PROFITABILITY AND EFFICIENCY OF YAM PRODUCTION AMONG SMALL-HOLDER FARMERS IN SELECTED LOCAL GOVERNMENT AREAS OF NIGER STATE, NIGERIA

BY

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(MSc / AGRIC / 40911 / 2012-13)

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

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ZARIA, KADUNA STATE
NIGERIA

DECEMBER, 2015

DECLARATION

I declare that this dissertation titled **"Profitability and Efficiency of Yam Production among Small-Holder Farmers in Selected Local Government Areas of Niger State, Nigeria"** has been carried out by me in the Department of Agriculture and Rural Sociology. The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this dissertation was previously presented for another degree or diploma at this or any other Institution.

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CERTIFICATION

This dissertation titled **'Profitability and Efficiency of Yam Production among Small-Holder Farmers in Selected Local Government Areas of Niger State, Nigeria'** by Man ABDULLAHI meets the regulations governing the award of the degree of Master of Science in Agricultural Economics of the Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

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I dedicate this dissertation to Almighty Allah (SWT).

ACKNOWLEDGEMENT

I am deeply grateful to Almighty Allah (SWT) for favour bestowed upon me throughout the period of my study.

My profound and unreserved gratitude goes to my supervisors: Prof B. Ahmed and Dr O. Yusuf, the Head of Department (Prof Z. Abdulsalam) and Postgraduate Coordinator (Dr M. A. Damisa) under whose careful supervision this research work was conducted. May Almighty Allah reward them. My appreciation also goes to the entire academic and non-academic staff of the Department of Agricultural Economics and Rural Sociology, Ahmadu Bello University, Zaria for their contributions.

I am sincerely grateful to my beloved parents: Alhaji B. A. Abubakar and Mrs Aishatu Usman for their support, prayers, encouragement and the special virtues they have taught me through my upbringing, especially the priority they gave to my education. Special thanks also go to my lovely wife; Fatima Salisu, brothers and sisters; Ibrahim Abdullahi, Mohammed Abdullahi, Yanda Ndagi, Fatima Abdullahi and my daughter; Aisha Abdulkadir. Finally, My appreciation to all my friends and entire colleagues, particularly Mohammed Suleiman, Rabi’u Awaisu, Abdulrahman Sani, Sani Alhaji. May Almighty Allah reward them.

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ABSTRACT

The study examined the profitability and efficiency of yam production among small-holder yam farmers in Munya, Paikoro and Suleja Local Government Areas of Niger State. Primary data were collected from 264 yam farmers selected using simple random sampling technique. The data from 2014 cropping season were collected with the aid of structured questionnaire. Data collected were analyzed using stochastic frontier production function. The maximum likelihood estimate (MLE) of the stochastic frontier model production function revealed that the inputs were under-utilized. The technical efficiency score of each respondent revealed that the most efficient farmer operated at 98% efficiency, the least was found to operate at 68% efficiency level, while the average was 90%, indicating that yam farmers still have the potential to increase the efficiency in their farming activities by 10% in the study area. The predicted allocative efficiencies differ substantially among the farmers ranging between value 0.411 and 0.979 with the mean allocative efficiency of 0.893. The yam farmer with the best and least practice had economic efficiency of 0.952 and 0.325 respectively. The mean economic efficiency was 0.807. The determinants of technical efficiency revealed that age, farm size, farming experience, extension contact and household size affect technical efficiency of the farmers. The variance parameters of the frontier production model were Sigma-squared (δ^2) and Gamma (γ) and their estimated coefficients in the study area were 0.0385 and 0.9617 respectively. The return per ₦1 invested was estimated to be ₦1.67. Hence, yam production was profitable in the study area. The major constraints were inadequate access to credit facilities, poor transportation network, pests and diseases, poor storage facility and high cost of labour. The study recommended that farmers should limit the use of agrochemicals while yam sett, fertilizer and labour that significantly affect production should be increase alongside with intensive use of farm size to boost more production.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Agriculture, a major resource based activity in terms of capital and labour utilization has the potential of increasing Nigeria's food self sufficiency (Bamire and Amujoyegbe, 2010). Statistical evidences however show that food sufficiency ratio of Nigeria has for sometime especially from (1997-2010) been less than one. Actual yield of major food crops are lower than their potential yields (Rahji, 2012). The productive yield efficiency of yam in particular was 54.1% in 1991(FOS, 1997).

Yam is, however, one of the principal root crops in Nigeria both in terms of land under cultivation and in volume and value of production. It's one of the carbohydrate foods that is nutritionally superior to most roots and tubers in terms of digestible proteins and minerals (Calcium, Magnesium and Potassium) Ebewore *et al.,* 2013. Tuber crops, such as yam has high relative value per unit of land used in its cultivation when compared with other crops particularly, the cereals (Mbah, 2010). As a food crop, yam has inherent characteristics. Firstly, it is rich in carbohydrates especially starch and has a multiplicity of end use. Secondly, it is more resistant to drought, pest and disease and tolerates different climatic and edaphic conditions (Ugwumba and Omojola, 2012).

Yam is an important source of income for all value chain participants. Yam comprised 32% of farmers' gross income from crops for farmers in eastern Nigeria. The share of the value of yam farm gate sales (31%) was second only to cassava (37%) out of the nine major food crops compared in Nigeria in 2004 (Sanusi and Salmonu, 2010). The higher nutritional quality and market value commanded by yam when compared with other crops like cassava, have encouraged greater investment by the Nigerian government and foreign donors to increase production and improve yam marketing efficiencies to enhance income and food security levels for smallholders. Main initiatives include: Yam Improvement for Income and Food Security in West Africa project and the National Root and Tuber Expansion Programme (Agbaje *et al.,* 2010).

1.2 Problem Statement

Over the years, the farm hectarage of yam production has been increasing with corresponding increases in the usage of inputs. Unfortunately, the increase in output seems not to have been commensurable with those in input usage (Jonathan and Anthony, 2012). However, the Nigerian Government made concerted efforts to encourage larger investment in the agricultural sector including product such as yam for export. In 1998, the Nigerian Government initiated an Export Promotion Incentive Scheme. Under this scheme, some staple foods including yam were delisted from the export prohibition list. In 2001, the Nigerian Government initiated the Root and Tuber Expansion Program (RTEP) to improve farmers' productivity and profits from root and tuber crops. In 2003, an export subsidy of 10% on agricultural commodities was introduced and remains in place till date (Akande and Ogundele, 2009).

Despite the government initiatives, Bamire and Amijoyegbe (2010) noted, in South Western Nigeria, that there is an increasing gap between the levels of supply and demand for yam. Also, Oladeebo and Okanlawon (2010) noted that the absolute level of yam production has remained static over a decade. This static trend may not be unconnected with production resources which are not being efficiently utilized. In order to meet the level of demand, there is need to assess the level of technical efficiency and its determinants in yam production. Previous studies carried out on food crop production in Nigeria have shown that food crop farmers have low productivity because of inefficiency in resource use (Idiong *et al.,* 2010).

High cost of seed yam was the major problem of yam production in the study area. According to Spore (2011) about 35-50% of the total cost was constituted by planting material. Consequently, there has been a decline in production over the years with area under cultivation and yam output declining (Ayanwuyi *et al.,* 2011). Meanwhile, the report of Niger State Yam Production Trend established by the Niger State Agricultural and Mechanization Development Authority from 2001 to 2012 showed that the average yam yield per hectare declined from 18.53 tonnes in 2009 to 14.12 tonnes in 2012.

It was against these problems that this study was undertaken to empirically ascertain the efficiency and profitability of yam production among small-holder farmers in the study area. In view of this, the following research questions were addressed:

i. What are the socioeconomic characteristics of yam farmers in the study area?

ii. What are the technical, allocative and economic efficiency of yam production?

iii. What are the determinants of technical efficiency in yam production?

iv. What are the costs and return in yam production? And

v. What are the constraints to yam production?

1.3 Objectives of the Study

The broad objective of the study was to examine the profitability and efficiency of yam production among small-holder farmers in Munya, Paikoro and Suleja Local Government Areas of Niger State. The specific objectives were to:

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

ii. estimate technical, allocative and economic efficiency of yam production;

iii. estimate the determinants of technical efficiency in yam production;

iv. determine the costs and return in yam production;

v. identify and describe the constraints to yam production.

1.4 Justification for the Study

As the campaign for household food security gains momentum all over the world that extreme hunger and poverty must be eradicated by year 2015, yam is one of the food crop whose production has got to be emphasized (Michael, 2011). Yam being an important food crop for at least 60 million people in West Africa, it is therefore necessary to lower its production cost and scale up its production through an efficient use of its production resources (Babaleye, 2009).

As a food crop, the place of yam in the diet of people in West Africa and in Nigeria in particular cannot be overemphasized. According to Reuben and Barau (2012) yam contributes more than 200 dietary calories per capita daily for more than 150 million people in West Africa and also an important source of income generation and trade. It is thus important that the profitability of its production be assessed. It is obvious that there is a potential for the increase in its production and much can be done to derive foreign exchange from its export (Ebewore *et al.*, 2013). In spite of this, little or no study has been conducted to assess the profitability of yam production among farmers, especially in Munya Local Government Area of Niger State (NSBS, 2012).

Boosting yam production could lead to an improvement in the food production level of the nation. This, however, requires that resources be used efficiently to achieve optimum production. Thus, it is expected that the finding of this research would help in providing information and, probably, solution to the declining productivity and yield of yam by identifying problems associated with yam production, prospects and potential areas of improvement. It is also expected that the research work will serve as a guide to farmers currently engaged in yam production to determine the actual level of their profitability and performance. Similarly the research work will be valuable to Government on the basis of rational and empirical policy formulation with respect to yam production. Finally, it is hoped that this research work will be of assistance to researchers who will identify other areas for further improvement in yam production.

1.5 Research Hypotheses

The hypotheses tested in this study are:

i. There is no significant relationship between socio-economic characteristics and technical efficiency of yam producers.

ii. There is no significant difference between the cost of production and revenue of yam producers in the study area.

CHAPTER TWO

LITERATURE REVIEW

2.1 Yam and the Nigerian Economy.

Yam serves as staple food in many tropical and even sub-tropical countries of the world. World yam production amounts to 30 million tonnes annually and 90% are grown in the yam production regions of West Africa (FAO, 2002). According to International Institute for Tropical Agriculture, Yam is grown on 5 million hectares in about 47 countries of the world with Nigeria as the leading producer (IITA, 2009). In 2005, 48.7 million tonnes of yams were produced in the world and 97% of these were in Sub-Saharan Africa and Nigeria accounted for 70% of world production grown on 2.83 million hectares of land (CGIAR; IITA, 2009). Nigeria's yam production was 34 million tonnes in 2005 and by 2006 this increased by 8% to 35.017 million tonnes. According to 2008 figure, yam production in Nigeria has nearly doubled since 1985 with Nigeria producing 36.7 million metric tonnes with value equivalent of $5.654 million annually (CBN, 2012). In perspective, the world's second and third largest producers of yam, Cote d'Ivoire and Ghana, only produced 6.9 and 4.8 metric tonnes of yam in 2008 respectively. In 2010, Nigeria produced 60% of the world's yam and was the largest contributor in Africa's "Yam Belt," a yam production area that comprises Nigeria, Ghana, Benin, Côte d'Ivoire, Central African Republic, Cameroon, and Togo that altogether produces about 92% of the world's yam (FAO, 2012). In 2011, world production figure rose to 56 million tonnes with Nigeria producing about 37.1 million tonnes representing 67% of world production (FAO, 2012). The Federal Ministry of Agriculture and Water Resources (FMA & WR, 2008) reported that all the states in the Federation produce yam.

