PROFITABILITY AND PRODUCTION EFFICIENCY OF COCOYAM (*Colocasia esculenta*) AMONG SMALL HOLDER FARMERS IN SELECTED LOCAL GOVERNMENT AREAS OF KADUNASTATE, NIGERIA

BY

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FEBRUARY, 2015

DECLARATION

I hereby declare that this thesis titled "**Profitability and Production Efficiency of Cocoyam among Small Holder Farmers in Kaduna State, Nigeria"** has been written by me and it is a record of my research work. No part of this work has been presented in any previous application for another Degree or Diploma at any institution. All citations and sources of information are duly acknowledged by means of references.

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CERTIFICATION

This thesis titled '**Profitability and Production Efficiency of Cocoyam among Small Holder Farmers in Kaduna State, Nigeria',** by Sanni Abdulrahman meets the regulations governing the award of the Degree of Master of Science, Ahmadu Bello University, Zaria, and is approved for its contribution to scientific knowledge and literary presentation.

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DEDICATION

This thesis is dedicated to Almighty Allah (SWT) who created the universe and the creator of all creatures.

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I glorify the exalted name of Almighty Allah (SWT), the cherisher and sustainer of the universe, for His mercy, assistance and protection especially for seeing me through this programme successfully. I say: "*Shukran Jazeelan Laka Yaa Rabbi.*" I specially wish to express my deep appreciation and sincere gratitude goes to my supervisors, namely Prof. S.A. Sanni and Prof. Z. Abdulsalam for their invaluable assistance, close supervision, constructive criticisms, suggestions and pieces of advice that aided the completion of this research work. May God bless you all and your families. My appreciation also goes to Dr. O. Yusuf for his support and encouragement. May Allah bless you and your family too.

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Abstract

This study was carried out in three Local Government Areas in Kaduna State, Nigeria between August and November during the 2013 cropping season. A multistage sampling technique was used in selecting respondents for this study. The first stage was purposive selection of the three Local Governments based on predominance of cocoyam production among the farmers. Secondly, nine villages were purposively selected, Three from each local government area based on their intensity of cocoyam production. Finally, a simple random sampling was employed in selecting farmers from each of the villages. Fifty percent of the sample frame (248) was used as the sample size. In all, 124 farmers were randomly selected. Descriptive statistics, net farm income and stochastic frontier production function was used in analyzing the data. The study showed that 34% of the respondents fell within the age range of 30 and 39 years. The majority of the farmers (50%) had no formal education. The household size ranged from 6-10 persons while majority of the farmers (73%) were not members of a Cooperative Society. Variables included in the model to observe the efficiency effects were age, educational status, household size, extension visit, credit and Cooperative Association. The parameters of the stochastic frontier production function were estimated simultaneously with those of the model of inefficiency effects. Results indicated that all the variables were significant ($P < 0.01$). The mean technical and allocative efficiencies were 83% and 61% respectively. Findings further revealed that none of the sampled cocoyam farms reached the frontier threshold. However, the average economic efficiency of the cocoyam farmers was 51%. Also, cooperative association was the only socio-economic variable responsible for the variation in technical efficiency of the cocoyam producers. It was therefore recommended that timely and adequate supply of fertilizer, seed and labour should be made available to farmers through e-wallet programme at affordable prices in order to enhance the production of cocoyam.

CHAPTER ONE

INTRODUCTION

1.1 Background Information

Nigeria's domestic economy is partly determined by agriculture which accounted for 40.9% of the Gross Domestic Product (GDP) in 2010 (Central Bank of Nigeria, 2011). Agriculture has been an important sector in the Nigerian economy in the past decades and is still a major sector despite the oil boom. Basically, it provides employment opportunities for the teeming population, eradicates poverty and contributes to the growth of the economy. Despite these however, the sector is still characterized by low yields, low level of inputs and limited areas under cultivation (Izuchukwu, 2011).

Root and tuber crops which are among the most important groups of staple foods in many tropical African countries (Osagie, 1998) constitutes the largest source of calories for the Nigeria population (Olaniyan *et al,*. 2001). Cassava (*Manihot esculenta*) is the most important of these crops in terms of total production, followed by yam (*Dioscorea spp*), cocoyam (*Colocasia spp and Xanthosoma spp*) and sweet potato (*Ipomoea batatas*) (Olaniyan *et al.*, 2001).

Cocoyam (*Colocasia esculenta* and *Xanthosoma mafafa* (L) Okeke) are important carbohydrate staple foods particularly in the southern and middle belt areas of Nigeria (Asumugha and Mbanaso, 2002). Nutritionally, cocoyam is superior to cassava and yam in the possession of higher protein, mineral and vitamin contents in addition to having more digestible starch (Parkinson, 1984, Splitstoesser *et al.,* 1973). Cocoyam which ranks third in importance and extent of production after yam and cassava is of major economic value in Nigeria (Udealor, *et al*., 1996). Edible cocoyam cultivated in the country is essentially species of *Colocasia spp* (Howeler *et. al.,* 1993) and *Xanthosoma*

spp. The average production figure for Nigeria was 5,068,000mt which accounts for about 37% of total world output of cocoyam (Food and Agricultural Organization, 2011). Small scale farmers, especially women who operate within the subsistence economy grow most of the cocoyam in Nigeria. The surplus of the product is supplied to the market in the rapidly growing urban centers. The bulk of the production of cocoyam is in Southern Nigeria (Enyinnia, 2001).

Olaniyan *et al*, (2001) showed that cocoyam production plays a very significant role in the socio-economic life of the farmer. According to them a large number of households grow cocoyam as a cash crop, selling at least half of their yearly production. As a food, crop cocoyam tubers are eaten in homes in various forms. They can be boiled or roasted like yam. They can also be pounded or mixed with cassava and eaten with soup.

It is highly recommended for diabetic patients; the aged, children with allergy and for other persons with intestinal disorders (Plucknet, 1970). According to Ene (1992), boiled cocoyam corms and cormels are peeled, cut up, dried and stored or milled into flour. The flour can be used for soups, biscuits, bread and puddings for beverages. The peels can also be utilized as feed for ruminants.

Skott, Best, Rosegrant and Bokanga, (2000), Observed that research on cocoyam has trailed behind that of other staples in Nigeria and other countries. Ezedinma (1987), Had earlier noted that the totality of published scientific work on cocoyam is insignificant when compared with those of rice, maize, yam and cassava. However, Skott *et. al.* (2000) asserted that it was only in the last decade that policy makers and national agricultural research systems began to show systematic interest in the crop because of concern over biodiversity. There is a declining trend in cocoyam production as well as a

shortage of its supply in domestic markets as a result of a number of technical, socio-economic and institutional constraints, which need to be addressed.

1.2 Problem Statement

Nigeria is an agrarian economy with 70% of its people dependent on agriculture (National Bureau of Statistics, 2007). The Government of Nigeria has been trying to achieve food security at both house hold and national level through its mechanized approach. Despite the importance of cocoyam, more research attention has been given to cassava and yam (IITA, 1992; Tambe, 1995).

Cocoyams farmers generally operate within the subsistence economy grow most of the cocoyam in Nigeria. Production of cocoyam has not been given priority attention in many countries probably because of its inability to earn foreign exchange and its unacceptability by the high income countries for both consumption and other purposes (Onyenweaku and Ezeh, 1987; Okoye, 2005). Most of what is produced is consumed locally (Mbanaso and Enyinnaya, 1989: Okoye, 2005). The production is labour intensive with most operations carried out manually at the traditional level.

Sagoe *et al*., (2001) observed that per capital production of the crop is on the decline and that its ecological restriction in the humid zones further compounds this. From a socio-cultural and economic point of view, the crop has a low rating and as a result, the cultivation and consumption are of secondary importance. The major cocoyam producing areas in Nigeria are located in the humid zones and the production relies on small farmers having 0.5–2.0 ha in production. The production output in Nigeria has decreased drastically during the last few years, from 32,657,440 metric tonnes in year 2011 to 28,798,000 metric tonnes in year 2012, a decrease that is mainly due to diseases, and unstable prices (FAO, 2013).

Arising from the forgoing, there is need to have a look into the production of cocoyam, one of the major roots and tuber crops in Nigeria which is fast becoming an extinction crop. This is due to the general believed that most families no longer consume it because it is not readily available for consumption even during its season, as a result of reduction in its production level. Based on these, the questions of interest in this research were the following:

(i) What are the socio-economic characteristics of cocoyam farmers?

(ii) What are the costs and returns associated with cocoyam production?

(iii) What are the technical, allocative, and economic efficiencies in cocoyam production?

(iv) What are the constraints faced by cocoyam famers in the study area?

