ECONOMIC ANALYSIS OF SESAME PRODUCTION AMONG SMALL- HOLDER FARMERS IN BENUE STATE, NIGERIA

BY

Sharon Ocheinehi ADOLE
M Sc/AGRIC /11971/ 2011-12

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

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

JANUARY, 2016

DECLARATION

I hereby declare that this dissertation titled "**Economic Analysis of Sesame Production among Small–Holder Farmers in Benue State, Nigeria."** was written by me and it is the record of my research work. No part of this work has been presented in any previous application for another degree or diploma in this or any other institution. All borrowed information have been duly acknowledged in the text and a list of references provided.

______________________________ ______________

Sharon Ocheinehi ADOLE **Date**
Student

CERTIFICATION

This dissertation titled "**Economic Analysis of Sesame Production among of Small–Holder Farmers in Benue State, Nigeria.**" by **Sharon Ocheinehi ADOLE** meets the regulation governing the award of the Degree of Master of Science of Ahmadu Bello University, Zaria, and is approved for its contribution to scientific knowledge and literary presentation.

Prof Ben Ahmed — **Date**
Chairman, Supervisory Committee

Prof S. A. Sanni — **Date**
Member, Supervisory Committee

Prof Z. Abdulsalam — **Date**
Head, Department of Agricultural Economics & Rural Sociology

Prof K. Bala — **Date**
Dean, School of Postgraduate Studies

DEDICATION

This dissertation is dedicated to the Almighty God.

ACKNOWLEDGEMENT

My greatest appreciation goes to God Almighty, who through His son Jesus Christ has made life meaningful to me. I would like to express my thanks and appreciation to my supervisors, Prof. Ben Ahmed and Prof. S.A. Sanni for their constructive criticisms, contributions and suggestions in this research. I feel highly indebted to them for their unflinching support throughout this course.

I sincerely appreciate the Head of Department Prof. Z. Abdusalam and all lecturers in the Department of Agricultural Economics and Rural Sociology for their contribution to the success of this research work. I am grateful to Dr. O.O. Ugababe, Mrs. M. Azakah Secretary of the Department of Agricultural Economics and Rural Sociology, Dr. O. Yusuf for their encouragement and immeasurable support.

I extend my deepest appreciation to my parents Mr and Mrs. Michael Adole for their love, your prayers and financial support. I specially thank Mrs Onyanta Ikpe, Mr and Mrs Bryan Emadia, Okopi Onu, Emmauel Achichi, Otali Achichi, Enaji Achichi, Stacy Achichi, Augustina Adole for being there for me as a family. My profound gratitude also goes to my beloved friends, Akosua Yeboah, George Bivan, Francois Siewe, Joel Wamba, Jacob Timothy, Alhaji Idi Sadiq who have extended unreserved help during my request, shared their ideas, and thought me different ways of doing the course and research works.

TABLE OF CONTENTS

Contents **Pages**

LISTS OF TABLES

Tables **Pages**

LIST OF FIGURES

Figure **Page**

LIST OF APPENDICES

Appendix **Page**

ABSTRACT

The broad objective of the study was to examine the Economics of Sesame Production among small-holder famers in Benue State, Nigeria. Specifically, the study examined the socio-economic characteristics of farmers in the study area, profitability, technical, allocative and economic efficiencies and constraints of sesame production in the study area. A multi-stage sampling procedure was used to randomly select 180 farmers from 12 villages in the state. Primary data were collected using structured questionnaire and analyzed using net farm income and stochastic frontier production function. The results revealed that majority (85.6%) of the farmers were male with a mean age of 37. About 97.8% of the respondents were literate with a mean farm size of 3.13 hectares. The gross farm income, net farm income per hectare and the return per every naira invested were found to be of ₦121, 435.20, ₦67,261.95 and ₦1.24. Labour was the most prominent cost item and it accounts for 57.85% of the total cost. The estimate of the technical efficiency indicates that farm size was positive and statistically significant at 1% while the coefficients for fertilizer and herbicide were statistically significant at 5% and 10% level of probability. Farming experience, extension contact and membership of cooperative society were found to influence technical efficiency. The analysis of allocative efficiency revealed that seed, fertilizer and herbicide were all statistically significantly at 1%. The inefficiency model indicates that education, farming experience and extension service were significantly related to allocative efficiency. The mean technical, allocative and economic efficiencies estimates were 0.712, 0.968 and 0.689 respectively. The major problems encountered by the sesame farmers in the study area were inadequate capital (80.5%), poor market pricing (76.7%) and lack of modern cleaning facilities (73.9%). There is a need for farmers to form cooperative organisation so as improve their access to production inputs and enhance their marketing efficiency. Also, strengthening the present extension service will increase efficiency in the long term.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Available statistics show that agriculture is the most important Nigerian economic sector in terms of its contribution to the Gross Domestic Product (GDP), after oil. The sector contributes about 41% to the country's GDP, employs about 65% of the total population and provides employment to about 80% of the rural population. Agriculture is a major source of food and meat. It is estimated that some 25 million hectares of land are cultivated each year by small holders for food production and hence the sector plays an important role in rural livelihood. It is estimated that it accounts for about 70% of rural household's total incomes (Ogen, 2003). Agricultural growth in Nigeria is increasingly recognized to be central to sustained improvement in economic development. The sector plays a crucial role in food security, poverty alleviation and human development chain in Nigeria (Aye and Oboh, 2006).

According to the Department of Agriculture, Forestry and Fisheries (2012), Smallholder farmers are defined in various ways depending on the context, country and even ecological zone. It is often interchangeably used with 'small-scale, 'resource poor' and sometimes 'peasant farmer'. In general terms smallholder only refers to their limited resource endowment relative to other farmers in the sector. It can be defined as those farmers owning small-based plots of land on which they grow subsistence crops and one or two cash crops relying almost exclusively on family labour.

One of the main characteristics of the production systems of smallholder farmers are simple outdated technologies, low returns and high seasonal labour fluctuations. These smallholder farmers differ in individual characteristics, farm size, resource distribution between food and cash crops, livestock and off-farm activities, their use of external inputs and hired labour, the proportion of food crops sold and household expenditure patterns (DAFF, 2012).

In Nigeria, small-holder farmers constitute about 80% of the farming population (Awoke and Akorji, 2004). According to them, small-holder farmers are those farmers who produce on a small scale, not involved in commercial agriculture but produce on a subsistence level, and cultivate less than five hectares annually on the average. Small-holder and family farming agriculture remains the key and leading sector in economic development of many developing countries in the world (Quan, 2011). According to Quan (2011), in addition to producing staple food for domestic markets, small-holder farmers produce larger share of traditional export in these countries, hence, the economy of many developing countries is still reliant on small-holder agriculture. The agricultural sector in Nigeria is dominated by small-holder farmers who produce the bulk of the food requirements in the country (Asogwa, Umeh and Penda, 2011).

Sesame (*Sesamum indicum L.*) otherwise known as sesamum or benniseed, a member of the family padaliaceae, is one of the most ancient oil seed known to mankind. Sesame plays a major role in human nutrition. Most of the sesame seeds are used for oil extraction and the rest are used for edible purposes (El Khier, Ishag and Yagoub, 2008). Sesame is widely grown in the northern and central part of Nigeria as a minor crop initially until in 1974 when it became a major cash earner in many northern states such as Benue, Nasarawa, Jigawa, Kano, Katsina, Plateau and Yobe States and in Abuja, the Federal Capital Territory of Nigeria (NAERLS, 2010). Sesame is commonly grown by small-holder farmers in the major producing States of Benue, Nasarawa and Jigawa States.

Sesame has been reported to be a typical crop for farmers in the developing countries (Bennet, 2011). This is because it has deep roots and is well adapted to withstand dry conditions. It grows on relatively poor soils in climate generally unsuitable for other crops, and so it is widely valued for its nutritional and financial yield. It is well suited to small-holder farming with a relatively short harvest cycle of 90 – 140 days, allowing other crops to be grown in the field (Chemonics, 2002; Naturland, 2002; Nigeria's Harvest, 2009) and often intercropped with other grains. This makes it favourable to Nigerian farmers. Production can thus be sustained by small-holder farmers under minimum management with average yield of 700kg per hectare (Nigeria's Harvest, 2009). The three major languages in Nigeria, Hausa, Igbo and Yoruba call it Ridi, Isasa and Ekuku respectively.

1.2 Problem Statement

Sesame seed is an important component of Nigeria's agricultural export (Chemonics, 2002). It currently ranks second to cocoa in terms of export volume in Nigeria and is fast becoming prominent among non-oil exports because it is one of the few cash crops that can earn the country foreign exchange. Attributed to its high demand, any quantity of the product offered to the market is easily sold. Although it is quite extensively cultivated, it is mainly a small-holder crop, often intercropped with others crops (Abu *et al.* 2011). Available records showed that Nigeria exported 140,800 tonnes of sesame seed worth $139 million in 2010. It was also recorded that Nigeria earned ₦210 billion from the export of sesame seed products in the first half of 2012 (Ciuci, 2013).

This increasing demand for sesame seed provides Nigeria an opportunity to increase its production to meet the international demand for the commodity. Market opportunities exist in Korea, India, the Middle East and Mediterranean countries where sesame seed oil is in very high demand (Ciuci, 2013). This therefore provides Nigeria with the opportunity to broaden its market base. Currently only about 300,000 hectares of the estimated 3.5 million hectares of Nigeria's 90 million hectares of arable land that is suitable for cultivating sesame seed is presently being used in the production of sesame seed (Tunde-Akintunde *et al.* 2012). By investing more in sesame seed production, the Nigerian government could increase annual revenue from sesame seed export from ₦21 billion to about ₦86 billion annually (Ciuci, 2013).

The realization of the potential of sesame production in the acquisition of 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. 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). However, some studies on sesame indicated a wide gap between potential and actual yields obtained (RMRDC, 2004, Olowe, 2007; NAERLS, 2010; Kanton *et al.*, 2013). The NAERLS (2010) reported actual sesame yield of 300kg/ha against potential yield of between 700-1,000 kg/ha which is below the world average yield of 4,900kg/ha and four times lower than the average yield of other oil seed crops like groundnut and soybean. Manyong *et al.* (2005) reaffirmed actual sesame yield of 0.55 tonnes/ha against a potential yield of 2 tonnes/ha with a yield gap of 264% for North-Central

Nigeria. Nigeria's inability to fully tap into the economic potentials of the crop might be a reflection of its inefficient nature in sesame production.

One of the major factors responsible for low agricultural productivity in Nigeria is farmers' limited access to production inputs which are necessary for attaining a high level of production (Nwaru, 2004). Amaza and Olayemi (2002) observed that crop farmers mostly carry out their production under conditions involving the use of inefficient tools and unimproved seed varieties and therefore, maximum efficiency is elusive to them. Productivity according to Coelli *et al.* (1998) is a measure of farm performance which indicates whether a farm uses the best available technology to obtain maximum output from a given set of inputs. On the other hand, technical efficiency is the ratio of total output to total inputs; the larger the amount of inputs per unit of output, the smaller the size this ratio becomes (Ohajianya and Onyenweaku, 2001).

Sesame is extensively cultivated in Benue State but there is little information on the productivity as well as the efficiency of resources used and profitability. One way farmers can raise productivity is improving the efficiency within the limit of the existing resource base and technology (Udoh, 2005). Productivity is reduced in the presence of technical inefficiency whereas the more efficient the firm, the higher its productivity, ceteris paribus (Kumbhakar, 2004). Boosting sesame production would require that farm resources be use efficiently since efficiency in the use of the production inputs is essential for optimum production. Therefore, there is the need to assess the level of efficiency of resources used in agricultural production in general and sesame production in particular. This therefore, necessitates answers to the following research questions:

i. What are the socio-economic characteristics of sesame producers?

ii. Is sesame production profitable?

iii. Are the resources efficiently utilized?

iv. What are the constraints associated with sesame production in Benue State?

1.3 Objectives of the Study

The broad objective of the study was to examine the economic efficiencies of sesame production in Benue State.The specific objectives were to:

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

ii. determine the cost and returns in sesame production;

iii. estimate the economic efficiency in sesame production; and

iv. describe the constraints associated with sesame production in the study area.

1.4 Justification of the Study

Sesame is a major cash crop highly cultivated in Benue state and makes significant contribution to household income.They have been various interventions by the state government to promote its production byencouraging farmers to increase its output.According to Zerihun (2012), to increase the yield potential, the quality of sesame crop and achieve better profit requires the collaborative efforts of all stake holders in capacity building on sesame crop improvement and post harvest handling of the crop, development of high yielding widely adapted cultivars with better resistance to diseases and pests, development of improved agronomic and management practices. It is necessary to identify the major problems affecting sesame production and to investigate how the resources are organized and utilized.This gap needs to be bridge through research by identifying the causes of inefficiency which may either be due to inefficient input combinations or misallocation of resources

The result of the study would add to academic knowledge,generate information for policy makers, governmental and non-governmental organization interested in sesame production in designing appropriate policies that will boost sesame production so as to bridge the gap between demand and supply in the local and international markets.

1.5 Hypotheses of the Study

The hypotheses tested in this study are:

i. Sesame production is not profitable in the study area

ii. Sesame farmers socio-economic characteristics have no significant influence on the technical and allocative efficiency of sesame production

1.6 Limitation of the study

The study encountered a number of limitations. In some occasions, the respondents were not able to give the correct record of their sesame production, quantity of inputs used, prices and earning because of inadequate or lack of record keeping. To overcome some these problems, different techniques were used this include the use of triangulation. Information from extension workers and traders complemented the information obtained from the survey

CHAPTER TWO

LITERATURE REVIEW

2.1 Origin and Morphology of Sesame (*Sesamum indicum L.*)

Sesame seeds (or Sesamum or benniseed) are the seeds of the tropical annual Sesamum indicum. The species has a long history of cultivation, mostly for its yield of oil. The original area of sesame domestication is obscure but it seems likely to have first being brought into cultivation in Asia or India (Chemonics, 2002). Archeological records indicates that it has been known and used in India for more than 5,000 years and is recorded as a crop in Babylon and Assyria some 4,000 years ago (Borchani *et al.* 2010).

Sesame is an annual plant, which grows either bush-like or upright depending on the variety. The plant is usually 60 – 120 cm tall and the fruit is a dehiscent capsule held close to the stem. When ripe, the capsule shatters to release a number of small seeds. The seeds are protected by a fibrous 'hull' or skin, which may be whitish to brown or black depending on the variety with 1,000 seeds weighing some 4 – 8 grammes. The seeds have a high oil content of 44 - 60% (Chemonics, 2002).

Sesame is planted at different times in different ecological zones depending on when the rains are fully established. It can be grown twice as an early or late crop, or once a year depending on the ecological zone. In the Sudan savannah, planting is by late June to the first week of July. In the Derived savannah, like Benue State, the early crop is sown at the onset of the rainy season around March - April, while the late crop is sown two months before the end of the rains around mid-July to early-August (USAID MARKETS, 2009; NAERLS, 2010).