2.2 Overview of Yam Production in Nigeria

Nigeria is ecologically diverse with various agro-ecological zones: mangrove swamps; rain forests along the coast; open woodlands and savannahs on the low plateau in the central part of the country; semi-arid plains to the north; and highlands to the east. Because of the high socio-cultural value attached yam, all farmers grow yam, though in much lower quantity in the North, since the arid climate is not well-suited for yam production. While yam is grown in all parts of the country, yam production is concentrated in the forest, derived and southern Guinea savannah agro-ecological zones in the central and southern part of the country (Fu *et al*., 2011).

The States with the highest production (Taraba, Benue and Niger) are not those with the highest yields (Nassarawa, Osun, Ekiti, Ondo and Imo). High production States have larger areas under cultivation, suggesting that yam production may be more intensive in the high yield States. The high yield States – Osun, Ekiti, and Ondo – fall in the rain forest zone which has higher levels of humidity and rainfall that are more conducive to yam growth. In most years between 1995 and 2006, the rain forest zone produced the highest yields. The highest producing States – Taraba, Benue, and Niger States – are found in the open woodland and savannah zones (Dumet and Ogunsola, 2008).

2.3 Trend of Yam Production in Niger State

Based on the Niger State Agricultural and Mechanization Development Authority (2012) data, the trend of yam production in the State particularly, the average yield can be deduced to have been fluctuating. The average yield was 11.26 tonnes per hectare in 2001 and it dropped to 8.95 tonnes in 2003. It began to increase in 2004 to 12.00 tonnes per hectare till 2009 where the average yield was highest (18.53 tonnes). It declined thereafter to 14.12 tonnes per hectare in 2012 in spite of the increased in the area harvested. This is presented in Table 2.1.

Table 2.1: Trend of Yam Production in Niger State: 2001- 2012.

Year	Area Harvested (000' Ha)	Production (000' Tons)	Yield (Tons/ha)
2001	297.15	3345.81	11.26
2002	250	2845.4	11.38
2003	249.25	2230.31	8.95
2004	245	2940	12
2005	202.251	2987.24	14.77
2006	268.2	4224.8	15.752
2007	299.55	4685.81	15.64
2008	333.29	5399.3	11.78
2009	336.6	6236	18.53
2010	343.231	6281.572	18.3
2011	358.705	6391.046	17.82
2012	382.73	5403.67	14.119

Source: NAMDA (2012)

2.4 The Yam Production Cycle

The yam plant life cycle consists of the following stages: prop-gules (true seed or tuber), emerging seedling or plantlet, mature plant, senescing plant (aging plant) and dormant tubers (Dumet and Ogunsola, 2008).

In most parts of Nigeria, farmers plant yam prop-gules (which are true seeds or saved tubers) towards the end of the dry season (February-March) and they harvest the yam at the end of the rainy season (September-October). However, in some other regions, especially in central Nigeria, farmers plant yam at the beginning of the dry season (November-December) and the yam remain dormant in the ground until the beginning of the rainy season (March-April) when they sprout (Etejere and Bhat, 1986). Yam tubers generally remain dormant for 3-6 months after planting, depending on the species, and mature 6-10 months after planting (Ibeawuchi, 2007). Yam regenerate once a year, starting when tubers break dormancy in storage which happens not long before the start of the rainy season for all yams-producing areas (Dumet and Ogunsola, 2008). Yam plants require loose, deep, free-draining soil to allow proper root formation and penetration. Although yam can be grown on flat soil, in holes, or on ridges, yam in Nigeria is traditionally planted on mounds. Yam is usually the first crop to be planted on newly cleared land due to the crops' high fertility requirement (Ibeawuchi, 2007).

2.5 Yam Varieties Grown and their Uses

The most cultivated species of yam (*Dioscorea sp*.) are white yam (*Dioscorea rotundata*), Guinea yam (*Dioscorea cayenesis*) and water yam (*Dioscorea alata*). Species of wild yam are also sometimes collected in times of food shortage (Amusa *et al.*, 2003). Yam is cultivated for seed yam and ware yam. Ware yam is intended for consumption while seed yam is the planting material used in the field production of ware yam (Eyitayo *et al.*, 2010).

The major uses of yam are for human consumption, income generation, and for social, cultural, or religious events. Most commonly, yam is consumed fresh. The tuber is usually eaten boiled, baked, grilled or fried. *Fufu,* a popular yam dish, is stiff, gelatinous dough prepared by pounding boiled tuber pieces in a mortar. In most yam-growing areas, damaged tubers are often peeled, sliced and sun-dried soon after harvest to extend their useful life. The dried slices are generally milled into flour, which is reconstituted with water and boiled to produce *Amala*, a thick brown paste or porridge served with soup. Yam has potential to be used for industrial starch manufacturing (Osisiogu and Uzo, 2009) and yam by-products also have limited uses in pharmaceutical manufacturing (Eka, 2008). Important occasions and rituals such as marriage ceremonies, harvest festivals, and meetings are celebrated with yam products. The Igbo tribe sacrifices large yams to the yam god to guarantee strong yields and continuity of life itself. Yam is seen as the Igbo icon of masculinity, achievement, and identity and represents a man's ability to provide for his family (Korieh, 2007). Yam is also considered an indispensible component of the bride price ceremony for the Tiv, Yoruba, and Ibo tribes of Nigeria.

2.6 Trade Pattern of Yam in Nigeria

Even though Nigeria is the largest yam producer in the world, yam export levels remain low. In 2009, Nigeria only exported 0.0013% of total production quantity. Export quantities have varied significantly since 2001. According to FAO (1990), a peak of 2,000 metric tonnes in 2003, presumably due to an export subsidy on agriculture products introduced in 2003, (Akande and Ogundele, 2009) was followed by large decreases in exports, which reached a low of 78 metric tonnes in 2007. After 2007, yam export levels have increased marginally. The export value of yam follows a similar trend. However, according to a report by the Nigerian Food Export Promotion Council (NEPC) in 2009 Nigeria realized $583 million from yam exports; against $466 million in 2008 and $288 million in 2007 (Vanguard, 2009).

Nigeria exports a lower proportion and volume of yam in comparison to Yam Belt countries. Ghana and Côte d'Ivoire export a larger volume of yam than Nigeria, even with much lower total yam production. In 2009, Nigeria ranked 8th in quantity of yam exported in the world and 13th in export value (FAO, 1990). FAO does not report data about major Nigerian yam importers but Nigerian newspaper sources report that United Kingdom (Daily Independent, 2010), China, (Daily Champion, 2010) and United States are main destination countries for Nigerian yam. According to the International Institute of Tropical Agriculture's (IITA) 2011 Annual Report, Nigeria exported $27.7 million worth of yams to the United States in 2011 in order to meet the demand of West Africans living abroad (IITA, 2011). Nigeria has a long-standing trade relationship with neighbouring countries like Niger, Benin in West Africa and Cameroon, Chad, Equatorial Guinea in Central Africa. Root plants and tubers, in particular yam and cassava products, are the second largest category of products exported by Nigeria to regional partners (Soule, 2010).

The Nigerian government has adopted policies to improve agricultural development and exports with limited success (Agbaje *et al.*, 2010). Nigeria was a large net exporter of agricultural products in the 1960s; after the discovery of oil, the economy shifted toward petroleum exploitation. In 2011, an estimated 99% of Nigeria's exports were petroleum and petroleum products (USDS, 2012). The country now imports a large quantity of its food (Ajibola *et al*., 2011). However, agriculture continues to be the leading earner of foreign exchange from non-oil exports (Nwibo, 2012).

2.7 Conceptual Framework

The production function stipulates the technical relationship between inputs and output in the production process (Olayide and Heady, 1982). This function is assumed to be continuous and differentiable in mathematical terms. The concept of efficiency is concerned with the relative performance of the process used in the production process (Upton, 1996). Three types of efficiency were identified. They include: technical, allocative and economic efficiency. Measurement of efficiency according to Ogunjobi (1999) is important for the following reasons: Firstly, it is a success indicator, performance measure by which productive units are evaluated. Secondly, only by measuring efficiency and separating its effects from the effects of the production environment can one explore hypotheses concerning the sources of efficiency differentials. Identification of sources of inefficiency is important to institution of public and private agencies designed to improve performance. Thirdly, the ability to quantify efficiency provides decision makers with mechanism with which to monitor the performance of the production system or units under their control. In some cases, theory provides no guidance or provides conflicting signals concerning the impact of some phenomena on performance. In such situations, empirical measurement provides qualitative as well as quantitative evidence.

2.7.1 Technical efficiency

Technical efficiency is based on expressing the maximum amount of output obtainable from given bundles of production resources with fixed technology. It is the attainment of production goals without wastage (Amaza and Olayemi, 1999). This is regarded as estimating average production function (Olayide and Heady, 1982). This definition assumes that technical inefficiency is absent from the production frontier. Farrell (1957) suggested a method of measuring technical efficiency of a firm in an industry by estimating the production function of firms which are fully efficient (i.e. frontier production function).

2.7.2 Allocative efficiency

Allocative efficiency on the other hand relates to the degree to which a farmer utilizes inputs in optimal proportions, given the observed input prices (Coelli *et al*., 2002; Ogundari *et al.*, 2006). Russell and Young (1983) looked at Allocative efficiency (AE) as a condition that exists when resources are allocated within the firm according to market prices. In a materialistic society according to them, this will represent a desirable characteristic when market prices are a true measure of relative scarcity. This will be the case when prices are determined in perfectly competitive markets, but when prices are distorted by monopolistic influences or where some goods remain outside the market system the role of prices in resource allocation is greatly impaired. Lau and Yotopoulos (1989) stated that a farm is said to be allocatively efficient if it maximizes profit, that is, it equates its marginal product of every variable input to its corresponding opportunity cost. A farm which fails to do so is said to be allocatively inefficient.

2.7.3 Economic efficiency (EE)

Economic efficiency in Farrell's frame work, is an overall performance measure and is equal to the product of Technical Efficiency (TE) and Allocative efficiency (AE) i.e. EE = TE ´ AE. The simultaneous achievement of both efficient conditions according to Heady (1952) occurs when price relationship are employed to denote maximum profits for the firm or when the choice indicators are employed to denote the maximization of other economic objectives.