1.3 Objectives of the Study

The broad objective of this study was to examine profitability and production efficiency of cocoyam among small holder farmers in Kaduna State, Nigeria. The specific objectives were to:

(i) describe the socio-economic characteristics of cocoyam farmers;

(ii) determine the costs and returns associated with cocoyam production;

(iii) analyze the technical, allocative, and economic efficiencies in cocoyam production and

(iv) describe the constraints faced by smallholder cocoyam famers in the study Area.

1.4 Justification for the Study

The measurement of production efficiency in agricultural production is an important issue because it gives pertinent information for making sound management decision in

resource allocation. The efficiency with which farmers uses resources and technologies available to them are imperative in Nigeria agricultural production. This has resulted in low farm income which has weakened the financial position of smallholder farmers who produce most of the crops in Nigeria, a condition that has led to poor funding of their economic activities.

This study is expected to provide valuable information on profitability and production efficiency of growing cocoyam to enable farmers consider its production as a viable option. This study focused on profitability and production efficiency of cocoyam among small holder farmers in Kaduna state. This will help farmers and other agencies by identifying problem areas for improvements. Similarly, the study will be useful to the government of Kaduna State, as a basis for rational and empirical policy formulation for cocoyam production in the State. Finally, it is hoped that this work will be of assistance to researchers who will identify other areas for further studies on cocoyam farming.

1.5 Hypotheses

i. there is no significant differences between costs and returns in cocoyam production in the study area

ii. There is no significant relationship between input and output in cocoyam production.

CHAPTER TWO

LITERATURE REVIEW

2.1 Economic Importance of Cocoyam

Cocoyam production is available all the year round, making it preferable to yam, cassava, etc. It is more resistant to drought, pests and diseases and tolerance to a variety of climatic and soil conditions on the farm. It is one of the recognized crops in Nigeria. Apart from the tuber, other parts of the cocoyam plant are of domestic significance. For instance, the leaves and petioles, may be cooked and eaten as a vegetable, taro *spp* is a valuable staple carbohydrate food, relatively easy and inexpensive to produce. It has become a staple food for most Nigerians, not only among rural people but also among the urban dwellers (Wilson, 1980). Furthermore, its roots are storable in the ground for months after they mature. Where cocoyam production system aim to produce human food, animal feed or industrial raw materials, yield is not the only objective. A further qualification of the earlier simple objective is that money is often the ultimate product which is required from the system through the sale of the crop materials. Profit from the system and an adequate return on investment are important considerations (Wilson, 1980).

Efficiency in the use of financial resources in growing crops is an important factor. This can be expanded by emphasizing the need to market the crops in such a way as to maximize returns (Harper, 1999). As noted by Zubair and Hunter (2000), the cultivation of cocoyam is not encouraging as the yield per hectare is still low. One of the reasons for the low yield may not be unconnected to dismal and little attention farmers give to cocoyam when compared with cassava and yam that are close substitute root/tuber crops. According to National Root Crop Research Institute (2003), the ignorance of the

nutritive value and diversities of the food forms from cocoyam by a large percentage of the populace is a major limiting factor to general acceptability and extensive production of the crop.

For profit efficiency of cocoyam farmers to be increased, there is need for the qualitative extension services among farmers. Their performance and interest in this respect have to be rose. Cocoyam farmers can be helped to obtain high yield through introduction of modern and effective farm technologies and improved varieties by the extension services, which bring about expected result to the farmer.

2.2 Nature of Smallholder Agriculture

To describe the nature of small holder agriculture involves having a good understanding of who the small holder farmer is. Consequently, this sub section attempts to provide a definition of small holder farmers following Machethe and Mollel (2000). Various terms are used to describe smallholder farmer. These include: “peasant farmers”, “subsistence farmers”, “small scale farmers”, “emerging farmers”, “food-deficit farmers” and “resource-poor farmers”. The main criteria often used to classify farmers as smallholder farmers by various analysts are (a) level of income of the farmers; (b) land size of the famers; (c) purpose of production etc.(Machethe and Mollel 2000).

In third world countries, smallholdings are usually farms supporting a single family with a mixture of cash crop and subsistence farming. As a country becomes more affluent and farming practices become more efficient, smallholdings may persist as legacy of historical land ownership practices and in more affluent societies smallholdings may be valued primarily for the rural lifestyle that they provide. Often the owners do not earn their livelihood from the farm (International Fund for Agricultural Development, 2011). There are an estimated 500 million smallholder farms

in the world, supporting almost 2 billion people (Christina *et al* 2013). Today some companies try to include smallholdings into their value chain. They provide them with seed, feed or fertilizer to improve their production. This model shows benefit for both parties (Bunnett, 2002).

Ted (1961), In British English usage, a smallholding is a piece of land and its adjacent living quarters for the smallholders and stabling for farm animals, on a smaller scale than that of a farm but larger than an allotment, usually under 50 acres (0.20 km^2). A Hobby farm in Australian usage is a variety of smallholding that may be as small as 2 hectares up to a self-sustaining farm size that allows the "city farmer" to have a house and a small number of animals or small crop fields or grape vines (Bunnett, 2002).

2.3 Concept of Efficiency

The decrease output of food production over the years may not only be connected with deviations of farmer's practices from technical recommendations, but also with the use of resources at sub-optimal levels which ultimately leads to technical and allocative inefficiency (Coelli and Battese, 1996). An underling premise behind much of research in efficiency is that farmers are not making efficient use of existing technology, then efforts designed to improve efficiency would be more cost-effective than introducing new technologies as a means of increasing agricultural output (Belbase and Grabowski, 1985: Huynh, 2008: Adeleke. 2008). Production efficiency has two components: technical and allocative efficiency. Technical efficiency is the extent to which the maximum possible output is achieved from a given combination of inputs or the ability of a firm to obtain maximum output from a given set of input. Allocative efficiency is the ability of a firm to use inputs in optimal proportions given their respective prices and production technology (Coelli *et al*., 1998). Technical inefficiency occurs when the level of production for the firm is less than the frontier output and it increases when

timing and methods of application of production inputs are mismanaged. Allocative inefficiency increases when the ratio of marginal products of input is not the same to the ratio of market prices (Bashkh, 2007).

2.4 Profitability Analysis

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

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

2.5 Concept of Profit Efficiency

The question of how to measure efficiency has received considerable attention in economic literature. A profit function is an extension and formalization of the production decisions taken by a farmer. According to production theory, a farmer is

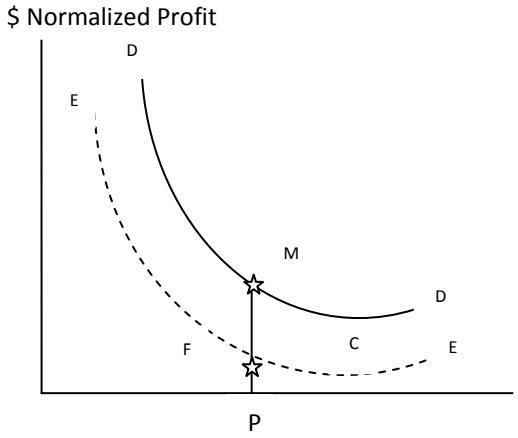
assumed to choose a combination of variable inputs and outputs that maximize profit subject to technology constraint (Sadoulet and De Janvry, 1995). Following the work of Farrell (1957), efficiency can be defined as the ability to produce a given level of output at lowest cost. The concept of efficiency has three components: technical, allocative and economic. Technical efficiency is defined as the ability to achieve a higher level of output, given similar levels of inputs. Allocative efficiency deals with the extent to which farmers make efficiency decisions by using inputs up to the level at which their marginal contribution to production value is equal to the factor cost. Technical and allocative efficiencies are components of economic efficiency (Abdulai and Huffman, 1998).

Lau and Yotopoulos (1971) and Yotopolous and Lau (1973) therefore popularized the use of the profit function approach, in which farm- specific prices and levels of fixed factors are incorporated in the analysis of efficiency. The advantage of using this approach is that input and output prices are treated as exogenous to farm household decision making, and they can be used to explain input use.

Adesina and Djato (1996) defined profit efficiency as the ability of a firm to achieve potential maximum profit, given the level of fixed factors and prices faced by the firm. Aigner *et al* (1977), however, showed that profit function models do not provided a numerical measurable of firm-specific efficiency and popularized the use of the translog production frontier approach. The stochastic frontier approach has gained popularity in firm- specific efficiency studies. Example of recent application includes (Ali and Flinn, 1989; Kumbhakar and Bhattacharyya, 1992; Ali *et al*, 1994).