Sesame cultivation can be carried out on a wide range of soils but optimum are well-drained, loose, fertile and sandy alluvial soils that have a pH value between 5.4 and 6.75. Very low pH values have a drastic effect on growth, whereas some varieties can tolerate a pH value up to 8 (Naturland, 2002). Good drainage is crucial, as sesame is very susceptible to short periods of water logging. Sesame is intolerant of very acidic or saline soils (Bennet, 2011). Sesame as a sole crop can be planted on a flat bed with an inter-row and intra-row spacing of 60cm x 10cm, planting on the flat by seed drilling makes the operation very easy and could be used in relatively large farms. The spacing between plants will ensure vigorous growth and high yield. Planting on ridges at an inter-row and intra-row spacing of 75cm x 15cm can be adopted when sesame is intercropped with another crop. This is usually carried out on smaller farms (USAID MARKET, 2009). According to NAERLS (2010), sesame does not require much fertilizer except where the soil is poor. NPK fertilizer is required where the fertility of the soil is low. Two bags of NPK fertilizer (15:15:15) is enough to fertilize one hectare. The recommended rates are Nitrogen 20-50kg/ha, Phosphorus 30-60kg/ha and Potassium 30-35kg/ha.

Weeds are serious problem in sesame production because they often cause drastic reduction in yields. For optimum yield, the crop must be kept weed free from planting to harvesting. Weeding can be carried out using different methods either by manual hand weeding or chemical weeding using the pre-emergence or post emergence herbicides stomp and sarosate respectively at recommended rates.

Sesame seed is harvested when 50% of capsules turn yellow in colour from green. Other indications of the optimum time of harvesting (physiological ripeness) include lowest capsules turning brown and beginning to pop open, stems turning yellow, leaves beginning to fall off, end of blossoming, leaves turning yellow (Kimbonguila *et al.* 2009). Harvesting should not be delayed to prevent seed loss through shattering. Harvesting should be done by cutting the stem with sickle. The size and shape of sesame (small and flat) makes it difficult to move much air through it in a storage bin. Therefore, the seeds need to be harvested as dry as possible and stored at 6% moisture or less (Langham *et al.* 2008; Nigeria's Harvest, 2009; Hansen, 2011). If the seed is too moist, it can quickly heat up and become rancid.

The two types of sesame produced in Nigeria are the white/raw which is a food-grade used in the bakery industry and the brown/mixed which is primarily oil-grade. The white food grade is grown around towns of Keffi, Lafia and Doma in Nasarawa State, Makurdi in Benue State and Taraba State. The brown/mixed grade grows in the North in places like Kano and Jigawa States and somewhat in the southern part of Katsina State (Chemonics, 2002). The improved varieties include NCRI BEN-01M, NCRI BEN-02M, NCRI BEN-032M, E8 and Yandev-55. According to NAERLS (2010), the NCRI BEN-01M is a medium maturing variety and matures between 102 – 115 days with its seeds white in colour and containing about 45% oil with a potential yield of 1000kg/ha. The NCRI BEN-02M is also medium maturing variety which matures between 102-115 days. The seeds are usually light brown in colour with a seed size of 3mm and also contains 45% oil with a potential yield of 700kg/ha.NCRI BEN-032M is a late maturing variety; it matures between 125-140 days. The seeds are white in colour and have an oil content of 40% with a potential yield of 600kg/ha.E8 is an early maturing variety with duration of 90 days. It is light brown in colour with a seed size of 3.6mm and has an oil content of 50% with a potential yield of 1000kg/ha. The Yandev- 55 is a long duration variety maturing above 125 days. The seeds are white in colour with an oil content of 40% with potential yield of 600kg/ha. Mixing of different seed sources or varieties will result in uneven height, maturity and seed quality.

2.2 Economic Importance of Sesame

Sesame is an oil seed grown predominantly as an export crop. The annual export from Nigeria is estimated at about US$20 million with potentials to increase in ten folds. It is grown for its seed and the primary use of sesame is a source of cooking oil. It is common to find roasted sesame seed sold either (sole or with groundnut) and eaten as snack among rural and urban dwellers across Nigeria. The young leaves may be eaten in stews and the dried stems may be burnt as fuel with ash used for local soap making. Sesame is commercialized in a number of forms. Most is processed directly into oil but can be sold at various stages of processing, for various uses, such as paste, meal, confectionery and bakery product (USAID MARKETS, 2009). According to NAERLS (2010), the seed cake is an excellent protein supplement in the animal feed industry. The press can be used for food enrichment of infant weaning. It is also used for medicinal purposes such as treatment of ulcers and burns.

A recent Raw Material Research and Development Council survey revealed that sesame has high economic potential in Nigeria for both industrial and export markets. Annual export from Nigeria is valued at about US$35 million from an estimated world trade of US$600 million in 2005. AlthoughFood and Agricultural Organisation (2013) asserted that Nigeria exported 59,600 metric tonnes of sesame seed worth $43million in 2005. In value terms therefore, the crop is second to cocoa as an agricultural export. Nigeria is the primary supplier of sesame seed to Japan, the largest importer.

According to Chemonics (2002) about 60-70% of sesame produced in Nigeria is exported to the major consuming countries. Without commercial scale production, only the seed is extracted from Nigeria. Four companies dominate the buying and export of sesame seeds in Nigeria namely OLAM Nigeria Limited, Akkay Limited, Dangote Industries Limited and Dantata Industries Limited. The market share of these and other exporters is not known. As a predominantly small-holder production, the crop is mainly traded by buyers or middlemen who tour the rural areas buying from the farmers. The sesame is transported to larger towns, bulked in store and sold to the agents of the major exporters. The major buying centers are the urban markets in the states where sesame is mostly cultivated. In Benue State, the urban market is in Otukpo.

2.3 Sesame Production in Nigeria

According to FAO (2006), global sesame seed production was estimated at 3.3 million tonnes in 2005. Twenty five percent (25%) of the world hectarage is planted in Africa. Sesame production increased from 15,000 tonnes in 1980 to 56,000 tonnes in 1994 (Alegbejo *et al.*, 2003). Available data from FAO shows that sesame production in Nigeria further increased from 60,000 tonnes in 1995 to 75,000 tonnes in 2005. The total global harvest was about 3.84 million tonnes of sesame seed in 2010 and Nigeria ranks seventh in the world and fourth largest producer in Africa after Ethiopia, Sudan and Uganda with 0.12 million tonnes and a production yield of 0.38 tonnes per hectare. The largest producers are China and India, each with an annual harvest around 750,000 tonnes followed by Myanmar (425,000 tonnes) and Sudan (300,000 tonnes). These figures are only rough estimates of the situation as sesame is a small-holder crop and much of the harvest is consumed locally, without record of internal trade and domestic processing (Chemonics, 2002; Bedigian, 2010).

In Nigeria, a steady increase in sesame production per hectare was recorded from 2007-2012except for 2009 when output per hectare declined by 2.4% from the previous year recorded. The table 1 below indicates that output per hectare increased about 98% from 2003-2012.

In Benue State, sesame production has been on the increase because of its unique attributes and its recognition as a cash crop which is supported by figures from Raw Material Research and Development Council (Table 2.1). The observed increase in sesame production in terms of output and land area cropped from 2006-2011 can be partly attributed to OLAM Nigeria Limited, a sesame export agent, having a Warehouse in the State that gives credit to the sesame farmers in kind and in turn they buy output from the debtor sesame farmers (Table 2.2). They supply modern production inputs like fertilizer and on condition that the output at the end of production would be sold to the agent.

In Nigeria, the acreage of sesame planted in some States between 2000 and 2004 and associated outputs are shown in Table 2 .1 and 2.2 below.

Table 2:1 Sesame Production Trend in Nigeria from 2003-2012

Year	Output (tons)	Area (Ha)	Yield (kg/ha)
2012	158,000	330,000	479
2011	155,000	325,000	477
2010	149,410	324,570	460
2009	119,710	308,230	388
2008	121,610	317,080	384
2007	117,700	229,280	393
2006	100,000	197,000	508
2005	100,000	196,000	510
2004	78,000	165,000	473
2003	80,000	167,000	479

Source**:** FAOSTAT (2013).

Table 2.2: Output of Sesame in Major Producing States in Nigeria (in metric tonnes)

State	2001	2002	2003	2004	2005
Benue	37,200.00	39,080.00	41,260.00	39,570.00	40,420
Nassarawa	8,300.00	7,180.00	7,180.00	8,750.00	8,880.00
Jigawa	38,000.00	40,000.00	37,000.00	10,292.00	N/A
Taraba	1,560.00	1,940.00	2,000.00	1,825.00	N/A
Bauchi	980.00	940.00	880.00	884.00	900.00
Plateau	1,900.00	1,800.00	N/A	N/A	N/A
Kaduna	61,370.00	62,560.00	N/A	N/A	N/A
Kebbi	3,671.00	3,079.00	2,861.00	2,861.00	3,068.00
Kano	N/A	N/A	N/A	5,900.00	N/A
F.C.T Abuja	N/A	1,496.00	1,824.00	2,017.00	2,420.00
Total	**54,509.60**	**56,334.60**	**51,786.30**	**32,734.60**	**55,950.40**

*Source***:** RMRDC Survey of Agro- Raw material, 2004
Note: NA = Figures not available

Table 2.3: Sesame Output and estimated Land Area in Benue State (2006 - 2011)

Year	Output (000MT)	Area cropped (Ha)
2011	58.70	47.34
2010	55.28	45.38
2009	47.95	46.55
2008	45.63	45.18
2007	43.65	43.22
2006	40.58	41.28

Source: BNARDA 2012

2.4 The Concept of Efficiency in Agricultural Production

The issue of increasing agricultural productivity has become the main concern to governments following the considerable increase in food prices over the last two years that followed decades of low food prices (Conradie *et al.,* 2009). Increasing productivity in agriculture will certainly lead to availability of food and reduction in the real prices of food and this increase in food production will have to come from increased yield. Agricultural productivity depends on how factors are efficiently used in the production process. The question of efficiency in resource allocation in traditional agriculture is not trivial.

It is widely held that efficiency is at the heart of agricultural production. This is because the scope of agricultural production can be expanded and sustained by farmers through efficient use of resources (Ali, 1996; Udoh, 2000). For these reasons, efficiency has remained an important subject of empirical investigation particularly in developing economies where majority of the farmers are resource poor and production is mainly in the hands of small-holder farmers who are still using unimproved farming techniques. Efficiency of resource use, which can be defined as the ability to derive maximum output per unit of resource, is the key to effectively addressing the challenges of achieving food security. To determine the efficiency of a particular firm, there is need for efficiency measurement through the production factor inputs and processes. Measuring of efficiency is important because this is the first step in a process that might lead to substantial resource savings. These resource savings have important implications for both policy formulations and firm management (Bravo-Ureta and Rieger, 1991).

The concept of efficiency measurement begins with Farrell (1957) who drew upon the work of Debreu (1951) and Koopman (1951) to define a simple measure of firm efficiency that could account for multiple inputs. He proposed that efficiency measurement consist of two components, technical efficiency and allocative efficiency. Technical efficiency refers to the ability of producing a given level of output with a minimum quantity of inputs under a given technology. Allocative efficiency refers to the choice of optimal input proportions given relative prices. Unlike technical efficiency concept that only consider the process of production, allocative efficiency concepts pertain to the idea that society is concerned with not only how an output is produced, but also with what outputs and balance of output are produced (Hensher, 2001).

Economic efficiency refers to "the capacity of a firm to produce a predetermined quantity of output at minimum cost for a given level of technology" (Farrell 1957) and is derived by multiplying the technical and allocative components of efficiency (Bravo-Ureta and Pinheiro, 1997).

2.5 Measurement of Production Efficiency

Efficiency is considered to be one of the most important issues in the production process. It is measured by comparing the actually attained or realized value of the objective function against what is attainable at the frontier subject to available inputs. Before the pioneering works of Farrell (1957) that provided insight about the possibility of estimating so-called frontier production functions in an effort to bridge the gap between theory and empirical work, econometricians were used to estimate average production functions. Essentially there are two main methodologies for measuring efficiency: the econometric (or parametric) approach and the mathematical (or non-parametric) approach. The two techniques use different methods to envelop data and in doing so they make different accommodation for random noise and for flexibility in the structure of production technology. Thus each method has its own advantages and disadvantages.

2.5.1 The Non-Parametric Approach: Data EnvelopmentAnalysis

Based on Farrell's (1957), Charnes *et al*. (1978), were the first to introduce DEA approach to estimate efficiency. Since its introduction, the approach has served as the corner stone for all subsequent developments in the nonparametric approach. The basic concept of the data envelopment analysis (DEA) is to measure the efficiency of a decision measuring unit (DMU) relative to similar DMU'S in order to estimate best practice frontier. DMU refers to any entity that is to be evaluated interms of its ability convert multiple inputs to outputs. The DEA method can be applied using either an output based or an input–based approach depending on whether these approaches use input distance function or output distance function. The two most common models that are used in research are the Constant Returns to Scale –model (CRS) and the Variable Returns to Scale –model(VRS) introduced by Banker et al, (1984).

In the DEA methodology developed by Charnes *et al.* (1978), efficiency is defined as a ratio of weighted sum of outputs to a weighted sum of inputs, where the weights structure is calculated by means of mathematical programming and constant return to scale (CRS) are assumed.

In 1984, as an improvement to the analytical technique, Banker *et al.* developed a model with variable returns to scale (VRS). Technical efficiency (TE) reflects the ability of (DMUs), such as firms to obtain maximal output from a given set of inputs (Farrell, 1957). When using the DEA model, there is no need to specify the functional form. In addition, there is no need to specify the distributional form for the inefficiency term (Coelli *et al.*, 1998). It is assumed that a sesame farm or DMU produce a quantity of sesame (yi) using multiple of inputs (xi), such as land, labour, seed, fertilizer and herbicide. To determine technical efficiency for the i^{th}sesame DMU in the linear programming (LP) problem in an output-oriented DEA, the model was solved as follows:

Maximize $\theta\lambda$ θ

Subject to: $-\theta y_i + Y\lambda \geq 0$

$X_i - X\lambda \geq 0 \; \lambda \geq 0$………………………….…………….. (1)

Where

y_i = sesame quantity for i^{th}DMU

x_i = Nx1 vector of input quantities for i^{th} DMU

Y = 1xM vector of sesame quantities

X = NxM matrix of input quantities

λ = Mx1 vector of weight

θ = scalar

The above specified theoretical empirical linear programming model was specified based on constant return to scale (CRS). For variable return to scale (VRS) equation (1) is altered by adding the convexity constraint, $N1'\lambda=1$.

The main advantage of the DEA is the preservation of production axioms in estimating the efficient frontier (Thanassoulis, Portela & Despić, 2008). DEA is considered to be more flexible in allowing for multi-input or multi-output production processes, due to the non parametric estimation and the exclusion of a specific production function (Bauer, 1990).

The major weakness of DEA is that they rule out the possibility of a deviation from the frontier being caused by measurement error or other noise (such as bad weather)

Therefore, any deviations from the estimated frontier are attributed to inefficiency. The method is also highly sensitive to outliers in the data and avoids defining an explicit production function. This typical problem of DEA models can be solved either by collecting and measuring accurately all relevant variables or by using Stochastic DEA models (SDEA). To use SDEA, however, it is necessary to provide information about the expected values and variances of all variables as well as probability levels at which feasibility constraints are satisfied. Another feasible alternative for including statistical noise in the model is to use a parametric approach for the estimation of the production function. Despite its limitations, DEA is surely a competitor with the stochastic production frontier efficiency analysis.