According to Adesina and Djato (1997) economic efficiency occurs when a firm chooses resources and enterprises in such a way as to attain economic optimum. The optimum implies that a given resource is considered to be most efficiently used when its marginal value productivity is just sufficient to offset its marginal cost. Thus, economic efficiency refers to the choice of the best combination for a particular level of output which is determined by both input and output prices.

2.8 Review of Analytical Tools

2.8.1 Stochastic production frontier

Following the seminal work of Farrell (1957), several empirical studies have been conducted on farm efficiency. These studies have employed several measures of efficiency. These measures have been classified broadly into three namely: i) deterministic parametric estimation ii) non-parametric mathematical programming and iii) the stochastic parametric estimation (Umoh, 2006). There are two non-parametric measures of efficiency known in literature. The first based on the work of Chava and Aliber (1983) and Chava and Cox (1988). They evaluate efficiency based on the neoclassical theories of consistency, restriction of production form and extrapolation without maintaining any hypothesis of functional forms. The second, by Farrell (1957) decomposed efficiency into technical and allocative. Fare *et al.*, (1985) extended Farrell's method by relating the restrictive assumption of constant returns to scale and of strong disposability of inputs (Llewelyn & Williams, 1996; Udoh & Akintola, 2001).

Both the parametric and non-parametric methods have been used in empirical studies of farm efficiency in several approaches. These include; the production functions, programming technique and the efficiency frontier. The frontier is concerned with the concept of maximality in which the function sets a limit to the range of possible observations (Forsund *et al.,* 1980). Thus, it is possible to observe points below the production frontier for firms producing less than the maximum possible output but, no point can lie above the production frontier, given the technology available. The frontier represents an efficient technology and any variation from it is considered inefficient.

The stochastic frontier modelling is becoming increasingly popular among production economists because of its flexibility and the ease with which it can be used to relate economic concepts in modelling reality (Kolawole and Ojo, 2007). And based on this, the model was employed in this paper to provide a basis for estimating the level of efficiency and profitability in yam production using the stochastic production analysis adopted by Coelli *et al.*, (2005); Ghosh and Raychaudhuri (2010) and Amodu *et al*. (2011). The farm frontier production function can be typically specified as:

$Y_i = f(x_{ij}; ß) + v_i - u_i$ (i=1,2,......, n) 1

Where; Y_i is the output of the i^{th} firm, X_{ij} is the vector of actual j^{th} input used by i^{th} farm, ß is the vector of production coefficients to be estimated, v_i is the random variability in the production that cannot be influenced by the farmer and u_i is the deviation from maximum potential output attributable to resource use inefficiency.

The model is such that the possible production Y_i, is bounded above by the stochastic quantity, $f(X_i; ß) \exp(V_i)$ (that is when $\mu_i = 0$) hence, the term stochastic frontier. Given suitable distributional assumptions for the error terms, direct estimates of the parameters can be obtained by either the Maximum Likelihood Method (MLM) or the Corrected Ordinary Least Squares Method (COLS). However, the MLM estimator has been found to be asymptotically more efficient than the COLS (Coelli, 1995). In the context of the stochastic frontier function, the technical efficiency of an individual firm is the ratio of the observed output to the corresponding frontier output, conditional on the levels of inputs used by the firm. Thus, the technical efficiency of firm *i* is:

$TE_i = Y_i/Y^* = \exp(v_i - u_i)/\exp(v_i) = \exp(-u_i)$...2

Where; TE_i is the technical efficiency of farmer *i*, Y_i is the observed output from farm *i* and Y^* is the frontier output. TE_i ranges between 0 and 1. Maximum efficiency has a value of 1. Lower value represent less than maximum efficiency in production. The cost frontier as used by Ogundari *et al*. (2006) can be derived analytically as:

$C = f(p_i, y_i; \gamma) \exp e_i$ (i = 1,2,.........., n) 3

Where; C is the total production cost, f is the suitable functional form, P is the vector variable of input prices, y_i is the value of output, γ is the parameter to be estimated and e_i is the composite error term.

2.8.2 Net farm income

Net farm income is the difference between gross income and total cost of production (Olukosi and Erhabor, 2005). It is used to show the levels of costs and return that accrue to farmers involved in production. The technique emphasizes the costs (fixed and variable cost) and returns of any production enterprise. Olukosi and Ogungbile (1999) have examined two major categories of costs involved in crop production. These are fixed and variable cost. Fixed cost (FC) refers to those costs that do not vary with the level of production or output while variable costs (VC) refer to those costs that vary with output. The total cost (TC) is the sum of total fixed cost (TFC) and total variable cost (TVC). The model for the estimating net farm income is presented as;

$$\sum_{i=1}^{m} PyiYi - \sum_{j=1}^{m} PxjXj + \sum_{k=1}^{k} PfkFk \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 4$$

Where: Y_i is the output, Py_i is the unit price, X_j is the quantity of variable inputs (where j= 1,2,3,....,m), Px_j is the price per unit of variable inputs, F_k is the quantity of fixed inputs (where k= 1,2,3…,k), Pf_k is the unit price of inputs and $\sum$ is the summation sign.

2.9 Empirical Study

2.9.1 Stochastic production frontier approach

Several empirical applications have followed the stochastic frontier specification. The first application of the frontier model to farm level data was by Battese and Coelli (1995) who estimated deterministic and stochastic Cobb-Douglas production frontier for the economics of scale in sheep production in Australia. The variance of the farm effects was found to be in a highly significant proportion of the value of sheep production in Australia. Their study did not, however, directly address the technical efficiency of farms. Similarly, Bagi (2004) employed the stochastic frontier Cobb-Douglas production function model to investigate differences in technical efficiencies of sole and mixed enterprise farm in West Tennessee. The study found that the variability of farm effects was highly significant. The mean technical efficiency of mixed enterprise farms was found to be smaller (0.76) than for sole crop farms (0.85). The study show that mixed enterprise farms were inefficient as compare to the sole crop farms as demonstrated by their various efficiency ratios.

In Nigeria, the application of this function is a recent development. Such studies conducted in the recent times include that of Udoh (2006), Okike (2000), Amaza (2000) and Umoh (2006). Udoh used the Maximum Likelihood Estimation of the stochastic production function to examine the land management and resource use efficiency in South-Eastern Nigeria. The study found a mean output-oriented technical efficiency of 0.77 for the farmers, 0.98 for the most efficient farmers and 0.01 for the least efficient farmers. Okike's study investigated crop -livestock interaction and economic efficiency of farmers in the savannah zones of Nigeria. The study found that average economic efficiency of farmers was highest in the Low-Population-Low Market domain; Northern Guinea and Sudan Savannas ecological zones; and Crop-based Mixed Farmers farming system. Similarly, Umoh's study employed the stochastic frontier production function to analyse the resource use efficiency of urban farmers in Oyo, South-eastern Nigeria. The result shows that 65% of urban farmers were 70% technically efficient; maximum efficiency is 0.91, while minimum efficiency is 0.43.

In a study of resource-use efficiency in yam production in Ondo State, Fasasi (2006) reported inefficiency in the use of land, hired labour, family labour and investment on seed yam. They were underutilized by farmers. In another study, Ekunwe *et al*. (2008) revealed that there was underutilization of land, labour and planting materials (seed yam), as the ratio of the value of marginal product to marginal fixed cost were greater than one in both Delta and Kogi States.

Awoniyi and Omonona (2007) in a study carried out under three yam production systems (wet land, upland and combination of the two), discovered that yam setts were over-utilized in all three production system. In addition to this, family labour and fertilizers were also over-utilized in wetland production system. Ike and Inoni (2006) in their study on determinants of yam production and economic efficiency among small-holder farmers in south-eastern Nigeria, using a stochastic frontier production function, observed that farmer-specific variables such as education, farming experience and access to credits were significant factors causing inefficiency among yam producers, while labour and material inputs such as yam seed were the major factors that influenced changes in yam production.

In a study of farmers' perception of and action on resources management constraints in the yam-based system of western Nigeria, Manyong *et al.* (1998) reported that women (35% of surveyed farmers) were widely involved in yam production. Women were found more efficient in yam production than men. They observed that the major constraint in yam production were pests and diseases in both field and storage.

2.9.2 Net farm income approach

Several researchers have used net farm income as a tool for determining the profitability of production. Folorunso *et al*. (2013) examined the profitability analysis of small-holder root and tuber crop production among Root and Tuber Expansion Programme (RTEP) farmers in Plateau state using the net farm income analysis and found that RTEP farmers had an average total cost and total revenue of ₦97, 447.00/Ha and ₦225, 916.60 /Ha respectively, with an average Net farm Income of ₦128, 469.60. Also, the average total cost and total revenue for Non-RTEP farmers were ₦100,710.00/Ha, and ₦202,172.30/Ha respectively with an average net farm income of ₦91, 462.30/Ha. The result shows that RTEP farmers' total revenue and net farm income was higher than that of Non-RTEP farmers in the study areas.

Omojola and Joseph (2014) examined the Gross margin analysis and constraints to yam production in Osun State and found that the total cost of yam production in the area amounted to ₦160,228,574 with variable cost accounting for about 96.69% (₦154,927,864) and fixed costs of 3.31% (₦5,300,710) only. The production of yam generated gross margin, net farm income, mean net farm income and net return on investment values respectively of ₦152, 685, 340; ₦147, 384, 681; ₦921, 154.26 and 0.92. They concluded that, yam farming was a profitable enterprise in the study area.

CHAPTER THREE

METHODOLOGY

3.1 The Study Area

The study was conducted in Niger State. The State lies between latitudes 08^o to 11^o:30' North and longitudes 03^o 30' to 07^o 40' East. It shares borders with Zamfara State to the north, Kebbi State to the west, Kogi State to the south, Kwara State to the southwest, Kaduna State to the northeast and Federal Capital Territory to the southeast. It also has an international boundary with the Republic of Benin along Agwara and Borgu LGAs. The State covered a land area of 76,469,903 Square Kilometres of which about 85% is arable (NSBS, 2012). It has an estimated population of 3,950,249 people (NPC, 2006).