Fig. 1 shows the stochastic profit frontier function adopted from Ali and Flinn (1989).The stochastic profit frontier function is an extension of incorporating farm level

prices and input used in the frontier production function. A production approach to measure efficiency may not be appropriate when farmers face different prices and have different factor endowment Ali and Flinn, (1989). Hence the use of stochastic profit functions to estimate farm specific efficiency directly (Ali and Flinn, 1989; Ali *et al*, 1994; Wang *et al*, 1996). The profit function approach combines the concepts of technical, allocative and scale inefficiency in the profit relationships and any errors in the production decision translate into lower profits or revenue for the producer (Rahman, 2003). Profit efficiency is defined as the ability of a farm to achieve highest possible profit given the prices and levels of fixed factors of that farm and profit inefficiency in this context is defined as the loss of profit from not operating on the frontier (Ali and Flinn, 1989).



Normalized input price given fixed resources Pi/Zj
Source: Ali and Flinn, 1989
Figure 1: Frontier MLE and OLS Stochastic Profit Function

In the context of frontier literature, DD in figure 1 represents profit frontier of farms in the industry (the best practice firm in the industry with the given technology). EE is the average response function (profit function) that does not take into account the farm specific inefficiencies. All farms that fall below DD are not attaining optimal profit given the prevailing input and output prices in the product and the input markets. They

are producing at allocativelly inefficient point F in relation to Min Figure 1. Profit inefficiency is defined as profit loss of not operating on the frontier. In Figure 1, a firm operating at F, is not efficient and its profit inefficiency is measured as FP/MP (Ali and Flinn, 1989; Sadoulet and De Janvry, 1995).

In agriculture, a farmer has to pay attention to relative prices of the inputs such that the production is undertaken at the point where the isoquant is tangent to isocost line. If that is not done, economic efficiency is not achieved. The farmer may be able to achieve technical efficiency but not allocative efficiency. This inefficiency could arise from a number of sources, which include access to appropriate information in a timely manner or lack of skills to take advantage of modern agricultural inputs.

Basically, what is being referred to here is the managerial ability of the farmer. The farmer should be able to make decisions that lead to optimal utilization of resources and this requires accurate information on availability of the new varieties, the inputs, and access to markets.

2.6 Measurement of Farm Efficiency

Farm efficiency, and the question of how to measure it, is an important subject in developing countries' agriculture (Shah, M. K, 1995; Hazarika and Subramanian, 1999). There are four major approaches to measure and estimated efficiency (Coelli *et al*., 1998). These are the non parametric programming approach (Charnes *et al*., 1978), the parametric programming approach (Aigner and Chu, 1968; Ali and Chaudry, 1990), the deterministic statistical approach (Afriat, 1972; Schippers, 2000; Fleming *et al*, 2004)] and the stochastic frontier production function approach (Aigner *et al*., 1977; Kirkley *et al*., 1995). Among these, the stochastic frontier production function and non-parametric programming, known as data envelopment analysis (DEA), are the most popular

approaches. The stochastic frontier approach is preferred for assessing efficiency in agriculture because of the inherent stochasticity involved (Ezeh, 2004 and Coelli 1994).

2.7 Stochastic Frontier Analysis

The stochastic frontier production function is a method of economic modeling. It has its starting point in the stochastic production frontier models simultaneously introduced by Ogundari (2006), Rahman and Umar (2009), Thomas (2007), Emokaro and Ekunwe (2009) and others which derived from the error model of Aigner *et al*. (1977) and Meeusen and Van den Broeek (1977). The stochastic frontier production function is specified as:

$Y_i = f(x_i.\beta) + e_i$ **……1**

$e_i = v_i - u_i$ **……..2**

Where:

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

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

β = a vector of the parameters to be estimated

e_i = composed error term

v_i = random error outside farmer's control

u_i =technical inefficiency effects

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

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

$\ln Y = \beta o + \beta_1 \ln X_1 i + \beta_2 \ln X_2 i + \beta_3 \ln X_3 i + (Vi-Ui)$ **……...3**

Where:

ln = the natural logarithm,

Y = output of cocoyam (kg/ha),

βo = constant term,

β_1- β_3 = regression coefficients,

X_1 = quantity of seed (kg),

X_2 =quantity of fertilizer (kg),

X_3 = total labour used (man days),

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

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

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

$-U_i = \delta_0 + \delta_1 1nZ_1 + \delta_2 lnZ_2 + \delta_3 lnZ_3 + \delta_4 lnZ_4 + \delta_5 lnZ_5 + \delta_6 lnZ_6$ …….4

Where,

U_i = inefficiency effects,

Z_1 = Age of farmer (years),

Z_2 = Household size (number),

Z_3 = Education (years),

Z_4 = Source of capital (informal/formal source),

Z_5 = Access to extension services (number of times have contact),

Z_6 = cooperative membership (years),

δ_0 = constant and

δ_1-δ_6 = Parameters to be estimated.

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

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

The stochastic frontier cost function is defined by:

$C = F (Wi, Yi; \alpha) \exp ei \quad i = 1,2 \ldots n$ **……..**5

Where,

C = Represents the minimum cost associated with cocoyam production,

W= Vector of input prices,

Y = Cocoyam output,

α = Vector of parameters and

ei = Composite error term.

Using Sheppard's Lemma we obtain

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

This is a system of minimum cost input demand equations (Bravo – Ureta and Evenson, 1994; Xu and Jeffrey, 1995 and Bravo-Ureta and Pinheiro, 1997). Substituting a farm's input prices and quantity of output in equation (6) yields the economically efficient

input vector Xc.. With observed levels of output given, the corresponding technically and economically efficient costs of production will be equal to X_{it} P and X_{ie}, respectively. While the actual operating input combination of the farm is Xi P. The three cost measures can then be used to compute the technical (TE) and economic efficiency (EE) indices as follows;

$TE = (X_{it}. P) / (X_i. P)$ ……7

$EE = (X_{ie}. P) / (X_i. P)$ ……8

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

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

The efficient production is represented by an index value of 1.0 while the lower values indicate a greater degree of inefficiency. Using the method by Bravo-Ureta and Pinheiro (1997) which was based on the work of Jondrow *et al* (1982), efficiency can then be measured using the adjusted output as shown in equation (10)

$Y^* = f(Xi; \beta) - u$ …… 10

Where U can be estimated as

$$E(ui / \varepsilon i) = \frac{\sigma \lambda}{1 + \lambda^2} \quad \frac{f^*(\varepsilon i \lambda / \sigma) - \Sigma i\lambda}{1 - f^*(\varepsilon i \lambda)} \quad \text{……..11}$$

Where

f* (.) is normal density and cumulative distribution functions respectively,

$\lambda = \sigma u / \sigma v$,

$\varepsilon = Vi - Ui$ and

Y* is the observed output adjusted for statistical noise.

When εi, σ and λ estimates, are replaced in equations (9) and (10), it will provide estimates for U and V. The term V is a symmetric error, which accounts for random variations in output due to factors beyond the control of the farmer e.g. weather, disease

outbreaks, measurements errors, etc. The term U are non negative random variables representing inefficiency in production relative to the stochastic frontier. The random error Vi is assumed to be independently and identically distributed as N(o, δv^2) random variables independent of the U is which are assumed to be non negative truncation of the N(o, δu^2) distribution (i.e. half-normal distribution) or have exponential distribution.

2.8 Cocoyam Producing Countries

Cocoyam ranks third in importance after cassava and yam among the root and tuber crops cultivated and consumed in Nigeria (Udealor; Nwadukwe and Okoronya, 1996). Currently, Nigeria is the world's leading producers of cocoyam, accounting for up to 3.7 million metric tonnes annually (NRCRI, 2003). This accounted for about 40 percent of total world output of cocoyam (Eze and Okorji, 2003). Table 1 shows the top ten (10) cocoyam producing countries in the world.

Table 1: Top ten cocoyam producing countries in the world

Rank	Countries	Production(mt)
1	Nigeria	32,657,440
2	China	1,702,367
3	Cameroun	1,490,000
4	Ghana	1,299,650
5	Madagascar	224,888
6	Papua New Guinea	222,916
7	Japan	171,928
8	Rwanda	168,521
9	Central Africa Republic	122,719
10	Philippine	110,718

Source: FAO (2011).

2.9 Theoretical Framework

Efficiency measurements involve a comparison of actual performance with optimal performance located on relevant frontier. Since the true frontier is unknown, an empirical approximation is required. The approximation is normally called a "best practice" frontier. Approximation of the best practice frontier can be done using parametric or non parametric techniques. Both techniques put emphasis on optimizing behaviour subject to constraints.

Data Envelopment Analysis (DEA) is a Non-parametric technique. It builds a linear piece-wise function from empirical observations of inputs and outputs, without assuming any *a priori* functional relationship between the inputs and outputs. Efficiency measures are then calculated relative to this surface. Testing of hypothesis is not possible and this method does not suffer multicollinearity and heteroscedasticity. The Stochastic Frontier Approach (SFA), also referred to as the econometric frontier approach, specifies a functional form for the cost, profit, or production relationship among inputs, outputs, and environmental factors, and it allows for random errors. Parametric methods are susceptible to misspecification errors. The advantage is that it becomes possible to test hypotheses.