2.5.2 The parametric approach: stochastic frontier models

The stochastic frontier production function was independently proposed by Aigner *et al*. (1977) and Meeusen and van den Broeck (1977).The stochastic production function is defined by:

$Y_i=f(X_i,\beta)E_i$ ………………………………………………… (2)

Where

$E_i=V_i-U_i$ …………………………………………………… (3)

$Y_i$is the observed output of the i^{th} sample farm, $f(x_i,\beta)$ is a suitable functional form, β is vector of the unknown parameters to be estimated, E_i is the error term made up of two components; V_i is the random error having zero mean which is associated with random factor outside the farmers' control such as weather, epidemics, measurement errors and other variables which are unidentified in the production function and is assumed to be independently and identically distributed normal $(0,\delta^2 v)$ random variable and independent of U_i. On the other hand, U_i is a non-negative truncated half normal random variable associated with farm specific factor, which lead to the i^{th}farm not attaining maximum efficiency of production. U_i is associated with technical inefficiency of the farm and range between zero and one. U_i follows an identical and independent half normal distribution $N(0,\delta^2 v)$. N represents the number of farms involved in the cross sectional survey. The measurement of production (technical) and cost efficiency can be done by estimating the stochastic frontier function of both models. The comparison from the actual and the frontier function will represent the farmer's efficiency.

The technical efficiency of an individual farm from above can be defined in terms of the ratio of the observed output to the corresponding frontier output, given the available technology. The technical efficiency is thus empirically measured by decomposing the deviation into a random component U_i (Ojo, 2003).

In that case Technical efficiency (TE_i) = Y_i/Y_i^* ………………………………. (4)

$TE_i = f(X_i, \beta)\exp(V_i - U_i)/f(X_i,\beta)\exp(V_i) = \exp(-U_i)$ …………………………….. (5)

Where *Yi* is the observed output and Y* is the frontier output.

This is such that so $0 \leq TE_i \leq 1$

The stochastic cost frontier function which is used for estimating the allocative efficiency of the farms is specified as follows:

$C_i = h(Y_i,P_i;\alpha) + \varepsilon i$ ……………………………………………………….(6)

Where:

C_i = represent the total input cost of the ith farms

Y_i = Output of the ith farms

P_i = represents input prices employed by the ith farm

α= parameters to be estimated

$v_i + u_i$ = error terms

Where v_i is the stochastic error which is assumed to be identically, independently and normally distributed with zeromean and a constant variance (σv^2). The other second component (u_i) is a one-sided error term which is independentof v_i and is normally distributed with zero mean and aconstant variance (σu^2), allowing the actual production to fallbelow the frontier but without attributing all short falls in output from the frontier as inefficiency.The specific allocative efficiency is computed as:

$$AE = Q_i^*/Q_i^m \qquad (7)$$

Where

AE = Allocative efficiency

Q_i^* = Frontier output

Q_i^m =Optimum output

The importance of Maximum Likelihood Estimation (MLE) is not only to estimate parameters β□, β*i* and μ, but also the two variances of $V_i$and U_i. The value of the variances can be used to measure the value of γ which is the contribution of the technical and cost efficiency of the total residual effect. Therefore the values of γ are between zero and one ($0 \leq \gamma \leq 1$).

The strength of the stochastic frontier is the inclusion of statistical noise in the observed deviation from the estimated frontier. This allows for the use of efficiency analysis and in situations where we cannot with certainty assume that the ‘output gap’ between observed production and the optimal production is free of stochastic elements and it also permits hypothesis testing.

The main criticism or limitations of the stochastic frontier model are:

- Accommodate single output technology
- It relies on distributional assumptions
- Functional form for production technology is required
- Endogeneity of inputs (Production function ill-suited regression model)

The model retains some flexibility in allowing the actual frontier underestimation to be specified in various ways, usually according to the specific objectives of the researcher. In addition to production frontiers, the model lends itself readily to the estimation of cost frontiers (Schmidt & Lovell, 1979) and profit frontiers (Kumbhakar, 1987). This is the decision rule in using the model

2.6 Empirical Application of Stochastic Frontier Production Function in Efficiency and Economics Studies

Omolehin *et al.* (2010) applied a Cobb-Douglas stochastic frontier production function in the analysis of technical efficiency in sesame production system in Jigawa State. The empirical result indicated that the technical efficiencies of the farmers varied widely ranging from 0.25 to 0.86 but with a mean technical efficiency of 0.57. The inefficiency model indicated that age of farmer, years of farming experience and extension contact significantly affected farmers' efficiency level.

Alabi *et al.* (2010) used the maximum likelihood method of stochastic production function in estimating the technical efficiency of sesame production in Nassarawa Doma Local government Area of Nassarawa State. The model shows that the elasticity of production for seeds (0.51), labour (0.710), capital (0.356) and farm size (0.55) had significant effect on sesame output. The inefficiency model revealed that education and access to credit were significant at 5% and positively affected farmers' efficiency level.
Abu *et al.* (2012), in their study of profit efficiency among sesame farmers in Nassarawa State, revealed that the estimated average allocative efficiency was 41.9%. Seed, fertilizer, labour, chemical and transportation were all statistically significant to allocative efficiency while the inefficiency model reveal factors such as farming experience, educational status and access to credit were all positively and significantly related to allocative efficiency.

2.7 Profitability Analysis

Profitability measures the ability of farmers to cover their costs and it is an important concept, because it provides incentives for entry into and longevity in the farming business. While many studies of Nigerian farms across the country report profitability, profit margins are often very small (IFPRI, 2011). The objective or goal of farm firms is to maximize profit or minimize cost. Profit can be defined as the total value of production less the total cost of production, while the total value of production is the product of total yield and price. The total cost of production comprises of two components the operating or variable costs and fixed costs. Variable costs vary according to output and are incurred at each production process examples are seeds, labour, herbicide and fertilizer. Fixed costs are those that do not vary with output in the short run as in the long run, all inputs become variable (Olukosi and Erhabor, 1988).Thus, all these are used in estimating the gross maginas well as net farm income. The gross farm income or total revenue is the total physical product per unit price of the product. The difference between the gross farm income and total cost of production (fixed and variable cost) is referred to as the net farm income (Olukosi and Erhabor, 1988). The net farm income measures the strength and weakness of the farm.According to Kay *et al.* (2008), the NFI should be a starting point for analysing farm profitability, rather than used as the only measure of farm`s profitability.

A number of studies have been conducted to study the profitability or otherwise of sesame production in Nigeria. For instance, OLAM (2005) in a survey on the profitability of sesame production in Benue and Nasarawa States reported that farmers realized on a per hectare basis gross revenue, average cost and gross margin of ₦77,500.00, ₦35,000.00 and ₦42,500.00 respectively. Similarly Abu *et al.* (2011), in their study on the costs and returns of sesame production in Nasarawa State, revealed that sesame production was profitable and that labour cost was the highest cost for respondents in the study area with a gross margin, mean total revenue and mean total variable cost of ₦132,910.00, ₦254,000.00 and ₦121,410.00 respectively. Makama *et al.* (2011) also carried out a study on economics of sesame production in Taura Local Government area Jigawa State and reported that labour cost was responsible for 86.97% of the total cost of production with a gross income and gross margin of ₦37,739.19 and ₦22,022.19 respectively.

2.8 Constraints Associated with Sesame Production

Umar *et al.* (2011) study of sesame farmers in Doma Local Government Area of Nasarawa State revealed that poor road network, high cost of inorganic fertilizer, poor extension service, high cost of transportation and low market price for sesame grain were the major constraints to an increased sesame production.

BNARDA (2012) reported that inadequate capital and low resource productivity as the major challenges limiting sesame production in the Benue state. These small holder farmers lacks the necessary technical and material inputs to improve sesame production and productivity, various governments under the agricultural development programmes (ADP's) have undertaken and supported research and developmental activities in an effort to improve small-holder resource productivity through the dissemination of high yielding cultivars, fertilizer, herbicides to the farmers to reduce the burden of capital during the production period. Despite all this efforts directed towards improving sesame production, low resource productivity prevails. There still exist wide gap between potential and actual farm yields obtained this simply accounts to the fact that the technological advances generated through research have not yet translated into increased efficiency and resource productivity.

Nakyagaba *et al., (*2005) in their study of agronomic constraint to simsim production in Uganda reported that low sesame yield are partly due to improper agronomical practice practices such as inappropriate fertilizer levels, dependence on lower yielding cultivars, poor planting systems, broadcast method of sowing and untimely weed management. The yield of sesame can be increased with adoption of improved technologies such as improved variety, recommended dose of fertilizer, weed management and plant protection.

Alemu and Meijerink (2010) in their own opinion noted that the current sesame marketing system is characterised by high transaction costs related to the lack of sufficient market coordination between buyers and sellers, lack of reliable and timely market information, lack of trust among market actors, lack of grades and standards, limited role of cooperatives and their unions and their limited ability to compete equally with local traders, high transportation cost due to the existence of physical movement of the product before transaction are made, and considerable default in case of mistrust among market actors narrows market channels and negative impact on smallholder producer livelihoods. This in turn slows down sesame output growth and the general development of the agricultural sector.

According to Ssekabembe *et al.,*(2001) revealed that diseases, insects among pests is a major factor limiting sesame production. Crop pests causes cosmetic damage in the early years of crop introduction but become more serious as production expands. The pests that attack sesame plants have the potential to limit its economic production. In Nigeria, the common diseases of sesame are *Cercospora Sesame and Fusarium wilt* causing severe leaf spot, collar and root rot in resulting in sudden death of infected plant.

Abera (2009) reported that absence of modern warehouses has resulted in mishandling of output since these small scale farmers are unable to build their own storage devices due to tenure insecurity. Due to inappropriate or adequate storage facilities the farmers are forced to sell part or most of their sesame immediately after harvest to prevent weight loss, rodents and insects attack reducing the quality and quantity of the seed when stored in sacks and kept in their house.

Zerihun (2012) conducted a study on the trends, challenges and future prospects of sesame crop production in Ethiopia and the result revealed that there is a problem of mechanical mixtures of different sesame varieties. When such seeds are planted will result in uneven height and lack of productivity of the seeds.

CHAPTER THREE

METHODOLOGY

3.1 The Study Area

This study was conducted in Benue State located between Longitudes 7º47′E and 10º 0 E and Latitudes 6°25′N and 8º8′N, and shares boundaries five other state namely: Nasarawa State to the north, Taraba State to the east, Cross River State to the south, Enugu State to the South west and Kogi State to the west (Benue state government, 2012). The State has a population of 4,253,641 people and a total land mass of 32,518 Km^2 (NPC, 2006). The UNFPA (2012) projected the population to 5,287,129 million by 2013 which is a 3% growth rate per annum. The State is characterized by the rainy season from April to October with an annual rainfall ranging from 100 – 200 mm and a dry season from late October to March. Arable land is estimated to be 3.8 million hectares. The State is predominantly rural with an estimated 75% of the population engaged in rain-fed agriculture. The State is the major producer of food and cash crops like sesame, yam, maize, sweet potatoes and cassava. Asogwa *et al.* (2011).

The strategic location of the State between the southern forest region and the northern semi and grassland region of the country makes it to have fertile land for agriculture. Average farm size is 1.5 to 2.0 hectares (BNARDA, 1999). Benue State is made up of three main ethnic groups namely Tiv, Idoma and Igede with the Tivs constituting 60% of the population. The State is divided into three agricultural zones namely Zone A, Zone B and Zone C (Figure 1). Zones A and B are made up of seven local government areas (LGAs) each and zone C has nine LGAs. All the LGAs in each agricultural zone are similar in vegetation, agricultural practices and socio-cultural activities. Each zone can boast of a great deal of livestock resources like sheep, goat and pigs which are traditionally reared on a free range by small holder farmers.

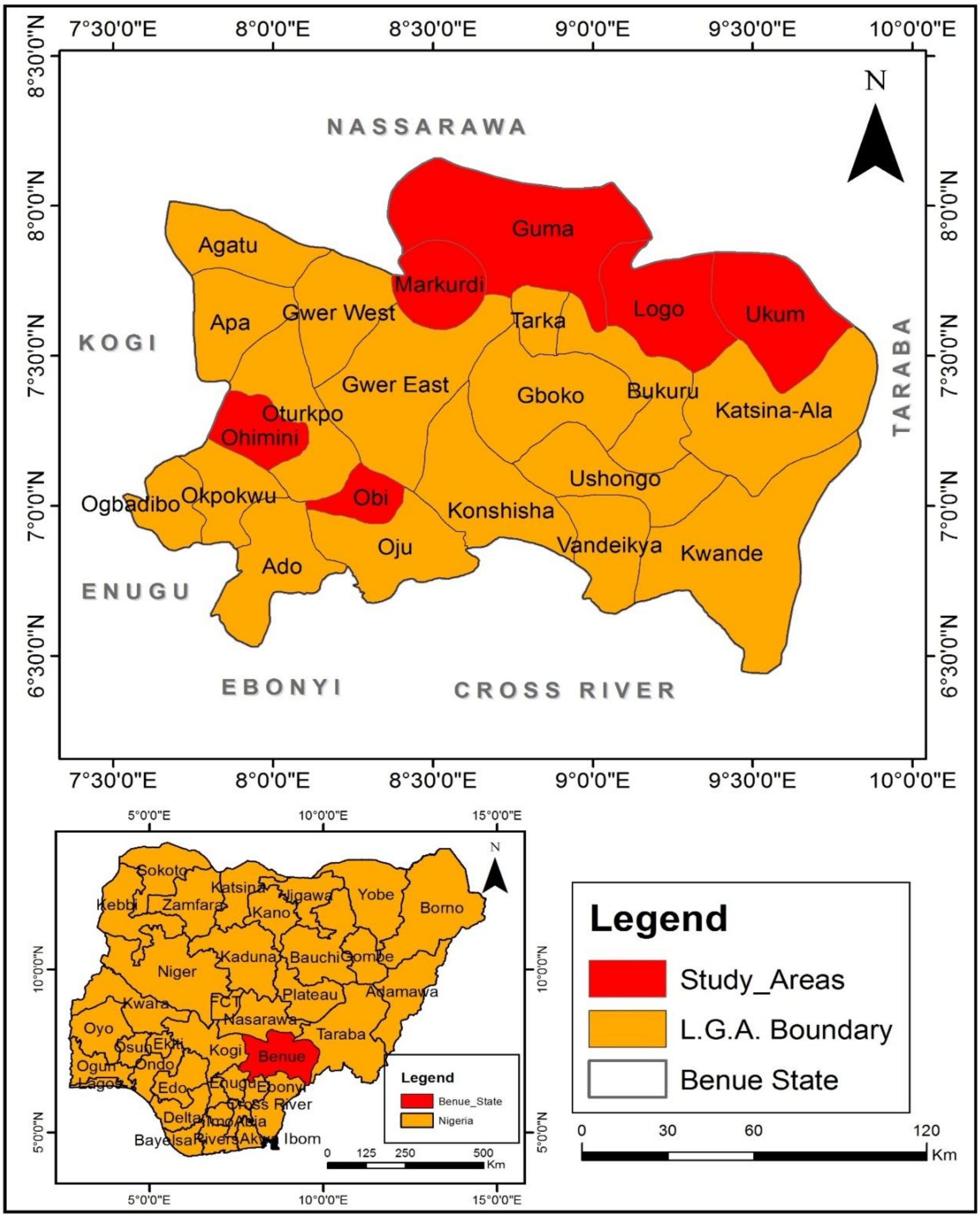

Figure 1: Map of Benue State Showing the Study Area

3.2 Sampling Procedures

Based on reconnaissance survey, a multi-stage sampling technique was used to select sesame farmers for this study. In the first stage, purposive sampling technique was used to select two Local Government Areas each from the three agricultural zones in the states as shown in Fig 1. The selection of the local government area was based on the fact that they are they are the most prominent sesame producing areas of the State (BNARDA, 2011). Secondly, two major villages were randomly selected from each of the six selected local government areas through the use of card. Thirdly, 10% of the farmers were randomly selected from each of the twelve (12) villages by using the table of random numbers. This is shown in Table 3.1.