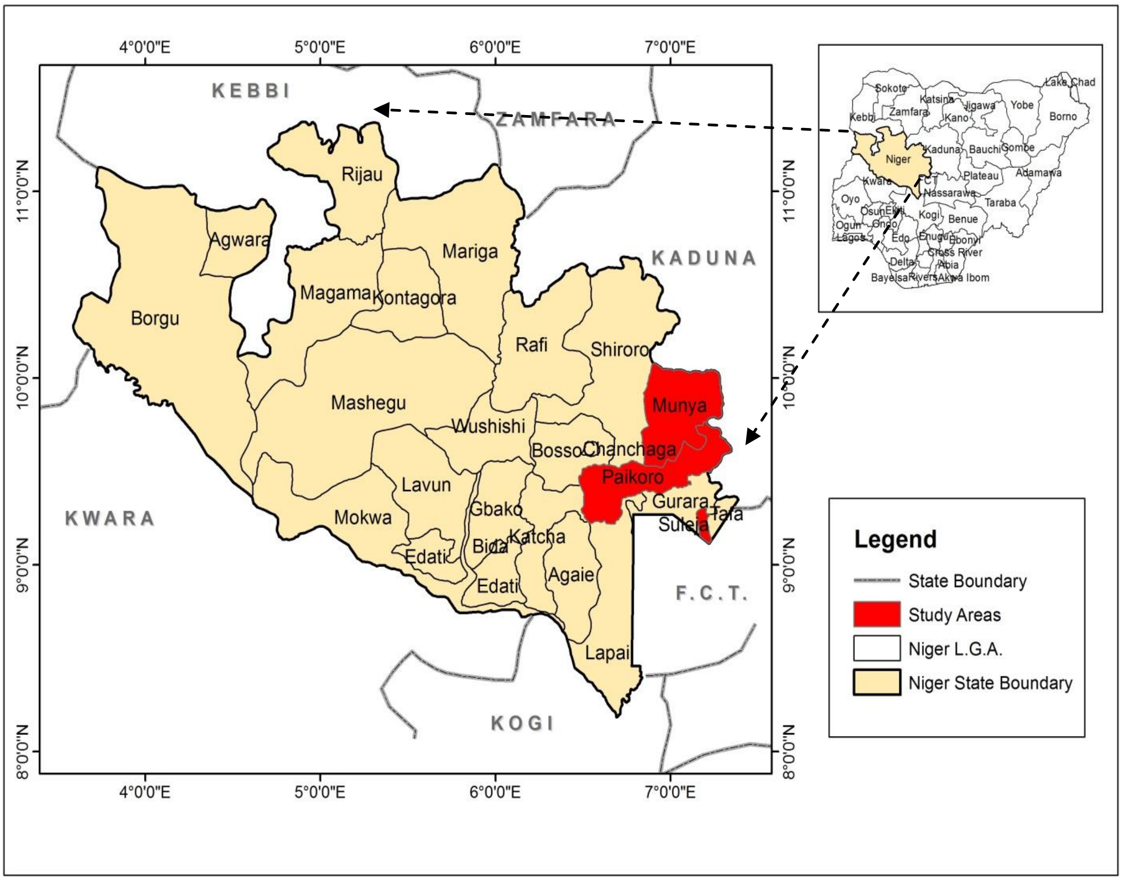

Figure 3.1: Map of Niger State showing the study areas
Source: Modified from the Map of Niger State

The State experiences distinct dry and wet seasons with annual rain fall varying from 1,100mm in the northern parts to, 600mm in the southern parts. The maximum temperature (94^{o}c) is recorded between March and June, while the minimum is between December and January. The rainy season lasts for about 150 days in the northern parts to about 120 days in the southern parts of the State. Generally, the fertile soil and hydrology of the State permits the cultivation of most of Nigeria's staple crops and still allows sufficient opportunities for grazing, water fishing and forestry (NSBS, 2012).

Majority of the populace in the State (85%) are farmers engaged in production of arable crops such as Melon, Rice, Groundnut, Yam, Cassava, Millet, Sorghum and Maize (NSBS, 2012). The soil types in the State are two: Loose soil and deep soil. The loose soil has little erosion hazards, while the deep soil has better water holding capacity. The vegetation consists mainly of short grasses, shrubs and scattered trees (NSBS, 2012).

3.2 Sampling Procedure

A multi-stage sampling technique was employed. From the reconnaissance survey conducted in the study area, 1,320 yam farmers were identified from the three selected Local Government Areas in the State. This information was obtained from Niger State Agricultural and Mechanization Development Authority Board. In the first stage, Munya, Paikoro and Suleja Local Government Areas were purposively selected from the 25 Local Government Areas in the State because of the predominance of small-holder farmers in the areas (NAMDA, 2012). In the second stage, nine villages were randomly selected, three from each Local Government Area. Finally, a simple random sampling technique was used to select 20% of the total number of yam farmers in each village. This resulted in a sample of 264 farmers from the sample frame of 1,320 farmers as shown in Table 3.1.

Table 3.1: Sample Frame and Sample Size for the Study

LGA	Village	Sample Frame	Sample Size (20%)
MUNYA:			
	Guni	197	39
	Kunchi	170	34
	Sarkin-Pawa	190	38
PAIKORO:			
	Adanu	103	21
	Gwam	159	32
	Jere	131	26
SULEJA:			
	Magajiya	140	28
	Maje	110	22
	Wambai	120	24
TOTAL	**9**	**1320**	**264**

3.3 Methods of Data Collection

The data for this study were collected from primary source only. The data were obtained using the interview method with a structured questionnaire administered among the respondents. The information collected from the respondents of yam farmers include: age, sex, number of years in farming, educational level, household size, farm size, number of extension visit, membership of associations, land renting, amount of credit received and interest charged, inputs availability and prices, source and quantity of labour. Other information collected are output and its price(s) and finally, constraints faced in yam production were also obtained from the respondents.

3.4 Analytical Techniques

The tools used for data analysis include:

- Descriptive Statistics
- Net Farm Income
- Stochastic Frontier Production

3.4.1 Descriptive statistics

Descriptive statistics such as the mean, frequency distribution, percentages, range, and ranking were used to achieve objectives i and v.

3.4.2 Net farm income

The net farm income analysis was used to achieve objective iv.

NFI= TR-TC...5

Where;

NFI= Net farm income

TR = Total revenue

TC = Total cost of production

TC = TVC+TFC...6

The model for the estimating net farm income is presented as;

$$\sum_{i_{=1}}^{m} PyiYi - \sum_{j_{=1}}^{m} PxjXj + \sum_{k_{=1}}^{k} PfkFk \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 7$$

Where;

Y_i = Output of yam (kg)

Py_i = Unit price of yam (₦)

X_j = Quantity of variable inputs (where j= 1 is labour per man day, 2= yam sett per kg, 3= fertilizer per kg, and 4= agrochemical per litre) in yam production.

Px_j = Price per unit of variable inputs in yam production (₦).

F_k = Quantity of fixed input (where k= 1 is machete in number, 2= hoe in number, 3= spade in number, 4= head pan in number, 5= rent on land) in yam production.

Pf_k= Price per unit of fixed inputs in yam production (₦).

$\sum$ = Summation sign

The fixed inputs such as machetes, hoes, spades and head pans in yam production are not normally used up in a production cycle. They were depreciated using the straight line method of depreciation given by:

$$D = \frac{P-S}{N} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 8$$

Where:

D = Depreciation (₦)

P = Purchase value of fixed input (₦)

S = Salvage value of input (₦)

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

Return per naira invested (RNI) is obtained by dividing the net farm income (NFI) over the total cost (TC). Therefore;

RNI= NFI/TC..9

Where;

RNI = Return per naira invested

NFI = Net farm income

TC = Total cost

3.4.3 Stochastic production frontier analysis.

The stochastic production function was used to achieve objective ii and iii. The stochastic production function is written as:

$Y_i = f(x_{i\,;}\,\beta) + e_i$..10

$e_i = v_i - u_i$...11

Where;

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

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

β = A vector of the parameters to be estimated

e_i = Composite error term

v_i = Random error outside farmer's control

u_i = Technical inefficiency effects

The explicit form of stochastic production frontier is specified as:

$\ln Y = \beta o + \beta_1 \ln X_1 i + \beta_2 \ln X_2 i + \beta_3 \ln X_3 i + \beta_4 \ln X_4 i + (V_i - U_i)$……...............12

Where;

ln = The natural logarithm

Y = Output of yam (kg)

βo = Constant term

β_1-β_4 = Regression coefficients

X_1 = Quantity of yam sett (kg)

X_2 = Quantity of fertilizer (kg)

X_3 = Total labour used (man day)

X_4 = Quantity of agrochemical (litres)

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

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

$U_i = \delta_0 + \delta_1 1nZ_1 + \delta_2 \ln Z_2 + \delta_3 \ln Z_3 + \delta_4 \ln Z_4 + \delta_5 \ln Z_5 + \delta_6 \ln Z_6 + \delta_7 \ln Z_7$............13

Where;

U_i = Technical effects of individual yam farmer

Z_1 = Age of farmer (years)

Z_2 = Number of years spent on formal education (years)

Z_3 = Farm size (in hectare)

Z_4 = Number of years in yam farming (years)

Z_5 = Number of extension visits (number visit)

Z_6 = Household size (number)

Z_7 = Amount of credit (in naira)

δ_0 = Constant

δ_1-δ_7 = Parameters to be estimated.

Stochastic Frontier Cost Function used in the study is specified as:

$C = f(p_i, y_i; \gamma) \exp e_i$ (i = 1,2,3,.........., n)..14

Where;

C = Represents the minimum cost associated with yam production

P_i = Vector of input prices

Y_i =Yam output

γ = Vector of parameters

ei = Composite error term

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

$\ln C = \beta_0 + \beta_1 \ln X_1 i + \beta_2 \ln X_2 i + \beta_3 \ln X_3 i + \beta_4 \ln X_4 i + (V_i + U_i)$............................15

Where;

ln = The natural logarithm

C = Total cost of yam output (₦)

X_1 = Cost of yam sett (₦)

X_2 = Cost of fertilizer (₦)

X_3 = Cost of labour (₦)

X_4 = Cost of agrochemical (₦)

β_0 = Constant term

β_1- β_4 = Regression coefficients

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

U_i = Deviation from minimum cost attributable to allocative inefficiency.

$U_i = \delta_0 + \delta_1 1nZ_1 + \delta_2 \ln Z_2 + \delta_3 \ln Z_3 + \delta_4 \ln Z_4 + \delta_5 \ln Z_5 + \delta_6 \ln Z_6 + \delta_7 \ln Z_7$...........16

Where;

U_i = Allocative effects of individual yam farmer.

Z_1 = Age of farmer (years)

Z_2 = Number of years spent on formal education (years)

Z_3 = Farm size (in hectare)

Z_4 = Number of years in yam farming (years)

Z_5 = Number of extension visits (number of visit)

Z_6 = household size (in number)

Z_7 = Amount of credit (in naira)

δ_0 = Constant

δ_1-δ_7 = Parameters to be estimated.

The *a priori* expectation was that the coefficients of the efficiency inputs X_1 to X_4 which are β_1, β_2, β_3 and β_4 should be positive (i.e. greater than zero) while the coefficients of the independent variables of the inefficiency inputs Z_1 to Z_7 (i.e. δ_1, δ_2, δ_3, δ_4, δ_5, δ_6 and δ_7) should be negative (i.e. less than zero) respectively.

Economic Efficiency

The product of technical efficiency (TE) and allocative efficiency (AE) provides the index of economic efficiency (EE).

$EE = TE * AE$………………………………………………………………...17

$TE_i = Y_i/Y^* = \exp(v_i - u_i)/\exp(v_i) = \exp(-u_i)$..18

Where;

TE_i = Technical efficiency of farmer *i*,

Y_i = Observed output from farm *i* and

Y^* = Frontier output.