Variation in output by different producers, caused by technical inefficiencies can be captured through specification of production function. Technical efficiencies can be estimated using Stochastic Frontier Approach (SFA) or Data Envelopment Analysis (DEA), which is non-parametric approach. DEA assumes that there are no random effects in production. The current study therefore employed the stochastic production frontier approach because most farmers operate under uncertain conditions (Abedullah and Ahmad, 2006). Review of literature revealed that Cobb-Douglas and Translog production functions are the widely used forms in agriculture. However, Translog

production function specification suffers from multicollinearity problem as a result of the square and interaction terms of the inputs used (Hussain *et al*., 2012). The estimated Cobb-Douglas production function is specified as:

$Y_i = (x_i \beta) + v_i - u_i$ **……. 12**

$e_i = v_i - u_i$ **…….. 13**

Where:

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

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

β = a vector of the parameters to be estimated

e_i = composed error term

v_i = random error outside farmer's control

u_i =technical inefficiency effects

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

Where Y_i is the output; x_i is a vector of inputs quantities used in production; β is a vector of parameters of the production function. The frontier production function $\{f(x_i, \beta)\}$ measures the maximum potential output from a vector of inputs. The error component v_i and u_i causes deviations from the frontier.

v_i is the systematic error component which captures random deviations from the frontier, caused by factors beyond the farmers' control such as temperature and natural hazards. It is assumed to be independently and identically distributed with a mean of zero and constant variance –$N(0, \sigma_v^2)$ and independent of u_i.

u_i is a non-negative error component that captures deviations from the frontier caused by controllable factors. It represents the inefficiencies in production. It is assumed to be

half normal, identically and independently distributed with a mean of zero and constant variance –N (0, σ_v^2).

2.10 Empirical Studies

2.10.1 Socio-economic characteristics of arable crop producers

Socio-economic characteristics play significant role in the farmers' lives in the sense that they influence willingness to accept changes which contributed significantly in raising farm productivity and ultimately their standard of living. Some of the most commonly used socio-economic variables includes age, sex, marital status, level of education, household size, farm size, farming experience, land acquisition, labour, access to credit, member of cooperative, extension contact and other estimated economic variables like income, output and standard of living.

In the study of Onwueme and Sinha (1999) observed that more than half (58.3%) of the farmers cultivated their cocoyam between May and June, (34.2%) between July and August while only (7.5%) planted between March and April. The reason for planting of cocoyam around May, June, and July is because cocoyam requires enough moisture and rainfall provides adequate water in the soil during this period of the year.

According to Ugbajah and Uzuegbuna (2012) Causative Factors of Decline in Cocoyam Production in Ezeagu Local Government area of Enugu State: Implications for Sustainable Food Security, reported that gender roles in the planting of cocoyam production revealed that 39.2% was done by only men in the household and 5% was done by only women. The result also showed that 20% of cocoyam planting was done by men and children together, while 27.5% of the planting was done by everybody in the family. About 6% of them indicated that men and women do the planting while 2.5% indicated that planting was done by children only

According to Emmanuel *et al*. (2006) farmers participating in irrigation project had some type of formal education and not all of them are illiterate. In survey of pigeon pea production systems utilization and marketing in semi-arid lands of Kenya, the average age of farmers in both locations was 46.5 years with over 40% having attended at least 4 years school and average family size was 8.6 people (Mergeai *et al*., 2001). Muhammed-Lawal *et al*. (2009) also reported that 82.73% of the youth in agriculture are male. Chikezie *et al*. (2012) revealed in his findings of factors constraining rural youth involvement in cassava production that majority of the youths in Onu-Imo local government area of Imo State were at the productive age where their energies could be harnessed and utilized for productive venture in agriculture especially cassava production. From his findings 9.17% of the respondents were less than 20 years, 43.33% and 33.33% were between 21–25 years and 26–30 years, respectively, while only 14.17% of the respondents were more than 30 years of age. He also revealed that 81.67% of the respondents were male, while 18.33% were female. According to Adewale *et al*. (2005) gender is no barrier to active involvement in cassava production activities.

Abdullahi *et al.* (2012), which reported that in Ikara Local Government Area of Kaduna State, majority of the sampled respondents were middle aged farmers. . This result suggests that majority of sorghum farmers in the study area are young farmers who are within the age bracket in which people are innovative and active at work (Asiabaka, 1998). Similarly, this findings is in line with Okwoche *et al.* (2012), found that 37.68% of sampled respondents were between 30 and less than 40 years, while 30% of the farmers were between 20 and 30 years. The implication of the foregoing results is that sorghum farming in the study areas has higher patronage among young people who are

energetic enough to withstand the stress involved in the sorghum farm operations and more so that sorghum farming is dominated by men considering the data from these Northern State. The result is also confirmation of Asogwa *et al.* (2012), findings on age, ranging between 31 and less than 40 years is predominant with 42%. Also 32% of the respondents are of the age of between 20 and less than 30 years.

Level of Education of farmers Mustapha *et al.* (2012), shows that most (41.10%) of the respondents had formal education. This implies that the respondents could apprehend the improved technology being disseminated to them. The findings was in agreement with that of Asogwa *et al* (2012), who asserts that most of respondents in study area have formal education (54%0).This result suggests that almost all the respondents are literate enough to give room for effective communication in doing their sorghum farming business in the study area. This is acceptable on the ground that education affects the way farm business is managed as well as overall production (Nkang *et al*., 2009). Educational level plays a good role in adoption of new policy and undertaking risks.

2.10.2 Cost and returns analysis

Cost- return analysis is usually form the basis for farm profitability analysis, it involves itemizing the cost and returns of production and use them to arrive at such estimates as the return to one unit of the resources used, the gross margin, as well as the gross and net returns. Daniel *et al.*,(2010) revealed that farmers incurred an average cost of ₦46, 046.75 per hectare; and within the same period they had an average estimated returns of ₦56, 224.90 per hectare. This implies that the farmers made a profit of ₦10, 178.15 per hectare.

The Gross Ratio (GR) of the farm was 0.54 which showed that 54% of the gross income went for total cost. A ratio less than 1 is always desirable for any farm business. The lower the ratio the higher the returns on naira invested (Olukosi and Erhabo, 1988). The returns on naira invested in cotton production by the farmers were ₦0.22 that is 22%.

Alam *et al* (2013) average costs and returns of cotton farmers in the study area. The average revenue from cotton output was found to be ₦58, 801.12 per hectare. The total cost incurred in cotton production was ₦37, 629 per hectare. Labour cost has the highest percentage (21%) of the total cost of production. The total variable cost constituted 95% while fixed cost constituted just 5% of the total cost. The enterprise had an average net farm income of ₦21, 172.12.

The result of the study further revealed that returns on Naira invested by farmers in the study area was ₦0.56, meaning that a farmer gain 56 Kobo in every one naira invested in cotton production. The result of the study clearly indicated that cotton production is a profitable venture and so farmers in the study area should be advised to venture into because it is profitable enterprise. This finding is in conformity with the result of Ibrahim (2008) who conducted a research on the economics of sole cotton production in Lau Local Government Area of Taraba State and came out with a similar result (that is, returns on investment of ₦0.76

2.10.3 Technical, allocative and economic efficiency

2.10.3.1 *Technical Efficiency*

By applying their model of technical inefficiency effects using panel data on Indian paddy rice producers, Battese and Coelli (1995) found a positive relationship between the degree of inefficiency and the producer's age, and a negative relationship between the degree of inefficiency and the educational level of the producer. Coelli and Battese

(1996) used the same approach to analyse the factors affecting the technical inefficiency of Indian farmers, and found the mean technical efficiency levels to be 0.74 and 0.71, respectively, for the villages of Aurelle, Kanzara and Shirapur. They also found a negative correlation between technical inefficiency and variables such as farm size and the level of education and age of the farmer.

By using the trans logarithmic stochastic frontier production function in which inefficiency effects are a function of socioeconomic variables, Ajibefun *et al*. (1996) obtained technical indicators whose average was 82%. They found positive correlations between the degree of technical inefficiency and the farmer's age, farm size and proportion of hired labour used, and a negative correlation between the degree of technical inefficiency and the producer's experience. Lyubov and Jensen (1998) used the same approach as Ajibefun *et al*. (1996) to analyse the technical efficiency of grain production in the Ukraine from 1989 to 1991. Out of the 80 farms considered, they found that variables such as the number of farm workers per hectare, the proportion of active household members engaged in non-agricultural activities, and the distance between the farm and the nearest city, have a negative impact on technical inefficiency.

Farrell (1957) defines allocative efficiency as the ability to choose optimal input levels given factor prices. According to Kalarijan and Shand (1999), the willingness and ability of an economic unit to equate its specific marginal value product is referred to as allocative efficiency. In effect, allocative efficiency refers to the adjustment of inputs and outputs to reflect relative prices (price efficiency) under a given technology (Ellis, 1988).