Table 3.1: Distribution of Sesame Farmers and Selected Respondents in the Study Area

Zones	LGA	Villages	Sample Frame	Sample Size selected
Zone A	Guma	Gbajimba	200	20
		Daudu	164	16
	Makurdi	Zango-akiki	133	13
		Agan	150	15
Zone B	Logo	Gbeji	204	20
		Ugba	178	18
	Ukum	Zakibiam	141	14
		Ayati	100	10
Zone C	Obi	Ito	151	16
		Adum East	119	12
	Ohimini	Ochobo	140	14
		Idekpa	122	12
Total			**1802**	**180**

3.3 Data Collection

Data for this study were collected from primary sources with the aid of structured questionnaires. The questions were structured to provide answers on the objectives of the study. The researcher visited the farmers in their homes and on their farms so as to verify some of their responses.

The primary data collected focused on:

a) Farm Production Information: inputs used in the production of sesame such as land size, type and amount of labour, quantity of seeds, quantity of agrochemicals quantity of fertilizer, output of sesame were be collected.

b) General Information: demographic data on age, farming experience, level of education, consumption and utilization of sesame, household size, number of extension contacts and access to credit.

c) Information on the number of and types of labour used (family, hired or communal) and also information on the type of operation they performed were collected.

d) Marketing information: information on the output price per unit, total output, cost of transportation and other marketing cost like taxes paid was collected.

3.4 Analytical Techniques

3.4.1 Descriptive statistics

Measures of central tendency such as frequency distribution, percentages, mean and measures of dispersion such as standard deviation were used to achieve objective I and I

3.4.2 Net farm income

This was used to address objective II. The model specification is expressed as:

$$NFI = GFI - TC \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

Where:

NFI = Net Farm Income (₦/ha)

GFI = Gross Farm Income or revenue which represents the sum total value of sesame harvested on the farm during the research season (₦/ha)

TC = TVC + TFC

TVC = Total Variable Cost incurred by the respondent including cost of labour, fertilizer, sees, herbicides and so on.

TFC= Total Fixed Cost.

For this study, fixed cost was mainly on depreciation of durable farm tools such as sprayers, hoes and cutlasses. The straight line method of evaluating depreciation was used to obtained fixed cost for the durable farm tools. The straight line depreciation method assumes that an asset loses value at a constant rate. Depreciation by this method is the difference between the purchase price (P) and the salvage value (S) divided by the number of years of life of the asset

$$D = \frac{P-S}{n} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (9)$$

Profitability is a measure of the efficiency of the business or farm using its resources to produce profit or NFI. In order to determine if an enterprise is profitable or not, profitability index estimated as follows;

Profitability Index (PI) – This is the Gross Farm Income (NFI) per unit of total variable cost

$$PI = \frac{NFI}{TC} \quad \ldots\ldots (10)$$

3.4.3 Stochastic frontier Cobb-Douglas production function

This was used to address objectives III. The implicit form of the model is specified as:

$$Y_i = f(X_i, \beta)E_i \quad \ldots\ldots (11)$$

Where,

Y_i= quantity of output of the ith farm

X_i = vector of the inputs used by the ith farm

β = vector of the parameters to be estimated

E_i= Two sided error term

The estimates for all the parameters of the stochastic frontier production function and inefficiency model was obtained using the programme FRONTIER 4.1 (Coelli, 1994)

The empirical model is specified as follows:

$$ln Y_i = \beta_o + \beta_1 ln X_1 + \beta_2 ln X_2 + \beta_3 ln X_3 + \beta_4 ln X_4 + \beta_4 ln X_5 + V_i - U_i \quad \ldots\ldots (12)$$

Where:

ln = Natural Logarithm

y_i = Sesame Output (kg)

β_0 = Intercept term

$\beta_{1-}\beta_5$= Partial regression coefficients (Elasticities of production)

x_1 =Quantity of seed (kg)

x_2 =Farm Size (ha)

x_3 = Total Iabour input (man-day)

x_4 =Quantity of Herbicide (L)

x_5= Quantity of Inorganic Fertilizer (kg)

v_i = Two-sided idiosyncratic error term

u_i = Non-negative error term (Measure of inefficiency) assumed to be truncated below by zero.

The inefficiency model is stated as follows:

$$U_i = \alpha_0 + \alpha_1 Z_1 + \alpha_2 Z_2 + \alpha_3 Z_3 + \alpha_4 Z_4 + \alpha_5 Z_5 + \alpha_6 Z_6 + \alpha_7 Z_7 + \alpha_8 Z_{8+} \alpha_9 Z_9 \ldots\ldots\ldots\ldots(13)$$

Z_1=Gender of farmers (dummy variable: 1= male and 0= female)

Z_2 =Age of farmers (years)

Z_3=Household size (Number of persons)

Z_4 =Educational level (Number of years of formal education)

Z_5 = Marital status (dummy variable: 1 married and 0 otherwise)

Z_6 = Membership of cooperative society (Years of participation)

z_7= Access to credit (amount borrowed in Naira ₦)

z_8= Extension visit (number of visit per year)

z_9 = Farming Experience

θ_i = Normally distributed error term with zero mean and constant variance.

3.4.4 Stochastic frontier Cobb-Douglas cost function

The stochastic cost function used in estimating the allocative efficiency of the farms. The model is specified as follows:

$C_i = y(P_i, Y_i; \gamma) + (v_i + u_i)$..(14)

C_i= represents the total costof production of the ith farm

Y_i = value of output in Kg

P_i= vector variable input prices of the ith farm

γ = parameters to be estimated

V_i and $U_i$are the random error terms.

$$\text{InC} = \beta_o + \beta_1 \ln P_1 + \beta_2 \ln P_2 + \beta_3 \ln P_3 + \beta_4 \ln P4 + V_i + U_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots(15)$$

ln = Natural Logarithm

c_i = Total cost of production

y_i = Sesame Output (kg)

β_0 = Intercept term

β_1–β_5= Partial regression coefficients (Elasticities of production)

p_1= Cost of seed (₦)

p_2 =Cost of labour input (₦)

p_3 =Cost of agro-chemical (₦)

p_4= Cost of inorganic fertilizer (₦)

v_i = Two-sided idiosyncratic error term

u_i = Non-negative error term (Measure of inefficiency) assumed to be truncated below by zero.

The allocative inefficiency model is stated as follows:

$$U_i = \alpha_0 + \alpha_1 Z_1 + \alpha_2 Z_2 + \alpha_3 Z_3 + \alpha_4 Z_4 + \alpha_5 Z_5 + \alpha_6 Z_6 + \alpha_7 Z_7 + \alpha_8 Z_8 + \alpha_9 Z_9 \text{............} (16)$$

Where:

Z_1=Sex of farmers (dummy variable: 1= male and 0= female)

Z_2 =Age of farmers (years)

Z_3=Household size (Number of persons)

Z_4 =Educational level (Number of years of formal education)

Z_5 = Marital status (dummy variable: 1 married and 0 otherwise)

Z_6 = Membership of cooperative society (Years of participation)

Z_7= Access to credit (amount borrowed in Naira ₦)

z_8= Extension visit (number of visit per year)

Z_9 = Farming Experience

θ_i = Normally distributed error term with zero mean and constant variance.

3.4.5 Definition of the variables and their a priori expectation

Sesame Output: This is the quantity of sesame harvested by the farmers during the last farming season in the study area. The sesame seeds are packed in 80kg and 100kg bag. For the purpose of this study, 100kg which is the standard conversion factor adopted by the Nigeria export promotion council was used.

Seed: It is quantity of seed used during the planting seasonfor the production of fresh sesame seeds. The seeds are usually measured using local measures (mudu) which is estimated to be 1kg. *Aprori* expectation, increasing the use of sesame seed will increase the quantity of sesame output.

Land: This refers to an area of ground in terms of its ownership and usage for agricultural bases. It is measured in hectares. Land size is expected to be positively related to sesame output.

Labour: This is the physical work done and it is measured in man hours per day. Labour in this study comprises of both family and hired.Family labour was evaluated using the principle of opportunity cost and it was assumed that family labour served as a substitute for hired labour. Consequently, the imputed cost of labour used for family labour equals the prevailing wage rate of hired labour. Labour is expected to have a positive effect on sesame production.

Herbicide: This is an agricultural input (chemical) applied to the farm land to kill weeds. It is measured in Litre per hectare for this study. The common herbicides used were stomp and fusillade. The sign on the coefficient of herbicide is expected to be positive and influencing output.

Fertilizer: Natural and synthetic materials including manure and nitrogen, phosphorus and potassium compounds worked into the soil the soil to increase its capacity to support plant growth. It is measured in kilogram per hectare in this study. The fertilizer commonly used was NPK 15:15:15. Urea and SSP. Fertilizer is expected to influence sesame output positively.

Age: Age is the length of time that a person has lived or existed it is measure in years.Age is expected to be positively related to efficiency because it has a significant influence on the decision making process of farmers and adoption of improved technology.

Sex: The state of being a male or female.The role gender in agriculture in Africa reflects cultural norms, physical capacities and acquiredcharacteristics. Incorporating gender into agricultural programs and activities can encourage the formulation of gender based innovations and technological development which can enhance agricultural productivity Dummy score was used to represent sex of the respondents (1 for male and 0 for females).

Household Size: This is the number of persons living together in one house. It includes the farmer, mother, children and extended relations. The size of the household largely depends on the status of farmers and particularly on the number of wives the farmer has. Household size is expected to be positively related efficiency through the provision of family thereby reducing cost of hired labour but a larger household size can act otherwise (Essilfie, 2011)

Level Education: Education is simply the process of imparting or acquiring particular knowledge, developing the power of reasoning and judgment. It is measured in years. Educational attainment of farmers is very important in agricultural operation because it does not only raise agricultural productivity but also enhances farmers' ability to understand and evaluate information on new techniques and processes and this is expected to be positively to related efficiency.

Marital Status: This refers to one's situation with regard to whether one is single, married, separated, divorced or widowed. These 5 classes of respondents were considered in this study.Dummy score was used to represent marital status (1 for married and o for otherwise). A number of studies showed that marital status influence social organization and economic activities such as agriculture and resources within a household. Marital status isoften correlated to household size as a source of labour for most farm operation and the unmarried young adult farmers provide labour on hired basis for sesame production (Nyunza and Nwakeje, 2012; Dimelu *et al*. 2009; Umar, 2010).

Membership of Cooperative: Membership of association provides a network connection among farmers which enhances mutual commitment. Membership of cooperative is expected to influence efficiency positively, it affords the farmers access to soft loans and productive inputs such as improved seeds and fertilizer which arebetter sought by group rather than individuals.For the purpose of this study, it is measured in the number of years the person has been in that cooperative society.

Access to credit: For the purpose of this study, credit refersto the amount of money borrowed by an individual from friends, family, banks and cooperatives so as to finance their farming activities with or without interest depending on the terms of agreement reach before the money was collected. Access to creditis expected to influence efficiency positively. Availability of credit will facilitate easy procurement inputs like fertilizers, agrochemicals and other yieldimprovinginputs on timely basisthat they cannot provide otherwise from their own resources.

Extension visit: This refers to the organized exchange of information and the deliberate transfer of skills to farmers to help them identify and analyse their production problems and become aware of the opportunities for improvement. It is measured in number of visits per year. Extension visit is expected to be positively related to efficiencybecause it provides the incentive and means for farmers to access improved crop technology.

Farming experience: It refers to the number of years the farmers have been involved in sesame cultivation.Farming experience is expected to influence efficiency positively because increased farming experience enable farmers to effective farm management decisions with respect to input combination or resource allocation through which agriculturalproductivity could experience a push into new direction of growth and development.

Total cost of sesame output: It is the total cost of incurred by farmers in the production of sesame output. It was computed as the sum of the cost of the inputs used such as fertilizer, family and hired labour, herbicide and seed. It represents the dependent variable in the stochastic frontier cost function and was measured in Naira.

Cost of seed: It represents the amount spent in acquiring the sesame seed that was used for the production of sesame output. It was expected to influence the total cost of sesame production positively since increasing the cost of seed is expected to increase the variable cost of product

Cost of labour: It is the cost incurred in employing both hired and family labour during the production of sesame. The cost was estimated in Naira and is expected to be positively related to the total cost of production**.**

Cost of fertilizer: It is the cost incurred in acquiring the quantity of inorganic fertilizerused in the production of sesame output. Estimated in Naira, the cost of fertilizer is expected to be positively correlated with the variable cost of sesame production and hence the total cost.

Cost of herbicide: It is the cost incurred in acquiring the quantity of herbicide used in the production of sesame output during the last farming season. It was estimated in Naira and the cost of herbicide is expected to be positively correlated with variable cost and hence the total cost of sesame production.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Socio-economic Characteristics of the Respondents

This section shows the distribution of respondents according to sex, marital status, age, education, household size, extension contact, farm size, farming experience, membership of cooperatives and amount of credit received.

4.1.1 Gender

The results of the analysis revealed that majority (85.6%)of the respondents were males and 14.4% were females implying that sesame production is dominated by men in the study area. This agrees with the findings of Tiamiyu *et al.* (2013) who reported that sesame farming was dominated by men.This could be attributed to the fact that male farmers have more access to family land than their female counterpart because of the exclusive right of male children to inherit family land. Another reason for male predominance in the study area could be attributed to the labour intensive nature of sesame farming which could be very tedious, hectic and time consuming especially for females who have to combine this farming activity with their domestic chores. Fasoranti (2006) reported that men have more access to the resources and information required to produce crops more efficiently than their female counterparts.

4.1.2 Marital status

The results showed that 86.1% of the respondents were married while 13.9% were single, divorced or separated collaborating with the findings of Abu *et al*.(2011). The high proportion of the respondents who are married is an indication that family labour could be available for sesame farmers in the study area.Rahman *et al.* (2009) reported that a high proportion of married respondents will contribute widely to the use of family labour by the households as the wives and children constituted the labour force.

4.1.3 Age

The age range of the sesame farmers was 23 – 60 years with an average of 37 years implying that majority of the respondents are young and able-bodied individuals who are in their productive age and can make positive contribution to agricultural production. This agrees with the findings of Yakubu (2002), who reported that famers that are between the age bracket of 30-49 years are more able and willing to take risk in expectation of profit than the older ones

Table 4.1**:** Age distribution of sesame farmers

Age (Years)	**Frequency**		**Percentage**
21 – 30	45		25.0
31 – 40	88		48.9
41 – 50	39		21.7
51 – 60	8		4.4
Total	**180**		
Minimum		23	
Maximum		58	
Mean		37	

4.1.4 Level of education

Education is an important socio-economic factor that influences farmers' decision because of its influence on farmers' awareness, perception, reception and adoption of innovations that can bring about increase in production or reduction in production cost. About 38.9% of the farmers had primary education, 19.4% had secondary education, 18.9% had adult education, 20.6% had tertiary education and 2.2% had no formal education. This indicates that 97.8% of the respondents were literate at least having one form of formal education. This implies that there is potential for increased sesame production since education will enable farmers to have access to information on new agricultural innovation which can be adopted to enhance their productivity. IITA (2002) reported that the level of education attained by farmers to a large extent determine the farmers level of adoption of new innovation without difficulties which in turn increase their farm output, and subsequently the profit obtain by the farmers.

