	8.38E-01
63	1	6.29E-01
64	1	3.81E-01
65	1	4.27E-01
66	1	6.23E-01
67	1	7.42E-01
68	1	5.60E-01
69	1	7.92E-01
70	1	5.40E-01
71	1	4.65E-01
72	1	4.80E-01
73	1	3.97E-01
74	1	6.28E-01
75	1	5.01E-01
76	1	1.46E-01
77	1	6.15E-01
78	1	5.56E-01
79	1	7.67E-01
80	1	6.73E-01
81	1	6.30E-01
82	1	2.06E-01

83	1	4.16E-01	129	1	7.65E-01
84	1	3.60E-01	130	1	8.31E-01
85	1	6.79E-01	131	1	7.39E-01
86	1	5.64E-01	132	1	6.74E-01
87	1	4.34E-01	133	1	6.70E-01
88	1	7.34E-01	134	1	5.35E-01
89	1	2.94E-01	135	1	7.65E-01
90	1	7.85E-01	136	1	8.58E-01
91	1	4.03E-01	137	1	7.50E-01
92	1	7.96E-01	138	1	7.13E-01
93	1	4.67E-01	139	1	5.07E-01
94	1	4.38E-01	140	1	3.86E-01
95	1	4.79E-01	141	1	4.80E-01
96	1	5.55E-01	142	1	6.09E-01
97	1	8.85E-01	143	1	4.33E-01
98	1	6.51E-01	144	1	6.78E-01
99	1	4.00E-01	145	1	7.65E-01
100	1	8.73E-01	146	1	5.06E-01
101	1	6.65E-01	147	1	2.41E-01
102	1	6.61E-01	148	1	5.82E-01
103	1	5.34E-01	149	1	7.99E-01
104	1	4.94E-01	150	1	5.96E-01
105	1	3.98E-01	151	1	6.93E-01
106	1	3.14E-01	152	1	4.37E-01
107	1	4.21E-01	153	1	7.40E-01
108	1	4.99E-01	154	1	3.77E-01
109	1	2.08E-01	**Total**		**8.91E+01**
110	1	4.44E-01	**Mean**		**5.79E-01**
111	1	5.73E-01	**Minimum**		**1.46E-01**
112	1	2.95E-01	**Maximum**		**8.89E-01**
113	1	3.50E-01			
114	1	7.22E-01			
115	1	5.66E-01			
116	1	4.78E-01			
117	1	7.31E-01			
118	1	7.04E-01			
119	1	4.42E-01			
120	1	5.07E-01			
121	1	4.94E-01			
122	1	5.78E-01			
123	1	8.85E-01			
124	1	7.46E-01			
125	1	2.50E-01			
126	1	6.64E-01			
127	1	8.60E-01			
128	1	8.31E-01			