Unlike technical efficiency concept that only consider the process of production, allocative efficiency concepts pertain to the idea that society is concerned with not only

how an output is produced, but also with what outputs and balance of output are produced (Hensher, 2001).

2.10.3.2 *Allocative Efficiency*

A firm is said to have realized allocative efficiency if it is operating with the optimal combination of inputs given input prices. The traditional approaches to measuring allocative efficiency require input prices (Atkinson and Cornwell, 1994; Greene, 1997; Kumbhakar, 1991; Kumbhakar; Oum and Zhang, 1995 and Tsionas, 2005) which are hardly available in reality. This explains why empirical studies of allocative efficiency are highly concentrated on certain industries, particularly banking, because information on input price can be readily obtained for these industries.

Recently, more attempts to measure allocative efficiency have been advanced. For example given incomplete input price data information, Kuosmanen and Post (2001) put forward a methodology to derive the upper and lower bounds of overall efficiency. Their technique makes an additional assumption that prices are within a convex polyhedral cone.

Kuosmanen *et al*. (2006) continue by taking advantage of the law of one price, which is theoretically asserted to hold in the competitive market. The authors, while acknowledging that the input price vector is often not observed, consider the whole price domain instead of separate single input price vectors. The derived domain includes relative price restrictions, which allow them to obtain an upper bound of efficiency via maximization in terms of input prices that are endogenously chosen from the domain. Camanho and Dyson (2005) and later Jahanshahloo *et al*. (2008) have developed ways to measure upper and lower bounds for allocative efficiency when some information of input prices is known.

In his seminal paper, Farrell (1957) used the concept of efficiency postulated by Koopmans (1951) and the radial type of efficiency measure considered by Debreu (1951) to introduce the foundation for efficiency analysis. He differentiated between technical and allocative efficiencies. A firm is technically efficient if it uses the minimal possible combination of inputs for producing a certain output (input orientation). Allocative efficiency, or as Farrell called it price efficiency, refers to the ability of a firm to choose the optimal combination of inputs given input prices. If a firm has realized both technical and allocative efficiency, it is then cost efficient (overall efficient).

2.10.4 Production constraints faced by small holder farmer

Research finding on the constraints to the effective performance of agricultural and rural development project revealed that, most past policies, strategies and interventions failed to achieve their objectives as a result of poor design (Tomori *et al*., 2005). In Nigeria, most of those policies were not successful due to "top down" policy in which development are forced on people regardless of their felt needs (Ijere 1992). Other factors that militate against project implementation (Wallace, 1979) included lack of understanding the socio-economic and socio cultural and religious factors of the beneficiary's communities. Arokoyo (1995) opined that lack of understanding of the socio-economic and socio-cultural elements of the communities or participants by the programme implementers which are lack of appropriate institutional framework and linkages between the government agencies and research institutes charged with the responsibilities. Morardet *et al.* (2005) identified inappropriate technology as hindrance in the transfer of many technologies to farmers practicing irrigation. These factors according to them; land possession, village-family structure and income were the most important.

Ugbajah and Uzuegbuna (2012) revealed the four major problems, namely logistic, agronomic, marketing and socio-cultural problems should be remedied by the collective effort of the government, extension agents and the farmers. Unavailability of improved processing facilities, poor funding and lack of production inputs, Lack of improved cultivars lead to the continued use of low–yielding local cultivars as planting materials.

The most common rice plant diseases found in Nigeria include blast, which can be severe in drought-prone rainfed systems, and rice yellow mottle virus and leaf scald in irrigated and more humid areas (Longtau 2003a). Common pests include birds and rodents. Labour: its high cost and scarcity at peaks of farm work during the farming season was also a major constraint reported. The labour problems perhaps explain why respondents cultivate small lowland rice plots The results on the prominence of pests and diseases infestation of rice farms especially for the lowland rice farms agrees with Abdullahi (1980) that the continuous moisture of the lowland fadama farms provides favourable conditions for disease agents such as fungi and bacteria, particularly on cereals like maize and vegetables.

CHAPTER THREE

METHODOLOGY

3.1 Description of the Study Area

The study was conducted in selected local Government Areas of Kaduna State, Nigeria. The State lies in the North western part of country's agro-ecological zones, about 200km away from Abuja the Nigeria's Federal Capital. The State lies between Latitudes 90^{o}N and 12^{o}N of the equator and between Longitudes 6^{o}E and 9^{o}E of the Prime Meridian. It shares boundaries with Katsina and Kano State to the North. Plateau to the north east, Nasarawa and Abuja to the South and Niger and Zamfara States to the west (Kaduna State Government, 2012). The State occupies an area of approximately 68,000 square kilometers or 7% of Nigeria's land mass. It has 23 Local Government Areas (LGAs) (National Population Commission, 2006). The mean annual rainfall shows a marked decrease from South to North (1,524mm to 635mm). Two distinct seasons, rainy and dry are witnessed in the State. The relative humidity is constantly below 40 degrees except in few wet months when it goes up to an average of 60 degrees. The duration of dry season is 5-7 months which normally starts from October. The state is agrarian and well suited for the production of arable crops such as maize, yam, millet, and sorghum because of favourable climatic conditions. Livestock production is also practiced in the State. Rearing of goats, sheep, cattle and different classes of poultry as well as marketing of their products is practiced in the state. The people of the State live mostly in organized towns and cities (Udry, 1990). A large variety of non-agricultural occupations also exit.

The total population of the State is 6.11 million (NPC, 2006). Based on annual population growth rate of 3.2%, the projected population of the State is about 7,474,369

million people in 2013. Within the State, there are a number of establishments ranging from companies, Research Institutes, Higher Institutions and Colleges.

3.2 Sampling Procedure and Sample Size

A multistage sampling technique was used in selecting respondents for this study. The first stage was the purposive selection of three (3) Local Governments Areas based on the predominance of cocoyam production activities among the farmers. Secondly, nine villages were purposively selected, Three from each LGA based on their intensity of cocoyam production. Finally, a simple random sampling was employed in selecting farmers from each of the villages. Fifty percent (50%) of the sample frame (248) was used as the sample size. In all, 124 farmers were randomly selected.

Table 2: Population distribution and sample size of farmers

LGA's	Villages	*Sample frame	Sample size (50%)
Giwa	Giwa	36	18
	Yakawada	40	20
	Guga	32	16
Ikara	Gimbawa	42	21
	Kwasallawa	21	10
	Malikanchi	17	09
Kudan	Musawa	26	13
	Hunkuyi	18	09
	Kudan	16	08
Total		248	124

* Source: Kaduna State Agricultural Development Project (KADP), 2013

3.3 Data Collection

Primary data were used for this study. These were collected with the aid of structured questionnaire. The information were collected on (a) farmer's socio-economic characteristics such as age, household size, educational status, amount of credit received, numbers of extension contact, years spent on the cooperative, income. (b) Production information; level of inputs used and output in cocoyam production. (c) Constraints faced by the farmers in cocoyam production.

3.4 Analytical Techniques

The tools used in the analysis include, descriptive statistics, Net farm income and the stochastic frontier production function.

3.4.1 Descriptive statistics.

Descriptive statistics were used to achieve objectives (i) and (iv) of the study. It involved the use of measures of central tendency such as means, frequency distributions and percentages to describe the socio-economic characteristics of cocoyam farmers in the study area, i.e. objective (i), and the constraint confronting the cocoyam production, objective (iv).

3.4.2 Net farm income

The Net Farm Income (NFI) was employed to achieve objective two (ii). It was used to estimate the costs and returns of cocoyam production. The formula for the net farm income model is stated as follows.

NFI= TR-TC **…….....** 14

Where,

NFI= net farm income (₦);

TR= total revenue (₦);

TC= total cost of production (₦); Also,

TC= TVC+TFC ………………………………………………………………… **15**

Where,

TVC= total variable cost (₦) and

TFC= total fixed cost (₦).

Total Cost (TC) = Total Variable Cost (TVC) + Total Fixed Cost (TFC)

TVC = (cocoyam sett, fertilizer and labour)

TFC = (cost of renting land and depreciation of tools (hoe, cutlass))

The fixed inputs are not normally used up at short run in a production cycle. They were depreciated using the straight line method given by:

$$\boldsymbol{D = \frac{(P - S)}{N}} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots. (\mathbf{16})$$

Where:

D = depreciation (₦),

P = Purchase value (₦),

S = salvage value (₦) and

N = life span of asset (years).

Returns per naira invested (RNI) was obtained by dividing the gross income (GI) by the total cost (TC).