Table 4.2: Distribution of sesame farmers based on level of education

Level of Education	**Frequency**	**Percentage**
No formal Education	4	2.2
Primary Education	70	38.9
Adult Education	35	19.4
Secondary Education	34	18.9
Tertiary Education	37	20.6
Total	**180**	**100**

4.1.5 Household size

Majority (83.3%) of the respondents had household size of 1- 10 persons with average household size of 8 persons. This implies that family labour would be readily available when needed for sesame farming operation. Larger household sizes have been reported to enhance family labour availability hence the need for hired labour will be minimal thereby alleviating labour constraints. However, Minot *et al.* (2006) argued that a large household size means more mouth to feed, so that, for a given farm size, large households could provide smaller marketed surplus.

Table 4.3: Distribution of sesame farmers based on household size

Household Size	Frequency	Percentage
1-5	18	10.0
6 -10	132	73.3
11-15	28	15.6
16-20	2	1.1
Total	**180**	**100**
Minimum	1	
Maximum	16	
Mean	8	

4.1.6 Extension visit

Only 21.1% of the sesame farmers in the study area had contact with extension agents during the year while majority (78.9%) had no contact with extension agents. This may have a negative influence on the adoption of improved sesame production technologies because contact with extension agents exposes farmers to new technologies and improved varieties of inputs particularly seed. According to Kudi (2005), extension contacts increased sesame productivity in Jigawa State. This low frequency of contact with extension agents can be attributed to the limited number of extension agents (1:4000 farmers) in Nigeria which makes it impossible to reach all farmers by interpersonal means (Baruwa, 2013). This is in agreement with Ekunwe *et al.* (2008) who reported that extension services in Nigeria are poorly organized and in some cases, unavailable.

Table 4.4**:** Distribution of sesame farmers based on number of extension visit

Extension Visit	Frequency	Percentage
0	142	78.9
1-3	17	9.4
4-6	12	6.7
7-9	9	5.0

Total	180	100

4.1.7 Farm size

According to Yusuf (2005), the total farm cultivated is related to the total farm size available to the farmers. The average farm size cultivated in the study area was 3.13 hectares with about 81% of the respondents cultivating less than 4 hectares of land. This implies that most of the farmers had small farm holdings. The relevance of farm size in this study stems from the fact that the larger the farm business in terms of acreage or labour requirements, the earlier the farmer tends to adopt new practices applicable to his farm enterprises (Imoh and Essien, 2005). Relatively small farm size could constitute a major constraint to technology adoption (Sani *et al*, 2014).

Table 4.5: Distribution of sesame farmers based on farm size

Farm Size (Ha)	Frequency	Percentage
0.1 – 2.0	35	19.4
2.1 – 4.0	111	61.7
4.1 – 6.0	33	18.3
6.1 – 8.0	1	0.6
Total	**180**	**100**
Minimum	1.03	
Maximum	8.66	
Mean	3.13	

4.1.8 Farming experience

Table 4.6 shows that majority (82%) of the respondents had 1-20 years in sesame production while less than 2% had 31-40 years experience with an average experience of 15 years. It is thus, reasonable to infer that farmers in the study area are well experienced in farming sesame and depicts good signal for higher productivity.This situation agrees with the findings of Abu *et al.* (2011), who reported that the average farming experience of sesame farmers in Nasarawa State was 12.8 years. Farming experience determines the ability of farmers to make farm management decisions effectively, not only by adhering to agronomic practices, but also with respect to input combination or resource allocation and are thus expected to run more efficient and profitable enterprises. Amaza and Olayemi (2002) reported that the higher the number of years spent in farming by a farmer, the more he becomes aware of new production techniques

Table 4.6: Distribution of sesame farmers based on farming experience

Farming Experience (Years)	Frequency	Percentage
1 – 10	42	23.3
11 – 20	106	58.9
21 – 30	29	16.1
31 – 40	3	1.7
Total	**180**	**100**
Minimum	3	
Maximum	33	
Mean	15	

4.1.9 Membership of cooperative society

The number of years farmers participated in cooperative society is presented in Table 4.7. Majority of the respondents (73.9%) do not belong to any cooperative organisation. Membership of a cooperative society creates an avenue for farmers to pool their risks, in addition to providing access to resources and information that will improve their production practices, highlighting the importance of some social capital in improving productivity (Idumah, 2006; Idiong *et al.*, 2009; Shehu *et al.*, 2010).

Table 4.7: Distribution of sesame farmers based on years membership of cooperative society

Cooperative membership (Years)	Frequency	Percentage
0	133	73.9
1 – 3	11	6.1
4 – 6	21	11.7
7 – 9	15	8 .3
Total	**180**	**100**
Minimum		
Maximum		
Mean		

4.1.10 Access to credit

The distribution of sesame farmers based on access to credit as presented in Table 4.8 revealed that about 56.1% of the respondents had no access to credit while 43.9% borrowed between ₦10,000.00 to above ₦100, 000.00 . The result agrees with the findings of Onyibe *et al.* (2011) that access to formal credit is a major constraint to sesame farmers in Nigeria. The implication is that the size of sesame production will be low and other inputs will be affected since capital is not available to enhance production. Access to credit reduces inefficiency as it enables farmers to adopt high yielding varieties and makes it possible for farmers to access information useful for increasing productivity and efficiency (Ogundari, 2006; Oluwatosin, 2011). Often times, cooperatives and farmer associations exist to fill the market failure caused by the absence of decent credit markets.

Table 4.8: Distribution of sesame farmers based on amount of credit received

Credit	Frequency		Percentage
0	101		56.1
10,000 – 40,000	37		20.6
40,001 – 80,000	28		15.6
80,001 – above	14		7.7
Total	**180**		**100**
Minimum		10,000	
Maximum		120,000	
Mean		47746.8	

4.2 Cost and Return Analysis

4.2.1 Cost of production

The cost and return associated with sesame production in the study area is presented in Table 4.9. The components of the total variable cost include cost of seed, cost of labour, cost of herbicide, cost of fertilizerand cost of sacks. The average variable cost was ₦51,968.00 per hectare out of which labour constituted the largest component (61.6%). The result revealed that labour is the most used input among the respondents because it has the highest variable cost (₦32, 000.00). Therefore, sesame production is labour intensive in the study area. The average quantity inorganic of fertilizer used by the farmers by was 161.20 kg per hectare which is above the recommended rate of 100kg per hectare. The high rate of fertilizer usage could be attributed to declining soil organic matter in the soils and inappropriate fertilizer usage.The cost of fertilizer which makes up 21.7% of the cost. The average quantity of seed planted per hectare was 15.78kg. The seeding rate is higher than the recommended seedling rate of 5kg/ha (NAERLS, 2010). These suggest that the farmers are over using seeds. Cost of seed constitutes 12.2%and seeds are important factor influencing yield potentials in terms of optimum return of the crop in the study area. Herbicide had the lowest cost in terms of input 3.22%. This may be due to the fact that the market price may be lower than that of other inputs and it is often combined with manual weeding in the study area. Theaverage quantity of herbicide used by sesame farmers was 2.09 litres per hectare which is consistent with the recommended rate of 2-2.5 litres per hectare. Cost of sacks constitutes 1.35%.

The fixed cost was estimated to be ₦2205.25per hectare constituting 4.24% of total cost of sesame production. The total cost of cultivating a hectare of sesame farm was ₦54,175.25.

4.3.2 Returns

The average quantity of yield per hectare in the study area was 674.64kg. Sesame seed yields on farmers fields in Nigeria are between 500kg – 750kg per hectare(RMRDC,2004).The average yield per hectare obtained 674.64kg/ha is lower than the average yield of 1000kg when grown under improved managementpractices as reported by Tiamiyu *et al*. (2013). The unit price varied widely from ₦180 to ₦400 on the average.The unit price was at its lowest amount of ₦180 during harvesting period and rose steadily to its peak at ₦400 at planting season. Average gross farm income of ₦121,435.20 per hectare wasestimated. The net farm income of ₦67,259.95per hectare was estimated. This finding implies that sesame production is profitable in the study area ($t = 18.89$, $P<0.01$) and thus any effort at expanding it would be a good decision because a significant differences were observed in terms of cost of inputs incurred and also in terms of return realized. The profitability index was estimated to be 1.24 indicating that for each naira invested, there is a return of ₦1.24. Similar finding was reported by Makama *et al.* (2011) that sesame production is a profitable activity. They found out that investing ₦1 in sesame production in Jigawa State the farmers realized ₦1.40.This result shows that sesame production in the study area is profitable. Therefore, the null hypothesis which state that sesame production is not profitable was rejected.

Table 4.9: Estimated Cost and Returns of Sesame Farming in the Study Area (₦/ha)

Variables	Unit Price(₦)	Average Quantity/ha	Value (₦/ha)	Percentage
1.Variable cost				
a. Seed(kg)	400	15.78	6,312.00	12.2
b. Labour (Man-days)	400	80.00	32,000.00	61.6
c. Fertilizer (kg)	70	161.20	11,284.00	21.7
d. Herbicide (Litres)	800	2.09	1,672.00	3.22
e. Sacks	100	7.00	700.00	1.35
2. Total Variable Cost			51,968.00	
3. Fixed Cost				
a. Cutlass				
b. Hoes			444.90	
c. wheel barrow			347.44	
d. sprayer			746.62	
			666.29	
4.Total Fixed cost			2205.25	
5.Total Cost			54,173.25	
6.Gross Farm Income	180	674.64	121,435.20	
7.Net Farm Income			67,261.95	
8.Returnon Investment			1.24	

4.3 Estimates of Stochastic Frontier Production Function

The maximum likelihood estimates (MLE) of the parameters of the stochastic frontier production function for sesame farmers are presented in Table 4.10. The sigma-squared (0.086) of the estimated model was statistically significant at 1%. This indicates a good fit and the correctness of the distributional form assumed for the composite error term. The estimate of the variance parameter gamma γ was positive and significantly different from zero, implying that the inefficiency effects are significant in determining the level and the variability of output. The estimated gamma (γ) parameter of 0.944 indicates that about 94.4% of the variation in the value of farm output of sesame farmers was due to differences in their technical efficiencies.This result is consistent with the findings of

Omolehin *et al.* (2010) who revealed that about 85% variation in sesame production in Jigawa State is due to technical inefficiency.

Seed and labour were the two input factors that were insignificant in terms of explaining variation in sesame output. Farm size, fertilizer and herbicide were statistically significant at different levels of probability in terms of explaining variation in sesame output and were consistent with the a priori expectation.

Seed is the most vital and crucial input for crop production. Its insignificance effect on sesame production is in agreement with the findings of (Musaba and Bwacha, 2014)) who reported that improved seed varieties are developed and disseminated to farmers so that yields can be improved but farmers are not getting the benefits of using suchimproved seed varieties either due to low usage of improved seeds or inappropriate seeding rate.

Table 4.10: Estimate of Stochastic Production Function and Inefficiency Parameter of Sesame Production

Variables	Coefficient	Standard Error	T-Ratio
Production Models			
Constant	5.557	0.578	9.614*
Seed	0.102	0.923	0.109
Farm Size	0.582	0.162	3.597*
Fertilizer	0.106	0.064	1.649***
Herbicide	0.091	0.038	2.394**
Labour	0.102	0.109	0.927
Inefficiency Model			
Constant	0.329	0.268	1.227
Age	-0.003	0.008	-0.375
Marital Status	-0.088	0.096	-0.918
Education	0.007	0.008	0.875
Household Size	0.043	0.024	1.792***
Farming Experience	-0.031	0.018	-1.722***
Extension Service	-0.185	0.076	-2.434**

Gender	-0.032	0.079	0.405
Credit Accessibility	0.129	0.059	2.186**
Cooperative Membership	0.218	0.077	-2.833*
Diagnostic Statistics			
Sigma Squared	0.086	0.018	4.778*
Gamma	0.944	0.045	20.977*
Log Likelihood Ratio			2.484*

*p < 0.01,**p < 0.05, ***p < 0.10

An increase in labour input by 1% will decrease significantly sesame output by about 0.102 ceteris paribus. This result is consistent with the findings of Musaba *et al*. (2014)who found out that labour was insignificant because there is abundant of household labour such that any increase in labour input in maize production reduces the technical efficiency maize production in Masaiti, Zambia.

The analysis of the estimated model revealed that the coefficient of farm size (0.615) was positive and statistically significant at 1% level. The positive relationship with output conforms to *apriori* expectation suggesting that a 1 unit increase in farm size will result to a 0.615 unit increase in output. This means that there is scope for increasing output by expanding farm size. This result is in conformity with the findings of Ogundari and Ojo (2006) which revealed farm size to be significantly related to cassava output.

Fertilizer is a major land augmenting input which improves the productivity of existing land by increasing yield per unit area.The coefficient of fertilizer was positive with a value of 0.106 and statistically significant at 10% level. This implies that fertilizer is a significant factor that influences changes in output of sesame. The positive coefficient is in agreement with the expected sign and implies that as the quantity of fertilizer increases by 1 unit, output will also increases by 0.106 units; this type of relationship is however expected where the available fertilizer is efficiently applied in terms of rate along with other inputs to avoid diminishing return to fertilizer. This result is consistent with the findings of Umoh (2006) who reported that fertilizers increases crop yield in urban farming. The coefficient of herbicide was positive and significantly related to sesame output at 5%. This implies that increasing herbicide by 1% will lead to 0.091 increase in sesame output.

Production elasticities which is a measure of resource productivity was estimated to be 1.02.Its determination is necessary for the estimation of responsiveness of output to input. Sesame production among farmers exhibit increasing return to scale.Sesame production is therefore at stage one of the production surface. If all inputs turn out to be variable in the long run and are increased by 1%, the quantity of sesame output will be increased by more than 1%, *ceteris paribus*. By increasing the variable inputs, farmers would still be able to make more profits since output per variable input is expected to increase at this stage, *ceteris paribus*.

4.3.1 Determinants of technical inefficiency

The variables influencing inefficiency were specified as those relating to farmers' socio-economic characteristics. The results of the analysis of the determinants of technical inefficiency are presented in Table 4.10. Analysis of the estimated coefficients of the inefficiency variables of the efficiency model tells us the contribution of the variables to technical efficiency. Since the dependent variable of the function represents inefficiency, a positive sign of an estimated parameter implies that the associated variable has a negative effect on efficiency and a negative sign indicates the reverse. That is, a negative sign on parameter inefficiencies means that the variable reduces technical inefficiency while a positive sign increases technical inefficiency (Ajibefun and Aderinola, 2004).

Contrary to *a priori* expectation, household size had a positive coefficient and was found statistically significant at 10%. The implication is that increase in household size will increase technical inefficiency and hence decrease technical efficiency. This is consistent with the finding of Ebong *et.al* (2009) that household size have a negative impact on efficiency implying that individuals in these households act as a drain on household resources instead of a source of labour supply.

Credit was significant but positively related to technical inefficiency. This implies that farmers with access to credit in the study areas are more technically inefficient than their counterparts who have no access. This implies thatthe credit system is not responding to the needs of the farmers in terms of amount, time and repayment procedure. Secondly, the level of loan diversion and inappropriate use of funds byfarmers may also cause the service to be ineffective in reducing inefficiency.Similar results were alsoreported by Seyoum *et al.* (1998).

Farming experience was negative and significantly related to technical inefficiency. Farmers with more years of farming experience are more efficient due to their ability to acquire technical knowledge through learning on the job. The result conforms to the earlier study by Khai *et al.* (2008) who reported that farming experience leads to a better assessment of the importance and complexities of good farming decision, including efficient use of inputs.

The estimated coefficient of extension visits was negativeand significantly related with technical inefficiency. This implies that more extension contacts with extension officers tend to have significant effect on the efficiency levels of sesame farmers. The result is in agreement with the findings of Rahman (2003), who reported that extension visits increases farmers' likelihood of adopting improved agricultural technologies which will eventually increase the efficiency level of the farmers.