$AE = Y^*/Y_i = \exp(v_i) / \exp(v_i - u_i)$..19

Where;

AE is the allocative efficiency of farmer *i*,

Y^* = Frontier output; and

Y_i = Observed output from farm *i*

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Socio-Economic Characteristics of the Respondents in the Study Area.

4.1.1 Age distribution of the respondents.

The age distribution of the respondents in the study area is presented in Table 4.1. The result revealed that about 38.6% of the respondents in the study area were within the ages of 46 – 55 years with a mean age of 47 years. This means that they are still in their active productive ages; an economic active age that can make positive contribution to agricultural production. This finding is similar to the findings of Ugwumba and Omojola, (2012) that the average age of 47 years obtained for the yam farmers in Ipao-Ekiti, Nigeria indicate that they were still in their active productive years.

Table: 4.1 Age distribution of the respondents

Variable	Frequency	Percentage
Age		
Less than 30	15	5.7
30 – 45	68	25.7
46 – 55	102	38.6
Above 55	79	30
Mean	**47**	

4.1.2 Number of years spent on formal education of the respondents.

The result in Table 4.2 revealed that about 20.8% of the respondents had no formal education, about 49.2% had only primary education, and 26.1% had secondary education while about 3.9% had tertiary education. However, altogether about 79% of the respondents had acquired one form of formal education or another. Notably, formal education is an essential tool for the adoption of modern production technologies and effective communication system that encourages increase in the productivity of any agricultural venture (Ugwumba and Omojola, 2012). Thus, with high level of literacy in the study area, yam farmers would easily adopt new technologies which could improve their levels of profits *ceteris paribus.*

Table: 4.2 Number of years spent on formal education of the respondents

Variable	Frequency	Percentage
Number of years spent on formal education		
No formal education	55	20.8
Primary	130	49.2
Secondary	69	26.1
Tertiary	10	3.9

4.1.3 Number of years in yam farming of the respondents.

The result in Table 4.3 revealed that 51.9% of the respondents had 21-30 years of farming experience with a mean of 23 years. This shows that the managerial ability of the farmers can be inferred to be reasonably good. It is of the general opinion that experience farmers would be more efficient, have a better knowledge of climatic conditions and are thus expected to run a more efficient enterprise (Oluwatayo *et al.,* 2008). This finding agrees with the findings of Izeko and Olumeze (2012). As one gets proficient in the methods of production, optimal allocation of resources is expected to be achieved. The more experienced one is the lower the profit inefficiency.

Table: 4.3 Number of years in yam farming of the respondents

Variable	Frequency	Percentage
Number of years in yam farming		
Less than 10	16	6.1
10 – 20	69	26.1
21 – 30	137	51.9
Above 30	42	15.9
Mean	**23**	

4.1.4 Number of years in cooperative association of the respondents.

The result in Table 4.4 revealed that 42.4% of the respondents did not belong to cooperative association. However, a greater percentage of the respondents (57.6%) are members of cooperative association. The average year of membership is 21 years. The effects of this result were that most of the respondents in the study area enjoy benefits such as having access to credit, market outlets, marketing information and information on new technologies accrued to co-operative societies through pooling of resources together for a better expansion, efficiency and effective management of resources, and for profit maximization. This finding is in line with Musa *et al.,* (2012) that cooperative groups ensure that their members derive benefits from the groups which they could have not derived individually.

Table: 4.4 Number of years in cooperative association of the respondents

Variable	Frequency	Percentage
Number of years in cooperative association		
No membership	112	42.4
1 – 10 years	10	3.8
11 – 20 years	40	15.2
above 20 years	102	38.6
Mean	**21**	

4.1.5 House hold size distribution of the respondents.

Table 4.5 revealed that majority (54.2%) of the respondents had family size ranging from 8-10. The average household size is 8. The implication of this is that most respondents have large families. Okoye *et al.,* (2010) and Udensi *et al.,* (2011) reported that a relatively large household size are more likely to provide more labour required for farm operations such as weed control, fertilizer application. Though large household size may not guarantee for increased labour efficiency since family which comprises mostly children of school age are always in school. Banmeke (2010) asserts that family size is an important index in any rural development intervention which can affect the outcome of such intervention.

Table: 4.5 Household size of the respondents

Variable	Frequency	Percentage
Household size		
Less than 5	13	4.9
5 – 7	61	23.1
8 – 10	143	54.2
above 10	47	17.8
Mean	**8**	

4.1.6 Sex distribution of the respondents.

The sex distribution of the respondents indicated that more males than females are involved in yam production. 229 out of the 264 respondents which represent 86.7% are males, while 13.3% are females. This may not be unconnected with the tedious nature of yam production which most females cannot contend with. The finding is in agreement with Nlerum (2012) who noted that yam production in Rivers State, Nigeria was dominated by males and it could be attributed to the energy demanding activities involved in yam production which require men who are naturally endowed with abundant strength necessary for such jobs.

4.1.7 Farm size distribution of the respondents.

Table 4.6 revealed that most of the respondents (50.8%) cultivated less than a hectare of land, while 32.9% cultivated between the ranges of 1–3 hectares. Only 15.2% of the respondents cultivated more than 3 hectares. This shows that farm sizes are relatively small. This is disadvantageous because to a large extent, farm size determines output level. The finding is in line with Kolawole and Ojo (2007) who noted that Nigerian agriculture involves small scale farmers scattered over wide expense of land areas with small holders ranging from 0.5-3.0 hectares.

Table: 4.6 Farm size distribution of respondents

Variable	Frequency	Percentage
Farm size (in hectare)		
Less than 1.0	134	50.83
1.0 – 3.0	87	32.9
3.1 – 5.0	40	15.2
Above 5	3	1.1
Mean	**2**	

4.1.8 Source of labour distribution of the respondents.

The result shows that 63.3% of the respondents used family labour while 36.7% employed hired labour. This shows that most of the respondents used family members for their farming activities. This was similar to what Rahman and Mali (2011) observed that majority of the small scale farmers are poor and usually utilize family labour.

4.1.9 Number of extension visits of the respondents.

The result in Table 4.7 shows that 41.7% of the respondents indicated that they received no visit by the extension agents, while 58.3% received at least one visit by the extension agents during the 2014/2015 farming season. This implies that majority of the respondents in the study area had access to some recent technologies on the best practices in the study area. This will greatly affect the outputs level of the yam farmers.

Table: 4.7 Number of extension visits of the respondents

Variable	Frequency	Percentage
Extension visit		
No visit	110	41.7
1– 2	94	35.6
3 – 4	60	22.7
above 4	0	0
Mean	**2**	

4.2 Efficiency of Yam Production

4.2.1 Estimated technical efficiency of the respondents

The Maximum Likelihood Estimates of the stochastic frontier production model specified in equations (12) and (13) for the parameters: β_1, β_2, β_3, and β_4 of the efficiency variables and δ_1, δ_2, δ_3, δ_4, δ_5, δ_6, δ_7 of the inefficiency variables were estimated using FRONTIER 4.1c software developed by Coelli (1996) as shown in Table 4.8

The estimates revealed that the coefficients of the resource inputs: β_1, β_2 and β_3 had positive sign, thus conformed to *a priori* expectation. β_4 was found to be negative and, thus, negates *a priori* expectation. Yam sett and labour were statistically significant at probability level ($p<0.01$); fertilizer and agrochemical were significant at ($p<0.10$) level each. However, output was found to be inelastic with respect to these inputs. Thus, an increase in any of these inputs except agrochemical will also lead to an increase, though less than proportionate in output of yam in the study area. The average technical efficiency for the respondents was 0.903 implying that, on the average, the respondents are able to obtain 90% of potential output from a given mixture of production inputs. Thus, in a short run, there is minimal scope (10%) of increasing the efficiency, by adopting the technology and techniques used by the best yam farmers.

Yam sett (β_1): the estimated coefficient was found to be 0.5159 and statistically significant at probability level ($p<0.01$) meaning that 1% increase in the quantity of yam sett *ceteris paribus* will lead to 0.5159% increase in the output of yam and vice-versa. This implies that, yam sett is an important variable input in yam production considering its high significant level and comparatively high coefficient in the study area. This finding agrees with Shehu *et al.* (2011) that yam sett is significant in yam production.

Fertilizer (β_2): the estimated coefficient was found to be 0.1394 and statistically significant at probability level ($p<0.10$). This implies that, yam production in relation to the quantity of fertilizer utilized in the study area was inelastic; meaning that 1% increase in quantity of fertilizer other things being equal will only lead to 0.1394% increase in the output level. This is in line with the finding of Michael (2011) who found the coefficient of fertilizer to be positive and significant at 10% level in his measurement of technical efficiency of yam farmers in Nigeria.

Labour (β_3): the estimated coefficient was found to be 0.3632 which is positive and statistically significant at probability level ($p<0.01$). This implies that a 1% increase in the quantity of labour *ceteris paribus*, will increase yam output by 0.3632%. This compares favourably with the finding of Rahman and Umar (2010).

Agrochemical (β_4): the estimated coefficient was -0.0171 but negative and statistically significant at probability level ($p<0.10$). This implies that 1% increase in quantity of agrochemical *ceteris paribus*, will decrease output by 0.0171%. This implies that agrochemical was over-utilized in the study area as it has a negative effect on output.

The result of the inefficiency model is contained in table 4.2. The coefficients with negative signs indicate reduction in technical inefficiencies among yam farmers, while positive signs indicate increase in technical inefficiencies. The results showed that extension visit, farming experience, farm size and age of the farmers significantly affect technical inefficiencies among yam farmers in the study area. While extension visit and farming experience were negatively related to technical inefficiencies, farm size and age of farmers were positively related and thus negate the *a priori* expectation.

Age (δ_1): the coefficient was estimated to be 0.0083 and statistically significant at probability level ($p<0.10$). Age is directly related to the technical inefficiencies and it implies that the older a farmer is, the more technical inefficient he become.

Farm Size (δ_3): The coefficient was estimated to be 0.0998 and statistically significant at probability level ($p<0.01$). The coefficient indicates a positive relation with technical inefficiencies of the farmers in the study area and implies that the larger the farm size, the higher the level of farmers' technical inefficiency.

Number of Years in Farming (δ_4): The estimated coefficient was -0.0483 and statistically significant at probability level ($p<0.01$). The coefficient indicates an inverse relation with farmers' level of technical inefficiencies and it implies that the more experienced a farmer is, the lower the level of his technical inefficiency.

Number of Extension Visits (δ_5): the estimated coefficient was -0.0598 and statistically significant at probability level ($p<0.01$). The coefficient indicates an inverse relation with farmers' level of technical inefficiencies and it implies that farmers with more number of extension visits have lower level of technical inefficiencies.