Therefore,

$$\boldsymbol{RNI = \frac{(GI)}{TC}} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots.. (\mathbf{17})$$

Where,

RNI = returns per Naira invested

GI = gross income and

TC = total cost.

Decision Rule:

RNI > 1, it implies the enterprise is profitable;

RNI = 1, it implies that the farmer is operating at breakeven point and

RNI < 1, the farmer is at loss

3.4.3 Stochastic frontier production analysis.

The stochastic frontier production function was used to achieve objective iii. It was specified implicitly as:

$Y_i = f(x_i.\beta) + e_i$ ……18

$e_i = v_i - u_i$ ……19

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 and

$-u_i$ =technical inefficiency effects.

Stochastic Frontier Production Function Model used in the study is specified explicitly as:

$\ln Y = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + (Vi-Ui)$ ……20

Where,

ln = the natural logarithm,

Y = output of cocoyam (kg/ha),

β_0 = constant term,

β_1- β_3 = regression coefficients,

X_1 = quantity of sett (kg),

X_2 =quantity of fertilizer (kg),

X_3 = total labour used (man days),

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

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

$-U_i = \delta_0 + \delta_1 1nZ_1 + \delta_2 lnZ_2 + \delta_3 lnZ_3 + \delta_4 lnZ_4 + \delta_5 lnZ_5 + \delta_6 lnZ_6$ **…… 21**

Where:

$-U_i$ = inefficiency effects,

Z_1 = age of farmer (years),

Z_2 = household size (number),

Z_3 = formal education (years),

Z_4 = source of capital (₦),

Z_5 = access to extension services (number of extension contact/period),

Z_6 = membership of cooperative society (years),

δ_0 = constant and

δ_1-δ_6 = Parameters to be estimated.

Stochastic Frontier Cost Function (Allocative Efficiency) Model used in the study is specified as:

$C = F(W, Y; \alpha) \exp e_i$ i = 1,2 ….n **……**22

Where:

C = Represents the cost associated with cocoyam production,

W= Vector of input prices,

Y = Cocoyam output,

α = Vector of parameters and

ei = Composite error term.

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

$\ln C = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + (Vi + Ui)$ **…… 23**

Where,

ln = the natural logarithm,

C = Total cost of output (₦),

X_1 = cost of sett (₦),

X_2 = cost of fertilizer (₦),

X_3 = cost of labour (₦),

X_4 = cost of Output (₦),

β_0 = constant term,

β_1- β_3 = regression coefficients

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

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

Economic Efficiency Model used in the study was specified as:

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

EE = TE * AE **…….** 24

Where;

EE= Economic Efficiency,

TE= Technical Efficiency and

AE= Allocative Efficiency

3.5 Measurement of Dependent and Independent Variables

Nine explanatory variables measured as continuous and discrete variables were hypothesized for determinants of cocoyam production.

(i) Age: This refers to the number of years of an individual attained from birth. It is a continuous variable and it will be measured in years. Hofferth (2003) argues that the higher the age of the household head, the more stable the economy of the farm household, because older people have also relatively richer experiences of the social and physical environments as well as greater experience of farming activities. More also, older household heads are expected to have better access to land than younger heads, because younger men either wait for a land distribution, or have to share land with their families. The estimated coefficient of age was expected to have negative sign on the technical inefficiency model.

(ii) Education level: Education is generally considered an important variable that could enhance farmer's acceptance of new technologies. Ogunbameru (2001) posited that education will likely enhance the adoption of modern farm technologies by youth and thereby sustaining a virile farming population. The more educated farmers are, the more likely they adopt technology and also translate into production experience. Level of education is measured by number of years spent in formal schooling. The estimated coefficient of education was expected to have negative sign on the technical inefficiency model; this implies that the educational level of the farmer is reducing technical inefficiency thereby increasing technical efficiency.

(iii) Household size: This means the total number of people in the house which includes the wives, children and dependents that reside within the same house. Since food requirements increases with the number of person in the household and also because land and finance to purchase agricultural inputs are limited. Increasing family size, according to Brown (2004), tends to exert more pressure on consumption than the labour it contributes to production. The larger the family size the more favorably disposed will be the members to participate in cocoyam production operation. The

estimated coefficient of household size was expected to have negative sign on the technical inefficiency model. This was measured as numbers of people living together and eating from same pot. The *a priori* expectation for household size was expected to be positive; this implies that the household size of the farmer is increasing technical efficiency.

(iv) Amount of money received: This refers to amount of money received from both formal and informal sources. It will be measured as the actual money/credit borrowed. Credit is a very strong important factor that is needed to acquire or develop farm enterprise (Ekong, 2003). Its availability could determine the extent of production capacity. This was measure as amount received in naira. The estimated coefficient of credit obtained is expected to have negative sign on the technical inefficiency model. The a priori expectation for amount of money received was expected to be negative, this implies that the amount of money received by the farmer is reducing technical inefficiency or increasing technical efficiency.

(v) Extension contact: Agricultural extension service constitutes a driving force for any agricultural development. The relationship between agricultural extension agent and the farmer is an important determinant in improving yield of cocoyam as well as in ensuring food security (Chikezie *et al*., 2012). The more number of visits of an extension agent to the farmers, the greater the chance for them to adopt innovation. It was measured in terms of number of visits made by an extension agent. The estimated coefficient of extension contact was expected to have negative sign on the technical inefficiency. This implies that the extension contact of the farmer is reducing technical inefficiency or increasing technical efficiency.

(vi) Co-operative membership: Co-operative groups are organized for the promotion of special interest or meet certain needs that cannot be achieved by the individual efforts.

They contribute to the dissemination of new ideas, practices and products as well as in sourcing for loan and farm input (Chikezie *et al*., 2012). Farmers that belong to a co-operative society are likely to adopt new technology easily than those not in any co-operative. Thus it influences the attitude of members towards community developmental projects. This variable was used to characterize farmers based on particular involvement in cocoyam production at the time of data collection. This was measure in years of participation. The estimated coefficient of cooperative membership was expected to have negative sign on the technical inefficiency.

(vii) Quantity of sett: This will be measured in kilograms (kg). It was be included in the model to examine the actual kilograms of the cocoyam seed used in production cycle. The a priori expectation for quantity of seed was expected to be positive; this implies that, a unit increase in quantity of seed will bring about increase in output.

(viii) Quantity of fertilizer: This will be measured in kilograms (kg). It was included in the model to examine the actual amount of fertilizer used in production. The a priori expectation for fertilizer was expected to be positive; this implies that, a unit increase in quantity of fertilizer will bring about increase in output.

(ix) Quantity of Labour: This consist of family and hired labour, it was included in the model to examine how variability in labour used affect output. Following Norman (1972), children age 7-14years are accorded 0.5 of adult male equivalent, female adult of 15-46years are accorded 0.75 and male adults of 15-64years are accorded 1.00. Labour will be measured in man-days. The a priori expectation for quantity of labour was expected to be positive; this implies that, a unit increase in quantity of labour will bring about increase in output.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Socioeconomic Characteristics of Cocoyam Farmers

4.1.1 Age

The study revealed that 34% of the cocoyam farmers were within the age range of 30-39 years with mean of 40 years. This implies that, the farmers are strong, agile, and active and can participate adequately in farming activities. The age distribution is expected to have positive influence on the respondent's participation in cocoyam production, which invariably mean better efficiency in production. This finding is similar to that of Adegboye (2011) which observed that youth constitute the majority of the cocoyam farmers in the study area. This result is also in line with the findings of Obeta and Nwagbo (1999) which observed that youth constitute the majority of the cocoyam farmers, and younger farmers are more flexible to new ideas and risk; hence they are expected to adopt innovations more readily than older farmers.

Table 3: Age distribution of cocoyam farmers

Variable	Frequency	Percentage
Age (years)		
20-29	32	25.8
30-39	42	33.8
40-49	17	13.7
50-59	20	16.0
>60	13	10.4
Mean	40	
Total	124	100

4.1.2 Educational level

Education is an important socio-economic factor that influences farmers' decision making because of its influence on farmers' awareness, perception and adoption of innovations that can bring about increase in productivity. The result in Table 4 shows that 50% of cocoyam farmers had no formal education, 9% of the respondents had only primary education, and 27% had secondary education while 14% had tertiary education. This indicates that the farmers' educational level was low. This finding is at variance with Amaza (2000), who found that education has a positive and significant impact on farmers' efficiency in production. Thus, literacy level will greatly influence the decision making and adoption of innovation by farmers, which may bring about increase in productivity.