The coefficient of the cooperative membership was negative and significantly related to technical inefficiency, implying that farmers who belonged to cooperatives are more efficient. Membership of cooperative society provides a network connection among farmers which lead to mutual commitment. It affords the farmers access to soft loans and productive inputs such as improvedseeds and fertilizer which are better sought by group rather than individuals.

The statistical insignificance of education may be attributed to the fact that the educated farmers in the study area were probably involved in other enterprises and devoting their time to salary occupations and had less time for supervision of their farms. This finding agrees with the result of Ojo (2003) in which he observed that level of formal education attained by poultry farmers influences technical inefficiency in poultry production.

4.3.2 The Estimates of Stochastic Cost Function

The estimated parameters of the stochastic cost function are presented in Table 4.11. The results revealed that the variance of the parameter estimates, sigma squared (δ^2), was positive (0.011) and was statistically significant at 1% level of probability. Gamma (γ) coefficient was 0.836 and was also statistically significant at 1% level of probability.

The estimated gamma (γ) parameter of 0.836 implies that about 83.6% of variations in the total cost of production of sesame were due to differences in the cost efficiencies. This means that the cost inefficiency effect do make significant contributions to the cost of producing sesame in the study area.

Sesame output, cost of herbicide, costs of seed and fertilizer was positively related to total cost of sesame productionindicating that as the cost of these variables increase, total cost of production increases and vice visa. Labour cost has been omitted as a result of collinearity. The significant positive relationship between the level of output and the total cost of production implies that as the total output increases by 1 unit, total cost of production will also increase by 0.380 units. The cost of seed was positive and significantly related to total cost of production. This implies that increasing cost of seed by 1%, total cost of sesame production will increase by 0.406*ceteris paribus*.

Total cost of fertilizers also had significant and direct relationship with total cost of production at 1% implying that a unit increase in total cost of fertilizer will increase the total cost of sesame production by 0. 074. The result is consistent with the findings of Ismatul *et al*. (2013) who observed that total cost of fertilizer is significantly related total cost of paddy farming system.

Total cost of herbicide was positively and significantly related to the total cost of sesame production at 1% level of probability. Increasing total cost of herbicide by 1%, total cost of sesame production will increase by 0.106

Table 4.11: Estimate of Stochastic Cost Frontier and Inefficiency Parameter of Sesame Production

Variables	**Coefficient**	**Standard Error**	**T-Ratio**

Cost Models			
Constant	2.390	0.096	24.89*
Output	0.380	0.024	15.80*
Cost of seed	0.406	0.017	23.88*
Cost of Fertilizer	0.074	0.013	5.692*
Cost of Herbicide	0.106	0.019	5.578*
Inefficiency Model			
Constant	0.629	0.268	2.347**
Age	0.008	0.009	0.889
Marital Status	0.029	0.092	0.315
Education	-0.043	0.024	-1.792***
Household Size	-0.044	0.189	-0.233
Farming Experience	-0.078	0.031	-2.514**
Extension Service	-0.057	0.029	-1.964**
Gender	-0.008	0.079	0.101
Credit Accessibility	-0.053	0.019	-2.789*
Cooperative Membership	-0.039	0.065	-0.607
Diagnostic Statistics			
Sigma Squared	0.011	0.003	3.667*
Gamma	0.836	0.161	5.192*
Log Likelihood			253.9*

*p < 0.01,**p < 0.05, ***p < 0.10

4.3.3 Determinants of Allocative Inefficiencies

The variables influencing allocative inefficiency were specified as those relating to farmers' socio-economic characteristics and institutional variable. The results of the analysis of the determinants of allocative inefficiencies are presented in Table 4.11. Education, farming experience, access to credit and extension visit are significantly related to allocative inefficiency at different level of probability.

Level of education was found to be negative and significantly related to allocative efficiency. This implies that farmers with more years of education tend to be more efficient in resource allocation, probably due to their enhanced managerial ability. The educated farmers are able to gather, understand and use information from research and extension more easily than illiterate farmers can. Moreover, educated farmers are very likely to be less risk averse and therefore more willing to try out modern technologies. This result is in agreement with those of Bakari (2010) and Rahman *et al*. (2012) who in their independent studies found a positive relationship between education and the resource allocation of their respondents.

The coefficient of farming experience was negative and significantly related to allocative inefficiency at 5%.The negative influence implies that farmers with more years of farming experience are expected to be more efficient. It is possible that such farmers gained more farming experience through "learning by doing" and thereby becoming more efficient.

The positive and significant estimated coefficient for contact with extension workers could be attributed mainly to the information about technical aspects of crop technologies, crop price patterns, seed varieties and marketing. This translates to optimal use of resources and farm level efficiency.

The coefficient of access to credit was negative and significant at 1%. Credit availability shifts the cash constraint outwards and enables farmers to make timely purchases of those inputs which they cannot provide from their own resources. This signifies that the higher the access to credit, the more efficient the farmer became.

4.3.4 Distribution of Farm-specific Efficiency Levels among Sesame Farmers

4.3.4.1 Technical efficiency

The result of the general distribution of sesame farmers' efficiencies presented in Table 4.12 indicates that the Technical Efficiency (TE) ranged from 0.432 and 0.976 with the mean TE of 0.712. The average TE index of 0.712 suggests that an average sesame farmer in the study area still has the capacity to increase TE in sesame production by about 28.8% to achieve the maximum possible level while the most efficient one can increase output by 2.4%. It therefore shows there is efficiency gap but with scope for improvement in sesame production in the study area.These results compares favourably with the findings of Abu *et al.* (2012) and Omolehin *et al*. (2010). The sample frequency distribution indicated a clustering of TE in the region 0.61 – 0.80 efficiency ranges representing 39.44% of the respondents.

4.3.4.2 Allocative efficiency

The allocative efficiency (AE) of the sampled farmers ranged from 0.825 to 0.994 with the mean value of 0.968. None of the farmers had 100% efficiency index. This implies that if the average farmer in the sampled area were to reach AE level of its most efficient counterpart, then the average farmer could experience a cost saving of 2.62% while the most inefficient farmer suggests a gain in AE of 17%. The frequency distribution indicated that entire respondents had AE of 0.81 and above. That is, the farmers are efficient in producing predetermined quantity of sesame at the minimum cost for a given level of technology. The implication of this finding is that resources were not allocated to their best alternative uses and prices were not allowed to perform their allocative function in the use of inputs.

4.3.4.3 Economic efficiency

The estimated economic efficiencies (EE) differ substantially among the farmers and ranged from 0.422 to 0.939 with an average of 0.689. Similar finding was reported by Abu *et al*. (2012). Farmers can still reduce input cost by 31.1%, while maintaining same output or they can increase output by 31.1% while still maintaining the same input costs and technology. If the average farmer in the sample area were to reach EE level of its most efficient counterpart, then the average farmer could experience a cost saving of 26.6%. While the most inefficient farmer suggests a gain in economic efficiency of 55.1%.This demonstrates that there are available potential that farmers in the study area can still exploit to enhance the productivity and profitability of sesame through the use of available technology and resources.The frequency distribution indicates that about 29.44% of farmers had economic efficiencies between 0.41 - 0.60 while 70.66% of the respondents had EE of 0.51 and above. That is, majority of the farmers were efficient in producing at a relatively high economic efficiency.

The result above indicates that 28.8%, 3.2% and 31.1% reduction in sesame production from maximum possible (frontier) output is attributed to technical, allocative and economic inefficiencies respectively.

Table 4.12: Technical, Allocative and Economic efficiency of sesame production

Economic efficiency	Technical efficiency Frequency	Percentage	Allocative efficiency Frequency	Percentage	Economic efficiency Frequency	Percentage
≤0.40	-	-	-	-	-	-
0.41-0.60	40	22.22	-	-	53	29.44
0.61-0.80	71	39.44	-		73	40.66
0.81-1.00	69	38.33	180	100.0	54	30.00
Total	180	100	180	100	180	100
Minimum		0.432		0.825		0.422

Maximum	0.976	0.994	0.939
Mean	0.712	0.968	0.689
Standard Deviation	0.147	0.029	0.144

The second hypothesis, which states that sesame farmers' socio-economic characteristics have no significant influence on technical and allocative efficiency of sesame production, is also rejected. (Farming experience, Extension services and membership of cooperative societies) in the inefficiency model for technical (education, access to credit, farming experience and extension service) at different level of probabilities for allocative made significant contribution to the explanation of the technical and allocative inefficiency effects associated with the output of the farmers involved.

4.4 Constraints associated with Sesame Production in Benue State

Table 4.13 summarizes constraints faced by sesame farmers in the study area. The major constraints perceived by farmers in sesame production are inadequate capital, poor market pricing, lack of modern cleaning facilities, high cost and diversion of fertilizer to other crops.

Table 4.13: Sesame Production Constraints in Benue State

Constraints	**Frequency**	**Percent (%)**
Inadequate capital	145	80.5
Poor market price	138	76.7
Lack of modern cleaning facilities	133	73.9
High cost and diversion of fertilizer to other crops	127	70.5
Inadequate extension contact	90	50.0
Inadequate credit	85	47.2

Poor road	70	38.9
Weed control problem	62	34.4
Inadequate storage facility	20	11.1

Multiple responses were allowed

Majority (80.5%) of the respondents identified inadequate capital as a major constraint in sesame production implying that they are not able to acquire necessary inputs like improved seeds, herbicides and fertilizers and as such those farmers who are willing to adopt new technology or expand their farm size find it difficult to do so. Similar result was reported by Makama *et al.* (2011).

Poor market prices ranked second among the constraints faced by farmers in the study area. These farmers produce small amount of sesame resulting in weak bargaining power and low prices. Access to market information on sesame price enables farmers to negotiate with buyers from a greater position of strength. It also facilitates spatial distribution of products from rural areas to urban areas, the quantity and varieties required. This constraint affected 76.7% of the respondents. This conforms tothe findings of Tiamiyu *etal*. (2013).

About 73.9% of respondents identified lack of modern cleaning as a constraint. Most farmers thresh and dry sesame on the bare ground, this leads to unclean sesame seeds because it becomes mixed with soil. Cleaning and sorting is done manually by women using trays and the seeds are not properly cleaned thereby devaluing the output price.

Inadequate storage facility affected 11.1% of the respondents. Most of the farmers store their sesame in bags and kept in their home in different location. The finding is consistent with the finding of Tiamiyu *et al.* (2013) who reported that clean seeds who reported that clean seed are packed inside polythene (BAGCO) bags and stored in the house before selling to the buyer.

High cost of fertilizers and diversion of fertilizers to other crops was considered as a major constraint by 70.5% of the respondents. The fertilizers provided by the government is not usually made available at the right time and they resort to buying from the open market which is almost twice the government subsidized price thereby increasing the cost of production. Most of the respondents do not apply the recommended rates of fertilizers on their farmlands because they believe that only a little quantity of it is needed for sesame production as it affects the seed such that it cannot be stored for a longer period.

About 34.4% of the respondents identified weed control problem as a constraint in sesame production implying that weed is one of the major challenge to sesame farmers and this have negative effect on production because it increases costs of labour and herbicides and equally affects the performance and yield of sesame production in the study area. Similar result was reported by Abu *et al*. (2012) who identified this as constraint.

Poor road was considered a constraint by 38.9% of the sampled respondents. Most of the roads leading to their farms are inaccessible by cars especially during the rainy seasons. They have to trek a long distance carrying their produce on their heads or use wheel barrow as a means of transportation. As a result of inadequate feeder roads, this translates into high cost of transportation in moving farm produce from the rural areas.

Fifty percent (50%) of the sampled respondents identified inadequate extension contact as a major constraint affecting sesame production. The implication is that 50% of the sampled farmers are unable to get information about the state of latest agricultural technology, pest management and proper and timely use of agricultural inputs.

Among the constraint faced by sesame farmers, 47.2% identified inadequate credit as a constraint. This is the inability of farmers to have access to money from organization like banks. Money lenders,family members and friends remains the main sources of farm credit in the study area whenever there is need for emergency loan or small investment fund because they cannot meet commercial banks' criteria in terms of provision of collateral security to grant them loans. This collaborate with the findings of Mark and Sorsa (2009) who reported that producers complained that that shortage of capital and stringent conditions imposed by banks for securing loans have deterred their performance in sesame production and marketing

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

The specific objectives of the study were to describe the socio-economic characteristics of sesame producers, determine cost and returns, hence profitability of sesame production,examine the economic efficiency and to identify the challenges faced by sesame farmer.

SixLocal Government Areas were considered for the study from which three villages were randomly selected from each of the LGAs using simple random sampling technique. Primary data were used for the study and were gathered from 180 randomly selected sesame farmers using structured questionnaires. The data collected were analyzed using descriptive statistics, net farm income and stochastic frontier production function. The findings revealed that 85.6% of the farmers were males and 14.4% were females. Age ranged from 21-30 with a mean age of 37 years. Majority (90.6%) of the respondents were married with a mean household size of 8 people and engaged full time in agricultural production with average farm size of 3.13 hectares. The respondents were fairly educated with 97.8% of them having attained some form of formal schooling and only 11.1% being members of cooperative societies. The average period of experience in sesame farming was 15 years with 78.9% of the respondents having no contact with the extension agents and with only 43.9% of the respondents having access to some form of credit facility.

The net farm income analyses revealed that sesame production was a profitable venture in the study area with total variable cost of₦51,968.00per hectare with total fixed cost and gross farm income of ₦2205.25 per hectare and ₦121,435.20 per hectare resulting in a net farm income ₦67,261.95per hectare. Profitability index was estimated to be 1.24 implying that ₦1.24accrued as net income on every Naira invested.

Analysis of farmers' overall efficiency in sesame production in the study area revealed that while farm size, fertilizers and herbicides significantly influenced sesame output, cost of herbicide, output, cost of seeds and cost of fertilizers were significant in influencing cost efficiency. Average technical, allocative and economic efficiencies of the farmers were 0.712, 0.968 and 0.689 respectively indicating ample opportunity exist for farmers to increase their productivity and/or reduce total cost of production. The analysis further indicated that the presence of technical and allocative inefficiencies had effect on sesame production as depicted by the significant estimated gamma coefficient of each model and the predicted technical and allocative efficiencies within the farmers.

However, a number of constraints, such as inadequate capital,inadequate credit facilities, poor market prices, lack of modern cleaning facilities, inadequate storage facilities, high cost and diversion of fertilizers to other crops, weed control problems, inadequate extension contacts and poor network of roads were perceived by farmers to hinder sesame production in the study area.

5.2 Conclusion

Sesame production is a profitable venture in the study area. This profitability has positive implications for investment opportunities for individuals and corporate organizations and thus, household incomes. Similarly, adjustments in the production inputs such as farm size, increase and efficient utilization of fertilizers and herbicides and their cost of acquisition could lead to increased production of sesame. In the same vein, Farming experience, membership of cooperative societies, accessibility to credit, extension visits and education were significant variables that influenced efficiency. Noticeable gaps in technical, allocative and economic efficiencies could be drastically improved upon if perceived constraints such as inadequate capital, poor market and lack of modern cleaning facilities were addressed thereby contributing to the wellbeing of farmers as well as their disposable income.

5.3 Contribution of the study to knowledge

i. The study found that sesame production in the study area was profitable with a net farm income of ₦67,261.95and a return to investment of ₦1.24 per hectare.

ii. The study discovered there is significant amount of resource use inefficiency in sesame production. The mean technical efficiency index was 0.712, suggesting that farmers' output can be improved by 28.8% through efficient input combination given the existing level of technology.

iii The study discovered that the most efficient farmer can reduce cost by 6.1% and the less efficient farmer can reduce cost by of production by 57.8% to achieve the potential minimum cost level without reducing output level.