The Gamma (γ) ratio of 0.9617 which is significant at probability level ($p<0.01$) implied that about 96% variation in the output of farmers was due to differences in their technical inefficiencies. The Sigma-squared indicates the total amount of variance found in the model. Its estimated coefficient was 0.0385 and statistically significant at probability level ($p<0.01$). Thus, the result reveals that inefficiency effects were present and significant in the study area.

Table 4.8: Results of Maximum Likelihood Estimates of Stochastic Frontier Production Function of yam production

Variables	Parameters	Coefficient	standard-error	t-ratio
Production Function				
Constant	β_0	0.3526	0.0995	3.5432
Yam sett	β_1	0.5159	0.0689	7.4916***
Fertilizer	β_2	0.1394	0.0845	1.6506*
Labour	β_3	0.3632	0.0921	3.9423***
Agrochemical	β_4	-0.0171	0.0096	-1.7769*
In-efficiency model				
Constant	δ_0	0.0129	0.0994	0.1298^{NS}
Age	δ_1	0.0083	0.0049	1.6812*
Education	δ_2	-0.0067	0.0946	-0.0708^{NS}
Farm size	δ_3	0.0998	0.0096	10.3761***
Farming experience	δ_4	-0.0483	0.0042	-11.4273***
Extension visit	δ_5	-0.0598	0.0097	-6.1470***
Household size	δ_6	0.0173	0.0126	1.3773^{NS}
Amount of credit	δ_7	0.0118	0.0818	0.1443^{NS}
Variance parameters				
sigma-squared	δ^2	0.0385	0.0188	2.0481**
Gamma	γ	0.9617	0.0184	52.2650***
Mean efficiency		0.9		
Number of observations		264		

Note: ***P<0.01, **P<0.05, *P<0.10 and NS = Not Significant.

4.2.2 Estimated stochastic frontier allocative (cost) function of the respondents.

The Maximum Likelihood Estimates of the stochastic frontier allocative (cost) model specified in equations (15) and (16) for the parameters: β_1, β_2, β_3, and β_4 of the efficiency variables and δ_1, δ_2, δ_3, δ_4, δ_5, δ_6, δ_7 of the inefficiency variables were estimated using FRONTIER 4.1c software developed by Coelli (1996) as shown in Table 4.9

The estimates revealed that the coefficients of the variable cost inputs: β_1, β_2 and β_3 had positive sign, thus conformed to *a priori* expectation. β_4 was found to be negative and, thus, negates *a priori* expectation. The costs of yam sett, fertilizer and labour were statistically significant at probability level ($p<0.01$). Agrochemical was not significant. Hence, an increase in any of these significant variable cost inputs will lead to an increase, though less than proportionate in the cost of yam production in the study area. The average allocative efficiency for the respondents was 0.89 implying that, on the average, the respondents are able to achieve 89% efficiency in resources allocation to yam production.

Yam sett (β_1): The coefficient of the cost of yam sett is 0.2019 and statistically significant at probability level ($p<0.01$). The implication of this is that 1% increase in the cost of yam sett other things being equal, will give rise to 0.2019% increase in the cost of yam production in the study area. This agrees with Shehu *et al.* (2011).

Fertilizer (β_2): The coefficient of the cost of fertilizer is 0.2391 and statistically significant at probability level ($p<0.01$). The implication of this is that 1% increase in the cost of fertilizer *ceteris paribus,* will give rise to 0.2391% increase in the cost of yam production in the study area.

Labour (β_3): The coefficient of the cost of labour is 0.4145 and statistically significant at probability level ($p<0.01$). The implication of this is that 1% increase in the cost of labour *ceteris paribus,* will give rise to 0.4145% increase in the cost of yam production. Comparatively, the cost of labour is more sensitive in the allocation of resources to yam production in the study area. This is related to the finding of Izekor and Olumese (2012) that cost of labour is the most significant variable cost in yam production.

Agrochemical (β_4): The coefficient of the cost of agrochemical is -0.0632. The implication of this is that 1% increase in the cost of agrochemical *ceteris paribus,* will reduce the cost of yam production by 0.0632% but this is statistically not significant.

The result of the inefficiency model of the stochastic frontier cost function revealed that education, farming experience and extension visit were the significant variables that influenced allocative inefficiency among the respondents in the study area. The coefficients were found to be negative and thus, conformed to *a priori* expectation. The coefficients of the variables were all significant at probability level ($p<0.01$).

Education (δ_2): the estimated coefficient was -0.0195 and statistically significant at probability level ($p<0.01$). This implies that allocative inefficiency of a farmer decreases as the level of education increases as indicated by the negative sign of the coefficient. Thus, an increase in level of education by one unit will decrease farmers' allocative inefficiency by 0.0195. Education enhances producers' ability to seek and make good use of information about production inputs (Kebede, 2001).

Farming experience (δ_4): the estimated coefficient was -0.2541 and statistically significant at probability level ($p<0.01$). This implies that the more experienced a yam farmer is, the lower the level of his allocative inefficiency. The estimated coefficient implies that the allocative inefficiency of yam producer will decrease by a magnitude of 0.2541 as experience increases by one unit. This finding disagrees with the finding of Tsoho *et al.* (2012) who reported that farming experience was positively related to the technical inefficiency of dry season vegetable growers in Sokoto State, Nigeria.

Extension visit (δ_5): the estimated coefficient was -0.2541 and statistically significant at probability level ($p<0.01$). This implies that extension visit reduces the level of allocative inefficiency as indicated by the negative sign. Thus, an increase in extension visit by one unit will reduce farmers' level of allocative inefficiency by 0.2541.

The variance parameters of the frontier allocative (cost) model were represented by Sigma-squared (δ^2) and Gamma (γ). The Sigma-squared indicates the total amount of variance found in the model. Its estimated coefficient in the study area was 0.1085 and statistically significant at probability level ($p<0.01$). Gamma indicates the systematic influences that are unexplained by the allocative (cost) function. Its estimated coefficient in the study area was 0.8917 and statistically significant at probability level ($p<0.01$). This shows that, 89% of the variation in cost of yam output was as a result of the differences in allocative inefficiencies of the farmers. Thus, the result reveals that inefficiency effects were present and significant in the study area.

Table 4.9: Results of Maximum Likelihood Estimates of Frontier Allocative (Cost) Function For yam production

Variable	Parameter	Coefficient	standard-error	t-ratio
Production Function				
Constant	β_0	0.1681	0.0976	1.7224
Yam sett	β_1	0.2019	0.0535	3.7773***
Fertilizer	β_2	0.2391	0.0852	2.8059***
Labour	β_3	0.4145	0.0848	4.8895***
Agrochemical	β_4	-0.0632	0.0555	-1.1381^{NS}
In-efficiency model				
Constant	δ_0	0.0741	0.0284	2.6134
Age	δ_1	0.0053	0.0034	1.5412^{NS}
Education	δ_2	-0.0195	0.0032	-6.1072***
Farm size	δ_3	0.116	0.091	1.2741^{NS}
Farming experience	δ_4	-0.2541	0.0313	-8.1089***
Extension visit	δ_5	-0.1598	0.058	-2.7550***
Household size	δ_6	0.1303	0.1036	1.2573^{NS}
Amount of credit	δ_7	0.1718	0.1053	1.6321^{NS}
Variance parameters				
sigma-squared	δ^2	0.1085	0.0216	5.0143***
Gamma	γ	0.8917	0.0159	55.9521***
mean efficiency		0.89		
Number of observations		264		

Note: ***P<0.01, **P<0.05, *P<0.10 and NS = Not Significant.

4.2.3 Distribution of the respondents according to economic efficiency estimates.

The frequency distribution of the economic efficiency estimates for the respondents in the study area as obtained from the stochastic frontier model is presented in Table 4.10. The predicted economic efficiency (EE) differs substantially among the respondents, ranging between 0.325 and 0.952 with a mean economic efficiency of 0.807. This means that if the average farmer in the sample area were to reach the economic efficiency level of its most efficient counterpart, then the average farmer could experience a cost saving of 15 percent [i.e. 1-(80.7/95.2) x100]. The same computation for the most economically inefficient farmer suggests a gain in economic efficiency of 66 percent [i.e. 1-(32.5/95.20) x100].

4.2.4 Distribution of the respondents according to technical efficiency estimates.

The frequency distribution of the technical efficiency estimates for the respondents in the study area as obtained from the stochastic frontier model is presented in Table 4.4. It was observed from the study that the respondent with the best and least practice had technical efficiencies of 0.981 and 0.686 respectively. The mean technical efficiency was 0.903. This implies that on the average, output fell by 9.7% from the maximum possible level attainable due to inefficiency.

The study also suggests that if the average farmer in the sample area was to achieve the technical efficiency level of its most efficient counterpart, then the average farmer could realize a cost saving of 7.95 percent [i.e. 1-(90.3/98.1) x100]. A similar calculation for the most technically inefficient farmer reveals cost saving of 30 percent [i.e. 1-(68.6.5/98.1) x100]. This finding is in line with Okoye, *et al.* (2010) who observed that average cocoyam farmer in the state would enjoy cost saving of about 32.9% (1-0.65/0.97) if he or she attains the level of the most efficient producer among cocoyam producers in the study area.

4.2.5 Distribution of the respondents according to allocative efficiency estimates.

The predicted allocative efficiencies differ substantially among the respondents ranging between value 0.411 and 0.979 with the mean allocative efficiency of 0.893. This implies that if the average farmer in the sample areas was to achieve allocative efficiency level of its most efficient counterpart, then the average farmer could realize 9 percent cost saving [i.e. 1-(89.3/97.9) x100]. A similar calculation for the most allocative inefficient farmer reveals cost saving of 58 percent [i.e. 1-(41.1/97.9) x100].

Table 4.10: Frequency Distribution of Technical, Allocative and Economic Estimates from The Stochastic Frontier Model

Efficiency level	**Technical Efficiency**		**Allocative Efficiency**		**Economic Efficiency**	
	frequency	percentage	frequency	percentage	frequency	percentage
0.30 - 0.39	-	-	-	-	10	3.8
0.40 - 0.49	-	-	13	4.9	11	4.4
0.50 - 0.59	-	-	11	4.2	16	6.1
0.60 - 0.69	17	6.4	23	8.7	34	12.8
0.70 - 0.79	25	9.5	25	9.5	47	17.8
0.80 - 0.89	78	29.6	59	22.3	98	37.1
0.90 - 0.99	144	54.5	133	50.4	48	18.2
Total	264	100	264	100	264	100
Minimum	0.686		0.411		0.325	
Maximum	0.981		0.979		0.952	
Mean	0.903		0.89		0.807	

4.3 Estimates of the Determinants of Technical Efficiency

The determinants of technical efficiency of yam farmers in the study area are presented in Table 4.11. Seven variables (age, education, farm size, farming experience, extension visit, household size and amount of credit) were included in the model. The result shows that only five variables (age, farm size, farming experience, household size and extension visit) affect technical efficiency of yam producers in the study area. Age, farm size and household size were inversely related to technical efficiency of yam farmers whereas, farming experience and extension visit were directly related to technical efficiency of yam farmers. The value of gamma (γ) is estimated to be 0.5671 and it was highly significant at ($p<0.01$) level of probability. This is consistent with the theory that true γ-value should be greater than zero. This implies that 56% of random variation in the yield of the farmers was due to the farmers' inefficiency in their respective sites and not as a result of random variability. Since these factors are under the control of the farmers, reducing the influence of the effect of γ will greatly enhance the technical efficiency of the farmers and improve their yield.