Table 4: Educational Status of Cocoyam Farmers

Variable	Frequency	Percentage
Educational Status		
No formal education	62	50.0
Primary education	11	8.9
Secondary education	34	27.4
Tertiary education	17	13.7
Total	124	100

4.1.3 Household size

Table 5 shows the distribution of cocoyam farmers by household size. The majority of the farmers (30%) had household size that ranged from 6-10 persons. The average household size was 13 persons implying that there is appreciable number of family labour supply to accomplish various farm operations. According to the report of Oluwatayo *et al.,* (2008), there is a positive and significant relationship between household size and farmers' efficiency in production. However, the absolute number of

people in a certain family cannot be used to justify the potential for productive farm work. This is because it can be affected by some important factors namely; age, sex and health status. Essentially, it is the composition of the household that determine labour supply for the accomplishment of farm operations.

Table 5: Household Size of Cocoyam Farmers

Variable	Frequency	Percentage
Household Size		
1-5	28	22.5
6-10	37	29.8
11-15	23	18.5
16-20	19	15.3
>21	17	13.6
Mean	13	
Total	124	100

4.1.4 Membership of cooperative society

The result in Table 6 shows the number of years spent as members of Cooperative. About (73%) of cocoyam farmers did not participate in any Cooperative Association and the reasons for this include: being small scale and unawareness of any association while 27% participated with average of 2.4years. The effect of this result is that most of the cocoyam farmers in the study area do not enjoy the assumed benefits accrued to co-operative societies through pooling of resources together for a better expansion, efficiency and effective management of resources and for profit maximization. Ekong (2003) and Ajayi (2002) observed that membership of cooperative societies has advantages of accessibility to micro-credit, input subsidy and also as avenue in cross breeding ideas and information.

Table 6: Distribution of Cocoyam Farmers on Membership of Cooperative Society

Variable	Frequency	Percentage
Membership of Cooperative Society		
Non members	90	72.6
1-5 years	21	16.9
6-10 years	4	3.2
11-15 years	4	3.2
>16 years	5	4.0
Mean	2	
Total	124	100

4.1.5 Numbers of extension contact

The ultimate aim of extension services is to enhance farmers' ability to efficiently utilize resources through the adoption of new and improved methods used in cocoyam production instead of using traditional methods which are inefficient, resulting to low yield. The distribution of the sampled farmers based on numbers of extension visit is presented in Table 7.

The result presented in Table 7 revealed that (85%) of cocoyam farmers in the study area had no access to extension service while (15%) had access to extension service with average of 1. this could be attributed to low extension agent-farmers' ratio in the study area.

Table 7: Extension contact

Variable	Frequency	Percentage
Extension contact		
No contact	105	84.7
1-3	16	12.8
4-6	03	2.4
Mean	1	
Total	124	100

4.1.6 Source of capital for cocoyam farming

Adequate funding is required by farmers to finance all cocoyam production activities. However, a large number of farmers face serious shortage of funds to finance their cocoyam production activities, which in turn limits their level of production. They obtained their funds through formal and informal sources as presented in Table 8

The result presented in Table 8 shows that 94% of cocoyam farmers financed their cocoyam production from personal savings while those who had access to credit ranges between ₦10,000 -₦40,000 which represent about 6% of the farmers with the minimum and maximum amount of ₦10,000 and ₦100,000 respectively. The low access to credit could be attributed to the fact that government seldom grants financial credit to farmers. Ekong (2003) asserts that credit is a very strong factor that is needed to acquire or develop any enterprise; its availability could determine the extent of production capacity. it also agrees with findings of Nasiru (2010) who noted that access to micro-credit could have prospects in improving the productivity of farmers and contributing to uplifting the livelihoods of disadvantaged rural farming communities.

Table 8: Distribution of cocoyam farmers according to source of capital

Source of Capital	Frequency	Percentage
No access to credit	116	93.5
10,000- 40,000	5	4.0
40,001- 80,000	2	1.6
80,001-120,000	1	0.8
Total	124	100
Mean	**6,000**	

4.2.0 Costs and Returns of Cocoyam Production in the Study Area

Summary statistics of inputs and output

The summary statistics of level of inputs used and output realized in the study area are reported in Table 9. The inputs that were used in cocoyam production include; land, seed, fertilizer and labour. Table 9 revealed the mean farm size was 0.82 hectares. The minimum and maximum land areas were 0.1 ha and 3 ha, respectively. The average quantity of sett used by cocoyaam farmers was 1068.2 kg/ha. The minimum and maximum sett used were 60.98 kg/ha and 25609.76 kg/ha, respectively. Average fertilizer used by cocoyam farmers was 490.47 kg/ha while the minimum and maximum were found to be zero and 8780.49 kg/ha, respectively. The mean labour recorded was 24.47 man-days while the minimum and maximum were observed to be 6.10 mandays/ha and 117.07 mandays/ha, respectively. This shows that agricultural production in the study area is of small scale and labour intensive.

The coefficient of variation of each variable inputs used and output realized are presented in Table 9. The higher the coefficient of variation, the greater the dispersion in the variable while the lower the ratio of standard deviation to mean return, the better

your risk-return tradeoff. The CV for a model aims to describe the model fit in terms of the relative sizes of the squared residuals and outcome values. The lower the coefficient of variation (CV), the smaller the residuals relative to the predicted value. This is suggestive of a good model fit.

The low of coefficient of variation is a reflection of reliability (precision) of the result (Johnson and Welch, 1939). Johnson and Welch (1939) reported that for a normal distribution, the ratio of mean to standard deviation should be of order of three or more. They mentioned that 33 percent is often stated as the permissible upper fiducial limit of coefficient of variation (CV).

Table 4 shows that the coefficient of variation of all the variable inputs such as the land size, seed, fertilizer and labour were 74.0, 248, 180 and 75.0 respectively. The high coefficient of variation of variable inputs implies high level of variation in the use of variable input among cocoyam farmers in the study area. However, the coefficient of variation for land size and labour were lower compared to other variable inputs used for cocoyam production. The wide variation in input used by the farmers could be attributed to the fact that they differ in purchasing power and size of production.

The coefficient of variation in cocoyam output was 12.30 percent which implies low inconsistency in output level among cocoyam farmers in the study area. This will help the country in attaining food security as greater proportion of farmers produces above average. The instability in output of cocoyam could be attributed to inconsistency and inadequacy of variable inputs among farmers in the study area.

Table 9: Summary of input utilized and output realized in cocoyam production

Variables	Mean	Std. Dev.	Min	Max	C.V
Sett (kg/ha)	1068.20	2647.60	60.98	25609.76	248.00
Fertilizer (kg/ha)	490.47	881.10	0.00	8780.49	180.00
Labour (man-day/ha)	24.45	18.22	6.10	117.07	75.00
Yield (kg/ha)	10217.84	1257.16	365.85	58536.59	12.30

4.2.1 Cost of cocoyam production in the study area.

Cocoyam seed used by the farmers in the study area were mainly unimproved seeds taken from the last harvest. The quantity of cocoyam set (seed) was 1068.2kg/ha with an average market price of ₦271 per kg was used and this constitutes 62.2% of the total cost of production. The quantity of fertilizer was 490.47kg/ha with an average market price of ₦100 per kg was used and this constitutes 28.5% of the total cost of production. Labour costs consisted of cost of land preparation, planting, fertilizer application, weeding, replacement and harvesting. The family labour was computed on the basis of opportunity cost in man-days. The wage rate varied according to farm operation performed. An average wage rate of ₦400 per man-day was used, giving the average labour cost per hectare to be ₦9,780 while the total cost of fixed inputs (cost of renting land and depreciation of tools) incurred on cocoyam production was ₦6113 and this constitute 3.6% of the total fixed cost.

4.2.2 Returns to investment in cocoyam production

Results presented in Table 10 indicated that the total revenue (TR) was ₦290,076.7/ha while the total cost (TVC + TFC) was ₦171,760/ha. The net farm income was therefore ₦118,316.7/ha. the average rate of returns on investment (return per naira invested) was 1.69, indicating that for every ₦1 invested in cocoyam production in the study area, a

profit of 69 kobo was made. Thus, it could be concluded that cocoyam production in the study area though on a small scale, was economically viable. This finding is similar to that of Okoye *et al.,* (2009) in Determinants of labour productivity on small-holder cocoyam farms in Anambra State, Nigeria. observed that cocoyam production is profitable by returning ₦1.80 to every ₦1.00 spent.

Table 10: Average costs and returns per hectare of cocoyam production

Variables	Values/ha (₦)	% Contribution
A. Variable cost		
i seed (kg)	106,820	62.19
ii fertilizer (kg)	49,047	28.56
iii labour (man-days)	9780.00	5.69
Total variable cost (i + ii + iii)	165,647	
B. Fixed costs		
i Cost of renting land	4813	2.80
ii Depreciation of tools (hoe and cutlass)	1300	0.76
Total fixed cost= (i + ii)	6,113	
C. Total cost	171,760	
D. Total Revenue	290076.70	
E. Net Farm Income (NFI)= (D -C)	118,316.70	
F Return per Naira Invested (D/C)	1.69	100

4.2.3 Test of hypothesis I

The null hypothesis (H_o) which stated that there is no significant difference between costs and revenue in cocoyam production in the study area was tested using the result of a t-test presented in Table 11. From the result in the table 11, an average cost was 93022.62 and average return was 23460161.29. Calculated t-value was 9.04 and exceeds the critical value (t-critical two tail) of 1.99. The calculated t-value was 9.04

and exceeds the critical value (t-critical two tail) of 1.99, therefore H_o is rejected at 5% level of significance. The result of the analysis indicates that cocoyam production is profitable in the study area.