5.4 Recommendations

The following recommendations are made based on the findings of this study:

i Since cooperative association is a significant determinant of technical inefficiency, farmers should form cooperative/farmer organisation or join the existing ones as this can attract private investors , improve their access to production inputs, output markets, reduce transaction cost and enhance marketing efficiency

ii Extension service link between the farmers and extension agents should be strengthened and encouraged by the State Government through adequate funding of ADP'sand provision of incentives and better salaries for the agents. The extension agents should be properly trained and provided with all the necessary technological packages required to teach and guide farmers on improved agricultural technologies to reduce cost of production by research institute.

iii. Since lack of modern cleaning facility was a problem, commercial cleaning facilities should be provided by the private sectors, Non-Governmental Organizations and governments (federal and state) to clean the sesame seed to purity of 99% as this will put the farmers at advantage and enable them to get better prices and improve their livelihood

REFERENCES

Abera,G. (2009). Commercialization of Smallholder Farming: Determinants and Welfare Outcomes. A Cross-sectional study in Enderta District, Tigrai, Ethiopia, M.Sc. thesis, Haramaya University, 2009

Abu, G.A., Abah, D and Okpachu, S.A. (2011). Analysis of Cost and Return for Sesame Production in Nasarawa State: Implication for Sustainable Development in Nigeria. *Journal of Sustainable Development in Africa* 13(3): 238-249.

Abu, G.A., Abah, D and Ater P.I. (2012). Profit Efficiency Among Sesame Farmers in Nasarawa State, Nigeria. *Current Research Journal of Social Science,* 4(4): 261-268

Aigner, D. C., Lovell, C.A.K and Schmidt, P. (1977). Formulation and Estimation of Stochastic Frontier Production Function Models. *Journal of Econometrics,* 6: 21-31

Ajibefun, I.A and Aderinola, E.A. (2004): “Determinants of Technical Efficiency and Policy Implications in Traditional Agricultural Production: Empirical Study of Nigerian Food Crop Farmers”. Final Reportpresented at the Bi-annual Research Workshop of the African Economic Research Consortium (AERC), Nairobi, Kenya, May 29 – June 24, 41pp

Alabi, O.O., Coker, A.A., Adeola, S.S. and Madueke, I.M. (2010). Technical Efficiency in Sesame Production in Nasarawa Doma Local Government Area of Nasarawa State Nigeria: An application of Stochastic Frontier Model. *International Journal ofAgricultural and Rural Development (IJARD)* 1(1): 115-121

Alegbejo, M.D., Iwo, G.A., Abo, M.E. and Idowu, A.A. (2003). Sesame: A Potential Industrial and Export Oil Seed Crop in Nigeria. *Journal of Sustainable Agriculture*, 23(1): 23-28.

Alemu, D. and Meijerink,G.W. (2010); Sesame Traders and the ECX: An Overview with Focus onTransaction Costs and Risks, VC4PPD Report No 8, Addis Ababa.

Ali, M. (1996). Quantifying the Socio-economic Determinants of Sustainable Crop Production: AAn Application to Wheat Cultivation in the Tarui of Nepal. *J. Agric.Econ*. 14: 45-60.

Amaza, D.S., Olayemi, J. K., Adejobi, A. O., Bila, Y. and Iheanacho, I. (2002). *BaselineSocioeconomicReport: Agriculture in Borno State, Nigeria*. International Instituteof Tropical Agriculture, Ibadan,Oyo State, Nigeria.

Amaza, P. S. and Olayemi, J. K. (2002). “Analysis of Technical Efficiency in Food Crop Production in Gombe State”, *Nigeria Journal of Applied Economics Letters*, 9: 51 – 54..

Asogwa B. C, Umeh, J.C and Penda, S. T. (2011). Analysis of Economic Efficiency ofNigerian Small Scale Farmers: A Parametric Frontier Approach. *J Economic*s, 2(2): 89-98

Awoke, M.U and Okorji, C. (2004). The Determination and Analysis of Constraints in Resource Use Efficiency in Multiple Cropping System by Small-holder Farmers in Ebonyi State, Nigeria. *African Development* 29 (3): 58-60

Aye, G.C. and Oboh, V.U. (2006). Resource Use Efficiency in Rice Production in Benue State, Nigeria.Implication for Food Security and Poverty Alleviation. In: Adepoju, S.O.and Okuneye, P.B. (eds)*Technology and Agricultural Development in Nigeria.*Proceedings of the 20th Annual National Conference of Farm ManagementAssociation of Nigeria, FRIN, Jos, Nigeria. Pp 11-16

Bakari, U.M. (2010). Economics of Rice Production Under Public Sector Irrigation Scheme: A Case Studyof Gerio Irrigation Project, Yola. Unpublished Doctoral thesis , Department of AgriculturalEconomics andExtension, Abubakar Tafawa BalewaUniversity, Bauchi State.

Banker, R. D., Charnes, A. and Cooper, W. W. (1984): “Some Models for Estimating Technicaland Scale Inefficiencies in Data Envelopment Analysis”. *Management Science,* 30 (9): 1078-1092.

Baruwa, O.I. (2013). Profitability and Constraints of Pineapple Production in Osun State, Nigeria. *Journal of Horticultural Research,* 21(2): 59–64

Bauer, P. (1990).Recent Developments in the Econometric Estimation of Frontiers. *Journal ofEconometrics*, 46: 39-56.

Bedigian, D. (2010). Sesame: *The Genus Sesamum*. St. Louis: Missouri Botanical Garden. www.wikipedia.org/wiki/sesame (accessed December, 2013).

Bennet, M. (2011). Sesame Seed: A Hand Book for Farmers and Investors. Available at www.agmrc.org/media/cm/sesame_38f4324EE52CB (accessed August, 2013).

BNARDA, (1999). Benue State Agricultural and Rural Development Authority. *Annual Report*

BNARDA, (2012). Benue State Agricultural and Rural Development Authority. *Annual Report*

Borchani, C., Bebes, S., Blecker, C.H. and Attia, H. (2010). Chemical Characteristics and Oxidative Stability of Sesame Seed, Sesame Paste and Olive Oils. *Journal of AgricultureScience and Technology*, 12:585-596

Bravo-Ureta, B.E and Rieger, L. (1991). Dairy Farm Efficiency Measurement using Stochastic Frontier and Neo-classical Duality. *American Journal of Agricultural Economics,* 5:421-427

Charnes, A., Cooper, W. W. & Rhodes, E. (1978): “Measuring the Efficiency of Decision Making units’’.*European Journal of Operational Research*, 2:429-444.

Chemonics International Inc. (2002). Overview of Sesame Industry. The United State Agency for International Development (USAID)/Nigeria RAISE IQC contract No PCE-1-00-99-00003-00

Ciuci Consulting (2013). Harnessing the Potentials of Nigeria’s N86 billion Sesame Seed Market Available:http://ciuciconsultingng.blogspot.com/2013/06/harnessing-the-potentials-of-nigeria’s-N86-billion-sesame-seed-market_KS_1702131.pdf-Adobe Reader (accessed January, 2014).

Coelli, T. J. (1994). A Guide to Frontier Version 4.1c:A Computer Programme for Stochastic Frontier Production and Cost Function Estimation. *Working Paper No. 96/07*, Centre for Efficiency and Productivity Analysis, Department of Econometrics, University of New England, Armidale, Australia

Coelli, T.J. and Battese, G.E. (1996): Identification of Factors which Influence the Technical Inefficiency of Indian Farmers. *Australian Journal of Agricultural Economics,* 40(2): 103-128

Coelli, T.J., Rao, D.S.P. and Buttese, G. (1998). An Introduction to Efficiency and Productivity Analysis.Boston Kluwer Academic Publisher. Pp 198

Concept Note on Sesame Enterprise and Value Chain Management for Sustainable Agribusiness Development in Nigeria. www.nigeriamarkets.org (accessed May, 2013)

Conradie, B., Piesse, J. and Thirle, C.(2009). District-level total factor productivity in agriculture: Western Cape Province, South Africa, 1952-2002. *Agricultural Economics* 40(3), 265-280.

Debreu, G. (1951). The Coefficient of Resource Utilization. Econometrica, 19(3): 273–292.

Department of Agriculture, Forestry and Fisheries (2012). A Framework for the Development of Smallholder Farmers through Cooperative Development, South Africa. 1-8pp.

Dimelu, M. U., Okoye, A. C., Okoye, B. C., Agwu, A. E., Aniedu, O. C. and Akinpela, A. O. (2009). Determinants of Gender Efficiency of Small-holder Cocoyam Farmers in Nsukka Agriculture Zone of Enugu State. *Scientific Research and Essay,*4(1):28 - 30

Ebong, V. O., Okoro U.S and E. O. Effiong E. O. (2009). "Determinants of Technical Efficiency Of Urban Farming In Uyo Metropolis Of Akwa Ibom State, Nigeria." *Journal of Agriculture and Social Science,* 5: 89–92

El Khier, M. K. S., Ishag K.E.A and Yagoub A. E.A. (2008). Chemical Composition and OilCharacteristics of Sesame SeedCultivars Grown in Sudan. *Research Journal ofAgriculture and Biological Sciences*, 4(6): 761-766.

Ekunwe, P.A, Orewa, S.I and Emokaro, C.O. (2008). Resource Use Efficiency in Yam Production in Delta and Kogi State, Nigeria. *Asian Journal of Agricultural Research,* 2(2):61–69.

Essilfie, L. E. (2011). Estimation of Farm level Technical Efficiency in Small Scale Maize Production in the Mfantseman Municipality in the Central Region of Ghana: Astochastic frontier approach. *Journal of Development and Agricultural Economics, 3*(14): 645-654

.

FAO (2013): FAOSTAS (online) www.faostat.fao.org/site/339/default.aspx 18/06/14

FAO (2006): FAO websitewww.faostat.fao.org/site/567/DesktopDefault.aspx?pageID=564 23/06/13

Farrell, M.J. (1957). The Measurement of Production Efficiency. *Journal of the Royal Statistical Society*, 120:253- 281

Fasoranti, M. M. 2006. "A Stochastic Frontier Analysis of Effectiveness Of Cassava-Based Cropping Systems In Ondo State, Nigeria." Phd Thesis, Department of Agricultural Economics and Extension, FUTA, Akure

Hansen, R. (2011). Sesame Profile. www.agmrc.org/commodities_products/grains_oilseeds/sesame_profile.cfm (accessed March, 2013)

Hensher, M. (2001). Financing Health Systems through Efficiency Gains. *CMH Working Paper Series.* Paper No. WG3: 2pp

Idiong, I. C., Agom, D.I., Effiong, E.O., Ohen S.B. (2009). "Analysis of Technical And Economic Efficiencies In Rice Production Systems In The Niger Delta Region Of Nigeria." In *Sustaining Agricultural Growth to Meet National Economic Development Goal*. Proceedings of the 23rd Annual Conference of the Farm Management Association of Nigeria, FAMAN.

Idumah, F. O. (2006). Productivity Differentials among Food Crop Farmers in the Niger Delta. Ph.D Thesis, Department of Agricultural Economics, University of Ibadan, Ibadan, Nigeria.

Imoh, A. N. and Essien, M. U. (2005). Adoption of Improved Cassava Varieties among Small Scale Farmers in Ikot Ekpene Agricultural Zone of Akwa Ibom state, Nigeria. Proceedings of the 39th Conference of the Agricultural Society of Nigeria, Benin City, October 9 – 13.

International Institute of Tropical Agriculture (2000). IITA Annual Report, IITA Ibadan, Nigeria. pp. 19 – 30

International Food Policy Research Institute (2011).A Review of Literature on AgriculturalProductivity, Social Capital and Food Security in Nigeria.*Nigeria Strategy SupportProgram Working Paper No. 21*

Kanton, R.A.L., Yirzagla, J., Asungre, P.A., Lamini, S., Ansoba, E., Kuukaraa, C., Alebkia, M. (2013). Contribution of Plant Spacing and N Fertilizer Application to Growth and Yield of Sesame (*Sesame indicum L.*). *Journal of Advanced Agricultural Science Technology*, 1(1): 9 – 13

Kay, A.K., Edwards, W.M. and Duffy, P.A. (2008). *Farm Management*. Sixth edition McGraw Hill Companies Inc., USA.

Khai, H. V., Yabe, M., Yokogawa, H. and Sato, G. (2008): "Analysis of Productive Efficiency of Soybean Production in the Mekong River Delta of Vietnam. *J. Fac. Agr. Kyushu Univ*., 53(1): 271-279

Khaleque M.A and Begum D (1991). Area and production of Oilseed crops, 1988-90. In fifteen years of oilseed research and development in Bangladesh. AST/CIDA 28:190

Kimbonguila, A., Silou, T.H., Linder, M and Desobry, S. (2009). Chemical Composition on theSeed and Oil of Sesame (*Sesamum indicum L.*) grown in Congo-Brazzaville.*AdvancedJournal ofFood Science and Technology,* 1(1): 6-11

Koopmans, T.C. (1951). An analysis of Production as Efficient Combination of Activities. In Activity Analysis of Production and Allocation, Koopmans, T.C., eds, Cowles Commission for Research in Economics, Monograph no. 13. New York.

Kudi, T.M. (2005). Economic Analysis of Sesame Production and Marketing in Jigawa State. Unpublished Ph.D Thesis, Department of Agricultural Economics and Rural Sociology, Ahmadu Bello University, Zaria, Nigeria. 122pp

Kumbhakar, S.C. (2004). Productivity and Efficiency Measurement using Parametric Econometric Methods. *Working Paper*, State University of New York, Binghamton, New York, pp 2

Kumbhakar, S. C. (1987): "The Specification of Technical and Allocative Inefficiency inStochastic Production and Profit Frontiers". *Journal of Econometrics*, 34: 335-348.

Langham, D.R., Riney, J., Smith, G. and Wiemers, T. (2008). *Harvest Guide.*www.sesaco.net/harvest%20pamphlet%20080903%20final%20b.pdf (accessed July, 2013)

Makama, S.A., Murtala, N and Abdul, Z. (2011). Economic Analysis of Sesame Production in Taura Local Government Area, Jigawa State. *Savannah Journal of Agriculture*, 6(2): 6-12

Manyong, V.M, Ikpi, A., Olayemi, J.K., Yusuf, S., Omonona, B.T., Okoruwa, V and Idachaba,F.S. (2005). Agriculture in Nigeria: Identifying Opportunities for Increased Commercialisation and Investment. International Institute for Tropical Agriculture, Ibadan, Nigeria. 159pp

Mark, S and Sorsa, D.G. (2009).Sesame trade arrangements, costs and risks in Ethiopia:A baseline survey. Development of Cooperation, Ministry of Foreign Affairs. 65pp

Meeusen, N. and van den Broeck, J. (1977). Efficiency Estimation from Cobb-Douglas Production Function with Composed Error. *International Economic Review,* 18:435 – 444

Minot, N., Epprecht M, Anh T.T.T. and Trung L.Q (2006). Income Diversification in the Northern Upland of Vietnam research 145. International Food Policy Research Institute Washington D.C.