Age (δ_1): the estimated coefficient of age was found to be 0.0083 and statistically significant at probability level ($p<0.10$). This implies that there was an inverse relationship between technical efficiency in yam production and the farmers' age in the study area. Thus, the older the yam farmers the less technically efficient they become. Yam farming is tedious and consumes more time. It requires someone who is energetic, hardworking and endurable like the younger farmers. Therefore, the older yam farmers were unable to give what was expected of them due to their natural inability (i.e. old age) and thereby led to a decrease in technical efficiency in the yam production as shows by the estimated coefficient of the farmers' age. A 1% increase in age of yam farmers will lead to a decrease in technical efficiency (i.e. decrease in production) by 0.0083%. This accords the finding of Kolawole and Ojo (2007) who in their study of small scale farmers in Nigeria found age to be inversely related to technical efficiency.

Farm size (δ_3): The coefficient of farm size was estimated to be positive (0.0998) and statistically significant at probability level ($p<0.01$). This implies that farm size had negative effect on farmers' technical efficiency. The inverse relationship between farm size and technical efficiency may be as a result of the fact that, given the traditional method of farming, farmers with large farm size have a lots of activities to contend with which often result in low technical efficiency. Thus, an increase of 1% in farm size will reduce farmers' technical efficiency by 0.0998% in the study area.

Farming Experience (δ_4): the estimated coefficient of farming experience was negative (-0.0483) and statistically significant at probability level ($p<0.01$). This implies that farmers with past yam production experience were more technically efficient in yam production. In other words, the farmers who have been in yam production for quite long period knew better the suitable land area where the crop can be planted, how to plant it, time of planting, weed control, fertilizer application and other resource inputs utilization than those who had just started. Therefore, as farmers' production experience increases by 1% the technical efficiency in yam production increases by 0.0483% and thereby increasing the output. This goes in line with the findings of Dengle *et al.* (2011) where farming experience was found to have negative coefficient (-0.009).

Extension visit (δ_5): the estimated coefficient was found to be -0.0598 and statistically significant at probability level ($p<0.01$). This implies that extension visit had a positive effect on technical efficiency of yam production. Therefore, farmers who received more and regular visit were better technically efficient in yam production than those who received less in the study area. Extension contact, however, could be received directly from an extension agent, experienced (yam) farmer or indirectly through the media, such as radio, television, and publications as in agricultural journals and write ups. As such, a 1% increase in extension visit, increases technical efficiency by less than proportionate margin of 0.0598%. This accords Ambali, *et al.* (2012). In their research work titled 'Analysis of Production Efficiency of Food Crop Farmers of Bank of Agriculture Loan Scheme in Ogun State' extension visit coefficient was found to be negative (-0.0464) and statistically significant at 1% level (-7.310).

Household Size (δ_2): the coefficient was estimated to be 0.0173 and statistically significant at probability level ($p<0.10$). This implies that there was a negative relationship between technical efficiency in yam production and the farmers' household size. Farmers with more household size tend to have more free hands in the farm. They use it as their farm main source of labour supply. These free hands usually do no good work (poor workmanship), because they feel that they were discharging free services to their family, as such no money is going to be paid to them after finishing, unlike if they were on hired basis. Thus, they quickly worked in the family's farm within short period, reserved energy and further moved to either their personal farms or where they can work for money. This attitude reduces technical efficiency in their family's farm. Hence, 1% increase in household size, other things being equal, will reduce technical efficiency by 0.0173% in the study area. This agrees with the findings of Amodu *et al.* (2011) who revealed household size in their study area to have positive coefficient (0.24) and statistically significant at 5% level (2.29).

Table 4.11: Results of Maximum Likelihood Estimates of Determinants of Technical Efficiency For Yam production

Variables	Parameters	Coefficient	standard-error	t-ratio
Constant	δ_0	0.0129	0.0994	0.1298
Age	δ_1	0.0083	0.0049	1.6812*
Education	δ_2	-0.0067	0.0946	-0.0708^{NS}
Farm size	δ_3	0.0998	0.0096	10.3761***
Farming experience	δ_4	-0.0483	0.0042	-11.4273***
Extension visit	δ_5	-0.0598	0.0097	-6.1470***
Household size	δ_6	0.0173	0.0097	1.7773*
Amount of credit	δ_7	-0.0118	0.0818	-0.1443^{NS}
Variance parameters				
sigma-squared	δ^2	0.4529	0.1501	3.0172***
Gamma	γ	0.5671	0.111	5.1061***
Number of observations		264		

Note: ***P<0.01, **P<0.05, *P<0.10 and NS = Not Significant.

Test of hypothesis i

The null hypothesis (H_o) which stated that there is no significant relationship between socioeconomic characteristics and technical efficiency of yam producers was tested using the result of Maximum Likelihood Estimates of Stochastic Frontier presented in Table 4.13. Based on the result, the null hypothesis is rejected because five variables (age, farm size, farming experience, extension visit and household size) out of the seven variables included in the model significantly influence technical efficiency at various levels of probability.

4.4 Costs and Return Analysis of Yam Production.

The items of cost were classified into fixed and variables cost items. The fixed cost items includes: cost of hoes, machetes, spades, head pans, interest on loan and rent on land. While the variable cost items comprised of cost of yam setts, labour, fertilizer and agrochemical. The fixed costs items were depreciated over time while the variable cost items were determined by each producer based on the quantity used for yam production at a particular price. The profitability of yam production enterprise was examined using the estimated costs and return analysis presented in Table 4.12.

The results indicated that a gross margin realized by a typical small-scale yam farmer was ₦410,269.17 per hectare. This was obtained by subtracting the total variable cost (₦172,319.55) from the total revenue (₦582,588.72). The total variable cost (₦172,319.55) per hectare in yam production was obtained by multiplying the total units of yam sett (2,150kg), labour (105.45man-days), fertilizer (187.5kg) and agrochemical (4.32litre) by the unit cost prices: (₦45), (₦451), (₦132) and (₦755) respectively. It was discovered from the study area that yam sett comprised of 44.3%, labour 21.8%, fertilizer 11.3% and agrochemical 1.5% of the total cost in yam production. The total revenue (₦582,588.72) was obtained by multiplying the total units of yam output (3664.08kg) per hectare by the unit selling price (₦159). The total fixed cost of yam production per hectare was ₦45,878.43. This was obtained by depreciating the fixed cost items using the straight line depreciation formula in equation (8). It was discovered that the total fixed cost comprised of 0.2% of hoe, 0.3% of machete, 0.4% of spade, 0.1% of head pan, 9.4% of land renting and 10.7% of interest on loan of the total cost. In all, fixed cost accounted for only 21.1% of the total cost in yam production. This implies that variable costs (78.9%) where the most important cost items in yam production in the study area compares to the fixed cost items. This agrees with the finding of Reuben and Barau (2012) who reported that yam farmers spent over 94% of the total cost of production on variable inputs. Table 4.5 further revealed that total cost of production was ₦218,197.98. This was obtained by adding the total fixed cost to total variable cost. The net farm income was ₦364,390.74. This was obtained by subtracting the total cost from the total revenue. The return per naira invested was ₦1.67. This was obtained by dividing the net farm income by the total cost. The result implies that yam production is a profitable enterprise in the study area. The economic implication of these findings is that credits granted to farmers for yam production were of benefit to both lenders and borrowers since returns were high enough to repay such credits and accrued interest.

Table 4.12: Average Costs and Return (in Naira) per Hectare for Yam Production

Variable	**Unit price (₦)**	**Total unit/ha**	**Value (₦)/ha**	**% of TC**
Yam revenue (TR)	159/kg	3664.08kg	**₦582,588.72**	
Variable Cost				
Yam sett	45/kg	2150kg	₦96,750	44.3
Labour	451/MD	105.45MD	₦47,557.95	21.8
Fertilizer	132/kg	187.5litres	₦24,750	11.3
Agrochemical	755/litre	4.32litres	₦3,261.60	1.5
Total Variable Cost (TVC)			**₦172,319.55**	**78.9**
Fixed Cost				
Land renting	10300/ha	2ha	₦20,600	9.4
Interest on loan			₦23,374	10.7
Dep. On hoe			₦360.03	0.2
Dep. On machete			₦506.27	0.3
Dep. On spade			₦781.10	0.4
Dep. On head pan			₦257.03	0.1
Total Fixed Cost (TFC)			**₦45,878.43**	**21.1**
Total Cost (TC) = (TVC + TFC)			**₦218,197.98**	**100**
Gross Margin(GM)=(TR - TVC)			**₦410,269.17**	
Net Farm Income(NFI)=(TR-TC)			**₦364,390.74**	
Return per ₦1 Invested=(NFI/TC)			**1.67**	

Source: Field Survey Data (2014). * Dep. = Depreciation, MD = man-day

Test of hypothesis ii

The null hypothesis (H_o) which stated that there is no significant difference between cost of production and revenue of yam producers was tested using the result of the paired T-test presented in Table 4.13. It reveals that calculated T-value is 17.55 and exceeds the critical value (T-critical two tails) of 1.96. Therefore H_o is rejected at probability level ($p<0.01$). The result of the analysis indicates that yam production is profitable in the study area.

Table 4.13: Difference between the Average Cost and Revenue of yam producers

Variable	Total revenue	Total cost
Mean	559215	194824
Variance	1.91E+10	7.47E+09
Observations	264	264
Pooled Variance	1.33E+10	
Hypothesized Mean Difference	0	
Df	526	
T- Stat	17.55***	
P(T<=t) one-tail	6.55E-55	
T- Critical one-tail	1.65	
P(T<=t) two-tail	1.31E-54	
T-Critical two-tail	1.96	

***P<0.01, **P<0.05 and *P<0.10

4.5 Constraints Faced by the Respondents.

The results of Table 4.14 showed that the respondents considered inadequate access to credit (33%) a major constraint and it ranked first among the identified constraints. This is so because credit is important to enhance access to inputs and marketing costs like storage and transportation. The problem of inadequate credit results in difficulty of accessing inputs like fertilizer, herbicide, insecticides, seed yams, and staking materials. Transportation (23.1%) was considered the next problem because yam is heavy and fragile, so transporting it can be difficult and costly. It is often transported manually using head pans or baskets. Difficulty in transporting yam output to market could result in low income and losses resulting from breakages and spoilage. Pest and disease (19.7%) ranked third because they are constraints to the yam farmers both on the field and when in storage. Those attacked by pest and disease result in losses reflected by fall in the price of the yam due to reduction in quality. The respondents also considered storage (15.5%) a problem because the bulky and perishability of yam requires special space for storage and this is not always available to farmers. The result is that most farmers sell their produce at low prices shortly after harvest. High cost of labour (8.7%) ranked least because family labour is used to compliment high cost of labour.

Table 4.14: Distribution of respondent according to the constraints faced in yam production.

Variable	**Frequency**	**Percentage**	**Rank**
Inadequate access to credit	87	33	1^{st}
Poor transportation network	61	23.1	2^{nd}
Pests and diseases	52	19.7	3^{rd}
Poor storage facility	41	15.5	4^{th}
High cost of labour	23	8.7	5^{th}
Total	**264**	**100**	

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

This study focused on the profitability and efficiency of yam production among small-holder farmers in selected local government area of Niger State, Nigeria. Multi stage sampling was employed. Three Local Government Areas were purposively selected. Nine villages and 264 yam farmers were randomly selected. The purpose of the study was to examine the profitability and efficiency of yam production in Munya, Paikoro and Suleja Local Government Areas of Niger State, Nigeria. To achieve this, the study came up with five main objectives. These were to: describe the socio-economic characteristics of yam farmers, estimate the technical, allocative and economic efficiency in yam production, estimate the determinants of technical efficiency, determine cost and return and to describe the constraint faced by the yam farmers in the study area. Primary data were collected from 264 yam farmers with the aid of structured questionnaire. The statistical tools used to analyze the data were descriptive statistics, stochastic production frontier model and net farm income.

The results of the socio-economic analysis shows that yam farming was dominated by male (86.7%) farmers within the age range of 46-55 years, majority of the farmers (50.83%) had farm size less than 1 hectare with at least 10 years farming experience. 58.3% of the farmers had at least one visit by the extension agent.

The stochastic frontier production function was estimated for technical, allocative and economic efficiency. It was observed from the study that yam farmer with the best and least practice had technical efficiencies of 0.981 and 0.686 respectively. The mean technical efficiency was 0.903. This implies that on the average, output fell by 9.7% from the maximum possible level attainable due to inefficiency. The predicted allocative efficiencies differ substantially among the farmers ranging between value 0.411 and 0.979 with the mean allocative efficiency of 0.893. This implies that if the average farmer in the sample area was to achieve allocative efficiency level of its most efficient counterpart, then the average farmer could realize 9 percent cost saving and the most allocative inefficient farmer could realize cost saving of 58 percent. The mean economic efficiency was 0.807. The farmer with the best practice has an economic efficiency of 0.952 while 0.325 was for the least efficient farmer. This implies that on the average, output fall by 19.3% from the maximum possible level due to inefficiency.

The average costs incurred and revenue obtained per hectare for yam farmers were estimated to determine the profitability or otherwise of yam production in the study area (table 4.6). The total revenue (TR) is ₦582,588.72 while the total cost (TVC + TFC) is ₦218197.98. The net farm income is therefore ₦364,390.74. The average rate of return on investment (return per naira invested) is ₦1.67, indicating that for every ₦1 invested in yam production in study areas, a profit of ₦1.67 kobo was made. Thus, it could be concluded that yam production in the study areas was economically viable. Finally, among the constraints identified in the study areas, the majority of the respondents attested to the fact that inadequate access to credit and poor transportation network were major constraints faced.

5.2 Conclusion

Based on the findings of the study, it can be conclude that although yam production was profitable, farmers still have the potential to increase their overall efficiency by 19% to maximize yield and profit in the study area.

5.3 Recommendations

From the findings of this study, the following recommendations were drawn:

i. Farmers should limit the use of agrochemicals while yam sett, fertilizer and labour that significantly affect production should be increase alongside with intensive use of farm size to boost more production.

ii. Extension visit significantly affect technical efficiency. Therefore farmers should intensify effort in accessing extension services. This is important so as to avoid losses that will arise in waste of farm inputs like agrochemical.

iii. Farming experience was found to have significant effect on the efficiency of the farmers. Therefore farmers should continue to engage in yam cultivation to gain more experience so that in the long-run, output and profit can be maximized.

iv. Problems of pest and diseases, transportation, storage and high cost of labour can be minimized if more farmers embraced cooperative association so that they can pool their resources together for seeking information on new technology, marketing and effective management of resources.

v. Education was found to have a significant effect on the allocative efficiency of the farmers; therefore government should also assist by improving the educational status of the farmers through adult education and literacy campaigns. Farmers should also be encouraged to register with adult/continuing education centres to improve on their education so as to minimize cost of production.

5.4 Contribution of the Study to Knowledge

i. It was revealed that yam farmers were averagely economically efficient in the study area having an economic efficiency of 81%.

ii. It was discovered that yam sett, fertilizer and labour influenced production by 51%, 14% and 36% respectively in the study area.

iii. It was found that yam production is profitable by returning ₦1.67 kobo for every ₦1.00 invested.

iv. The study discovered that about 96% variation in the output of farmers was due to differences in their technical inefficiencies.

v. It was discovered that 89% of the variation in the cost of production was as a result of the differences in allocative inefficiencies of the farmers.

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APPENDIX I: QUESTIONNAIRE

TOPIC: PROFITABILITY AND EFFICIENCY OF YAM PRODUCTION AMONG SMALL-HOLDER FARMERS IN SELECTED LOCAL GOVERNMENT AREAS IN NIGER STATE

Dear Respondent,

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

A. SOCIO –ECONOMIC CHARATERISTICS OF YAM FARMER (Last production cycle)

1. **Sex:** (a) Male [ ] (b) Female [ ]
2. **Age** (a) less than 30 years [ ] (b) 30-45 years [ ] (c) 46-55 years [ ] (d) above 55 years [ ]
3. **Level of education:** (a) No Formal Education [ ] (b) Primary School Education [ ] (c) Secondary School Education [ ] (d) Tertiary Education [ ]
4. **Household size:** (a) less than 5 [ ] (b) 5-7 [ ] (c) 8-10 [ ] (d) above 10 [ ]
5. **Farming experience** (For how long have you been in yam farming)?

   (a) Less than 10 years [ ] (b) 10-20 years [ ] (c) 21-30 years [ ] (d) above 30 years [ ]
6. **Farm size:** (a) less than 1.0 [ ] (b) 1.0-3.0 [ ] (c) 3.1 – 5.0 [ ] (d) above 5.0 [ ]
7. **Did you belong to any yam production cooperative association:** (a) Yes [ ] (b) No [ ]
8. **If yes, how long? (**a) 1-10 years [ ] (b) 11-20 years [ ] (c) above 20 years [ ]
9. **What was/were your major source(s) of capital for yam farming?** (a) Personal savings [ ] (b) Friends and family [ ] (c) cooperatives [ ] (d) commercial banks [ ]
10. **If '*Borrowing'*, how much did you borrow and the interest for last production?** Specify: (i) Amount **(₦)** ………………….... (ii) Interest rate **(%)**....................................
11. **Did any extension agent(s) visit you during production period?** (a) Yes [ ] (b) No [**]**
12. **If *yes*, how many times?** Specify.. ....
13. **Of what benefit were the techniques learnt from the agent to the success of your yam farming?** Specify...

14. B. INFORMATION ON YAM INPUTS (Last production cycle)

(i) Farm Size:

15. How many yam plots do you have? Indicate their respective size in table below:

Plot No	1	2	3	**Total**
Plot Size (Ha)				

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

	Mode of Acquisition			
Plot	Inheritance	Lease	Purchased	Borrowed
1				
2				
3				

(ii) Assuming you acquired the land through '*Lease*' for yam production last season, how much do you paid as rent? Specify (Ha/Naira)..

(iii) Variable Inputs:

- **Yam sett/seed (Kg)**

17. What quantity did you sow and how much did it cost you? *(Specify below)*

Plot No	**Quantity of sett Sowed (Bag/Kg)**	**Cost (₦)**
1		
2		
3		

- **Fertilizer**

18. Did you apply fertilizer or manure on your yam? (a) Fertilizer [ ] (b) Manure [ ]

19. What type and/or quantity of fertilizer/manure did you apply and how much did it cost you?

Plot No	**Fertilizer Type**	**Manure**	**Quantity (Kg)**	**Cost (₦)**
1				
2				
3				

❖ **Agro-chemicals:**

20. Did you apply agrochemicals on your yam? (a) Yes [ ] (b) No [ ] If yes, fill in below:

Plot No	**Agrochemical Type**	**Quantity (Liter)**	**Cost (₦)**
1			
2			
3			

❖ **Labour** *(Fill in where appropriate)*

(a) Land Preparation:

Plot No	**Hired Labour**			**Family Labour**			**Others (i.e. Tractor, Animal Traction)**	
	No of People	No of Days	Cost (₦)	No of People	No of Days	Cost (₦)	No of Days	Cost (₦)
1								
2								
3								

(b) Planting:

Plot No	**Hired Labour**			**Family Labour**			**Others (i.e. Tractor, Animal Traction)**	
	No of People	No of Days	Cost (₦)	No of People	No of Days	Cost (₦)	No of Days	Cost (₦)
1								
2								
3								

(c) Fertilizer Application:

Plot No	**Hired Labour**			**Family Labour**			**Others (i.e. Tractor, Animal Traction)**	
	No of People	No of Days	Cost (₦)	No of People	No of Days	Cost (₦)	No of Days	Cost (₦)
1								
2								
3								

(d) First Weeding:

Plot No	Hired Labour			Family Labour			Others (i.e. Tractor, Animal Traction)	
	No of People	No of Days	Cost (₦)	No of People	No of Days	Cost (₦)	No of Days	Cost (₦)
1								
2								
3								

(e) Second Weeding:

Plot No	Hired Labour			Family Labour			Others (i.e. Tractor, Animal Traction)	
	No of People	No of Days	Cost (₦)	No of People	No of Days	Cost (₦)	No of Days	Cost (₦)
1								
2								

(d) Harvesting:

Plot No	Hired Labour			Family Labour			Others (i.e. Tractor, Animal Traction)	
	No of People	No of Days	Cost (₦)	No of People	No of Days	Cost (₦)	No of Days	Cost (₦)
1								
2								
3								

C. INFORMATION ON YAM OUTPUT AND SALES (Last production cycle)

21. Specify below the total quantity of yam you harvested (produced) and sold:

Plot No	Quantity harvested (kg)	Price per unit sold **(₦)**	Total sales **(₦)**
1			
2			
3			
Total			

22. Did you sell it at the farm gate or market place? (a) farm gate [ ] (b)market place [ ]

23. If *took to the market for sale,* how much did that cost you? Specify...…………… (Naira)

24. What is your major constraint in yam production?

………………………………………...

………………………………………………………………...

....

25. Suggest possible solutions to the problem

…………………………………………………………………………………………………

…………………………………………………………………………………………………

………………………………………………………………...

26. Do you have any relevant information that you can add which was not asked earlier?

Commend……….………………………………………………………………………………

…………………………………………………………………………………………………

…………...