Musaba E and Bwacha, I. (2014).Technical Efficiency of Small Scale Maize Production in MasaitiDistrict, Zambia: A Stochastic Frontier Approach.*Journal of Economics andSustainableDevelopment*,5(4):104-111

NAERLS (2010). Beniseed Production and Utilization in Nigeria. *Extension bulletin No 154 & Horticulture series No 5*. 17/07/11. Available at www.naerls.gov.ng/extmat/bulletins/Beniseed .pdf (accessed March, 2013)

Nakyagaba, N.W., Ssekabembe C.K and Osiru, D.S.O. (2005). An overview of the agronomic constraints to simsim production in Uganda.African Crop Science Conference Proceedings, 7: 1221-1228

National Cereals Research Institute [NCRI] (2012). Modern Agronomic Practices in Sesame Production. In: *Training Manual for Sesame Stakeholders in Nigeria*. Shokalu. O. (Eds) Federal Ministry of Agriculture/NCRII, Nigeria.

Naturland (2002). Organic Farming in the Tropics and Sub-tropics: Sesame. available at www.naturland.de/fileadmin/MDB/documentss/publication/english/sesame.pdf (Accessed 21/05/13)

Nigeria's Harvest (2009). Small Seed Provide Large Income. Vol 5. October 21, 2009. www.nigeriamarkets.org./files/Nigeria%27s Harvwsting vol 5 Exporting Nigerian sesame.pdf (accessed July,2013)

Nwaru, J.C. (2004). Rural Credit Market Resource Use in Arable Crop Production in Imo State Nigeria. Unpublished Ph.D Thesis University of Agriculture Umudike, Nigeria

Nyunza.G and Mwakaje A. E.G. (2012). Analysis of Round Potato Marketing in Tanzania: The Case of Rungwe District, Tanzania. *International Journal of Business and Social Science 3 (23*):87-96

Ogen, O. (2003). Pattern of Economic Growth and Development in Nigeria since 1960. *In:* Arifalo, S.O. and Gboyega, A. (eds) (2003). *Essay in Nigeria Contemporary History.* Lagos First Academic Publishers.

Ogundari, K. (2006). Economic Efficiency of Food Crop Production in Ondo State of Nigeria. An M.Sc Thesis, Department of Agricultural Economics and Extension, FUTA, Akure.

Ogundari, K. and Ojo, S.O. (2006). An examination of Technical, Economic and Allocative Efficiency of Small Farmers: The Case Study of Cassava Farmers in Osun State of Nigeria. *J. Centr. Europ. Agric.,* 7(3): 423-432.

Ohajianya, D.O. and Onyenweaku, C.E. (2001). Gender and Relative Efficiency in Rice Production Systems in Ebonyi State, Nigeria; A Profit Function Analysis. *Journal of Sustainable Agriculture and Environment,* 3(2): 384 – 391

Ojo, S. O. (2003). "Productivity and Technical Efficiency of Poultry Egg Production in Nigeria". *International Journal of PoultryScience.* **2**(6):459 – 464.

OLAM (2006). OLAM Nigeria limited: Nucleus Estate Initiatives. Paper Presented at NESG Agricultural Submit, Abuja, November, 2006.

Olayemi, I.K. and Oni, S.A. (1971). Cost and Return in Peasant Cocoa Production: A Case Study of Western Nigeria. *Bulletin of Rural Economics and Sociology,* 6(2):1-15

Olowe, V.I.O. (2007). Optimum Planting Date for Sesame (*Sesame indicum* L.) in the Transition Zone of South West, Nigeria. *Agricultura Tropica et Subtropica,* 40: 156 – 153

Olukosi, J.O. and Erhabor, P.O. (1988). *Introduction to Farm Management Economics: Principles and Applications.* Agitab Publishers Limited, Zaria, Nigeria, 114pp

Oluwatosin, F. M. 2011. Measuring Technical Efficiency of Yam Farmers In Nigeria: A Stochastic Parametric Approach. *Agricultural Journals* 6(2): 40-46

Omolehin, R.A.,Usman, S. and Ahmed, B. (2010). Analysis of Technical Efficiency of Sesame Production in Jigawa State. *Savannah Journal of Agriculture,* 5:10-17

Onyibe, J. E., Abu, S. S. and Tologbonshein, E. B. (2012). The role of extension research and information dissemination in enhancing beniseed production,marketing of resource poor farmers. *Proceeding of the First Workshop onBeniseed,* held at the National cereal research institute, Badegi, Nigeria,March 3rd- 5th 1998. pp. 86-9.

Orewa, S.I. (1978). The Economics of Dry Season Tomato Production under the Cadbury Tomato Scheme in Zaria area. Unpublished M.Sc. Thesis, Ahmadu Bello University, Zaria, Nigeria.

Quan, J. (2011). A Future of Small Scale Farmers. *Science Review: SR25*, Foresight Project on Global Food and Farming Futures. University of Greenwich, London

Rahman S. (2003). Profit Efficiency among Bangladesh Rice Farmers. *Food Policy*. 28:483-503

Rahman, S.A., Ajayi, F.A. and Gabriel, J. (2005). Technical Efficiency in Sorghum Based Cropping System in Soba Area of Kaduna State Nigeria. *Journal of Research in Science and Management,* 3(1): 100-104

Rahman, K. M. M., Mia, M. I. A. and Bhuiyan, M. K. J. (2012) A StochasticFrontier Approach to Model Technical Efficiency of Rice Farmers in Bangladesh: An Empirical Analysis. *The Agriculturists10(2):9-19*

Raw Materials Research and Development Council of Nigeria [RMRDC] (2004). *Reports on Survey of Agro-Raw Materials in Nigeria*: *Beniseed*. The Raw Materials Research and Development Council of Nigeria, Garki Abuja. First Edition. 99pp.

Raw Materials Research and Development Council [RMRDC] (2004). *Survey Report of Ten Selected Agro Raw Materials in Nigeria: BENISEED* (Maiden Edition) 108pp

Sani, A., Abubakar B. Z., Yakubu, D. H., Atala, T.K and Abubakar, L. (2014)Socio-Factors Influencing Adoptionof Dual-purpose Cowpea Production Technologies in Bichi Local Government Areaof Kano State, Nigeria. *Asian Journal of Agricultural Extension,Economics & Sociology 3(4): 257-274*

Schmidt, P. & Lovell, K. (1979): "Estimating Technical and Allocative Inefficiency Relative to Stochastic Production and Cost Frontiers". *Journal of Econometrics*, 9:343-366.

Seyoum, E.T., Battese, G.E. and Fleming, E.M.(1998). Technical Efficiency and Productivity of Maize Producers in Eastern Ethiopia: A Study of Farmers within and Outside the Sasakawa – Global 2000 Project. *Journal of Agricultural Economics* 19 :341-348.

Shehu, J. F., Iyortyer, J.T., Mshelia, S.I. and Jongur, A.A.U. (2010). Determinants of Yam Productivity 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. & Okidi, J. 2001. Some aspects simsim production in northern and eastern Uganda. AfricanCrop Science Conference Proceedings **5,** 689-697

Thanassoulis, E., Portela, M. C. S. & Despić, O. (2008): "Data Envelopment Analysis: TheMathematicalProgramming Approach to Efficiency Analysis". In Fried, H. O., Lovell,K. & Schmidt, S. S. (eds.), *The Measurement of Productive Efficiency andProductivity Growth*, 251-420

Tiamiyu, S.A., Adagba, M.A. Ibrahim, P. A. and Shaahu, A. (2013). Profitability of SesameProduction and Marketing in Nigeria. Advanced Journal of Agricultural Research Vol. 1(6): 88-094,

Tunde-Akintunde, T.Y., Oke, M.O. and Akintunde, B.O. (2012). *Sesame Seed: Oilseeds.* Dr. Uduak G. Akpan (Ed.). ISBN: 978-953-51-0665-4, InTech, Available from: http://www.intechopen.com/books/oilseeds/sesameseed (accessed May, 2013)

Udoh, E.J. (2000). Land Management Resource Use Efficiency among Farmers in South Eastern Nigeria. Unpublished Ph.D Thesis, Department of Agricultural Economics University of Ibadan Nigeria.

Udoh, E.J. (2005). Technical Inefficiency in Vegetable Farms of Humid Region: An Analysis of Dry Season Farming by Urban Women in South-South Zone, Nigeria. *Journal of Agriculture and Social Science*, 1:80 – 85

Umar, H.S., Okoye, C.U and Agwale, A.O (2011).Productivity analysis of Sesame under Organic and Inorganic Fertilizer Application in Doma Local Government Area, Nasarawa State, Nigeria.*Tropical and Subtropical Agroecosystems, 14 : 405-411*

Umoh, G. (2006). Resource Use Efficiency in Urban farming: An Application of Stochastic Frontier Productions Function. *International Journal of Agriculture and Biology*, 8(1): 38 – 44

United Nation Population Fund (2013). UNPFA in Benue State. www.unpfa.org/benue.html (accessed October,2013)

USAID (2009). Package of Practices for Sesame Production. 20pp

Yakubu S. (2002) Economic Analysis of Groundnut Production in Azare Municipal, Katagum L.G.A of Bauchi State. An unpublished B. Tech. Project of Agricultural Economics and Extension Programme ATBU Bauchi pp62

Yusuf, O. (2005). Economics Analysis of Egusi Melon production in Qkehi Local Government Area of Kogi State. An M.Sc Agricultural Economics Thesis. Ahmadu Ahmadu Bello University, Zaria, Nigeria

Zerihun, J. (2012). Sesame (*Sesame indicum* L.) Crop Production in Ethiopia: Trends, Challenges and Future Prospects. *Science, Technology and Arts Research Journal*,1(3):01-07

APPENDIX I: FARMERS' RESEARCH QUESTIONNAIRE

Dear respondent,

This questionnaire will be used by a student of the Agricultural Economics Department of Ahmadu Bello University Zaria. Please tick where necessary. All information will be treated with utmost confidentiality and will strictly be used for the purpose of research. Thanks for your cooperation.

Zone……… Local government…………Village………………Questionnaire No………..

A. SOCIO-ECONOMIC CHARACTERISTICS

1. Name…………………………………………

2. Gender: Male ( ) Female ( )

3. Age (years): …………………………………..

4. Level of education

(a) No formal Education [ ]

(b) Years of Primary Education [ ]

(c) Years of Adult Education [ ]

(d) YearsSecondary of school Education [ ]

(e) Years Tertiary of Education [ ]

5. Family size (indicate the number of people depending on you for a living)………

(a) Male (b) Female

(a) 1-6 [ ] (b) 7-12 [ ] (C) 13-18 [ ] (d) 65 years and above [ ]

6. How many years of experience do you have in sesame farming……....years.

7. (a) Are you a member of any cooperative/common initiative group? Yes [ ] No [ ]

(b) If yes, how many years have you been a member………………………………..

8. What benefits did you derive as a member?

9. What is your major source of capital for sesame farming?

A .Personal savings ( ) b. Credit (borrow) ( ) c. Friends and family ( )

d. Money Lenders (Borrow) ( )

10. If you borrow, what were the sources of the credit?

a. Commercial Bank ( ) b. Nigeria Agricultural Cooperative And Rural Development banks ( )

c.Cooperative Society ( ) d. Money lenders( ) e. Friends and Family ( )

g. Others (specify)………………………………………………………………

11. How much did you borrow from these sources to finance your last production? (Fill for the source you indicated in Q.10)

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

12. Were you visited by any extension agent during the farming period? Yes [ ] No [ ]

(b) If yes, how many times? ....per year

13. What activities did the agent teach you? ....

14 What benefits were the techniques learnt to your farm? ....

………………………………………………………………………………………

……………………………………………………………………………………..

(1) B. INPUT USED Farm size (Ha)

(1) How many sesame farm plots do you have? .... Indicate and the size in the table below.

Plot NO	Plot Size (Ha)
1	
2	
3	

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

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

2					
3					

(iii). What does it cost to rent one Hectare of land per season in your village? ....……................... Naira

(II) Variable inputs (Last production Cycle)

(i) Where did you buy your seed from?

(a) ADP [ ] (b) Seed company [ ] (c) Open market [ ] (d) Others (specify)……

(ii) **Sesame seed planted**

Plot No	Quantity of seed(Kg)/ha	Cost #
1		
2		
3		

Unit: kg, bags, mudu

(iii) Fertilizer

Plot No	Fertilizer type	Quantity(Kg)/ha	Cost #
1			
2			
3			

Unit: kg, bags, mudu

iv) Herbicide

Plot No	Herbicide type	Quantity(Kg)/ha	Cost #
1			
2			
3			

Unit: liters

(v) **Labour input**

(a) **Land preparation/hectare**

Plot No	Hire Labour			Family Labour		
	No of people	No of Hours	Cost #	No of people	No of Hours	Cost#
1						
2						
3						

(b)Tractor or Plough used/hectare

Plot No	Hire Labour			Family Labour		
	No of people	No of Hours	Cost #	No of people	No of Hours	Cost#
1						
2						
3						

(c) **Planting/hectare**

Plot No	No of people	No of Hours	Cost ₦	No of people	No of Hours	Cost#

1						
2						
3						

(d) Fertilizer Application /hectare

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

(e) **Spraying/hectare**

Plot No	Hire Labour			Family Labour		
	No of people	No of Hours	Cost #	No of people	No of Hours	Cost#
1						
2						
3						

(i). How much does it cost to rent a sprayer in your village? …………

(ii).How many times did you spray your sesame farm this season? ....

(iii) Where did you buy your herbicide?

(a) Open market [ ] (b) Through cooperative [ ] (c) ADP [ ]

(d) Ministry of Agric [ ]

(f) **First weeding/hectare**

Plot No	Hire Labour			Family Labour		
	No of people	No of Hours	Cost #	No of people	No of Hours	Cost#
1						
2						
3						

(g) **Second weeding /hectare**

Plot No	Hire Labour			Family Labour		
	No of people	No of Hours	Cost #	No of people	No of Hours	Cost#
1						
2						
3						

(h) **Harvesting (Cutting)/hectare**

Plot No	**Hire Labour**			**Family Labour**		
	No of people	No of Hours	Cost #	No of people	No of Hours	Cost#
1						
2						
3						

(ii) Harvesting (threshing and winnowing)/hectare

Plot No	**Hire Labour**	**Family Labour**

	No of people	No of Hours	Cost #	No of people	No of Hours	Cost#
1						
2						
3						

(g) **Transportation of Threshed seeds**

Plot No	Hire Labour			Family Labour		
	No of people	No of Hours	Cost #/load	No of people	No of Hours	Cost#/load
1						
2						
3						

Wheel barrow, pick up van

(C) Depreciation

S/No	Type of equipment	Years of Purchase	purchase price(₦)	Years of Utilization	Resale value(₦)
1	cutlass				
2	hoe				
3	sprayer				
4	Wheel barrow				

(D) OUTPUT INFORMATION

Plot No	Quantity Cropped/Harvested/ha	Price per Kg	Value(₦)
1			
2			
3			
4			
5			

Estimate the total sales or revenue you generated from sesame farming (₦)………..

Did your family members consume any of the cropped sesame? Yes ( ) No ( )

If yes, what quantity did the family members consume? .... Kg

(E) MARKETING INFORMATION

(i) How much did you sell per Kg of sesame? (₦)

(ii) Did you sell all the sesame cropped immediately after cropping? Yes ( ) No ( )

(iii) If No, what quantity did you sell immediately after cropping?..............................Kg

(iv) How do you sell your sesame? Market ( ) On farm ( ) or both ( )

(v) if farm gate how much did you sell a basin or bag?₦

(Vi) If market, how far is the market from you? .... Km

(vii) If market, how much did you pay for transportation? ₦.......................

(F) CONSTRAINTS

(i) What are the constraints you face in sesame production and marketing? List them

…………………………………………………………………………………………
…………………………………………………………………………………………

(ii) What do you think are the possible suggestions for the constraints mentioned above?

…………………………………………………………………………………………
…………………………………………………………………………………………