Table 11: The result of t-test showing significant differences between costs and return in cocoyam production.

Variable	Average cost	Average return
Mean	93022.62	23460161.29
Standard deviation	116386.39	28867975.34
Observations	124	124
Pearson Correlation	0.76	
Hypothesized Mean Difference	0	
Df	123	
t Stat	-9.04	
P(T<=t) one-tail	0.00	
t Critical one-tail	1.66	
P(T<=t) two-tail	0.00	
t Critical two-tail	1.99*	

*P<0.05

4.3.0 Efficiency of Cocoyam Production

4.3.1 Estimated technical efficiency of cocoyam farmers

The model specified was estimated by the maximum likelihood (ML) method using FRONTIER 4.1 software developed by Coelli (1995). The ML estimates and inefficiency determinants of the specified frontier are presented in Table 12. The study revealed that the generalized log likelihood function was -154.585. The log likelihood function implies that inefficiency exist in the data set. The log likelihood ratio value represents the value that maximizes the joint densities in the estimated model. Thus, the functional form that is, Cobb-Douglas used in this estimation is an adequate representation of the data. The value of gamma (γ) is estimated to be 23% 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 234% 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 farmer, reducing the influence of the effect of γ will greatly enhance the technical efficiency of the farmers and improve their yield. The value of sigma squared (σ^2) was significantly different from zero level of probability. This indicates a good fit and correctness of the specified distributional assumptions of the composite error terms while the gamma γ indicates the systematic influences that are unexplained by the production function and the dominant sources of random error. This means that the inefficiency effects make significant contribution to the technical inefficiencies of cocoyam farmers.

However, the estimated coefficients of all the parameters of production function (seed, fertilizer and labour) were positive and significant at 1% level of probability and hence play a major role in cocoyam production in the study area. The average technical efficiency for the farmers was 0.83 implying that, on the average, the respondents are able to obtain 83% of potential output from a given mixture of production inputs. Thus, in a short run, there is minimal scope (17%) of increasing the efficiency, by adopting the technology and techniques used by the best cocoyam farmer.

The estimated coefficient for seed was 0.501 which is positive and statistically significant at 1% level. The estimated 0.501 elasticity of seed implies that increasing seed by 1% will increase cocoyam output by less than 1% which means, all things being equal the output is inelastic to changes in the quantity of seed used. The significance of seed quantity is however, due to the fact that seed determines to a large extent the output obtained. If correct seed rates and quality seeds are not used, output will be low even if other inputs are in abundance. This is in line with the findings of Shehu *et al*

(2010) who observed that the estimated coefficient of seed and labour inputs were positive as expected and significant at 1% level which implies that the more seed is applied and the more labour employed the better the output of cocoyam.

Table 12: Results of Maximum Likelihood Estimates of Stochastic Frontier Production Function of Cocoyam production

Variables	Parameters	Coefficients	Std. error	T-Value
Production Function				
Constant	β_0	3.1857	0.5626	5.662***
Seed	β_1	0.5009	0.0854	6.090***
Fertilizer	β_2	0.0761	0.0301	2.527***
Labour	β_3	0.6084	0.1627	3.740***
Inefficiency model				
Constant	Z_0	-0.3494	0.6330	-0.552
Age	Z_1	-0.0071	0.0204	-0.374
Education	Z_2	-0.0803	0.1874	-0.429
Household size	Z_3	-0.0545	0.0397	-1.375
Membership of Cooperative	Z_4	0.1482	0.0593	2.501***
Extension contact	Z_5	0.1521	0.2531	0.599
Amount credit borrowed	Z_6	0.00002	0.00006	1.000
Diagnostic Statistic				
Sigma-squared	(σ^2)	0.9067	0.3061	2.962***
Gamma	(γ)	2.3437	0.3169	7.394***
Log likelihood function	*L/f*	-154.585		
LR test	17.816			
Total number of observation	124			
Mean efficiency	0.83			

*Asterisk indicate significance ***=1%, **=5%, and *=10%.*

The production elasticity of output with respect to quantity of fertilizer was 0.076 which is positive and statistically significant at 1% level. This implies that a 1% increase in fertilizer will increase cocoyam output by 0.08%. Fertilizer is a major land augmenting input because it improves the quality of land by raising yields per hectare. This study is in agreement with the findings of Maurice (2004) and Oladiebo and Fajuyigbe (2007).

The coefficient of labour was 0.61 which is positive and statistically significant at 1% level. This shows that labour is an important variable in cocoyam farming in the study

area. This is in line with several studies by Umoh (2006) and Okike (2000) which show the importance of labour in farming, particularly in developing countries where mechanization is rare on small scale farms. In the study area, human power plays a crucial role in virtually all farming activities. This situation has variously been attributed to the practice of split-plot cropping on small scattered land holdings and lack of affordable equipment (Umoh, 2006).

The estimated result of the inefficiency model is contained in Table 12. Generally, a negative sign on a parameter means that the variable reduces technical inefficiency, while a positive sign increases technical inefficiency. The results show that all the technical inefficiency variable except cooperative association were not statistically different from zero.

The estimated coefficient of cooperative association has a positive sign related to inefficiency and significantly different from zero at 1% level of significance. This implies that they increase technical inefficiency.

4.2.3.1 Test of hypothesis II

The null hypothesis (H_o) which stated that there is no significant difference between inputs and output use in cocoyam production in the study area was tested using the result of a F-test presented in Table 13. The estimated F-value was 30.668 with a R^2-value of 0.618 which is greater than 0.001. In other words, the test is significant at 1% probability level. This implies that there is significant relationship between the physical inputs and output of cocoyam. The H_o hypothesis is therefore rejected and accepts the alternative.

Table 13: F-test result of differences between Input and Output relationship in cocoyam production

Hypothesis	Test-statistics	Value	R^2 Adjusted
Hypothesis	F-test	30.668***	0.618
(H_o)	Rejected		
(H_1)	Accepted		

Note: ***= Significant at 1% Level. H_o =Null Hypothesis. H_1= Alternative Hypothesis.

4.3.2 Estimated Stochastic Frontier Cost Functions

The Maximum Likelihood (ML) estimates of the stochastic frontier cost parameters for cocoyam are presented in Table 14. For the cost function, the sigma ($\sigma^2 = 0.76$) and the gamma (γ=0.006) are quite high and highly significant at 1.0% level of probability. The high and significant value of the sigma square (σ^2) indicate the goodness of fit and correctness of the specified assumption of the composite error terms distribution (Idiong, 2005). The gamma ($\gamma = 0.006$) shows that 0.6% of the variability in the output of cocoyam farmers that are unexplained by the function is due to allocative inefficiency.

The results of stochastic frontier cost function for cocoyam in Kaduna State are shown in Table 14. The estimated coefficients of the parameters of the cost function are positive except that of fertilizer which is negative. The cost variables seed and output are significant at 10% level while fertilizer and labour are not significantly different from zero.

The coefficient of the cost of planting material (sett) was positive and statistically significant at 10%. This implies that planting materials (sett) are important in crop production in cocoyam farms. The estimated coefficient of the variable output was

positively signed and statistically significant at 10% level indicating that if there is an increase in cocoyam output the total cost of production will increase. This shows that the cost of production is influenced by the quantity of output realized. The result of this research agrees with the findings of Ogundari *et al* (2006) where they reported direct effect of output on cost of production in their study on economies of scale and cost efficiency in small scale maize production in Nigeria. The factors influencing allocative efficiency of cocoyam farmers in Kaduna State were not statistically significant.

Table 14: Results of Maximum Likelihood Estimates of Frontier Cost Function for Cocoyam.

Variables	Parameters	Coefficients	Standard error	T-Value
Production Function				
Constant	β_0	7.0601	0.5767	12.24***
Seed	β_1	0.1510	0.0904	1.671*
Fertilizer	β_2	-0.0182	0.0306	0.594
Labour	β_3	0.0658	0.1722	0.381
Output	β_4	0.1645	0.0906	1.812*
Inefficiency Variable				
Constant	Z_0	0.3184	0.3795	0.8390
Age	Z_1	0.0117	0.0083	1.41
Education	Z_2	-0.0782	0.1081	-0.723
Household size	Z_3	-0.0806	0.0116	-0.698
Cooperative association	Z_4	-0.0033	0.0185	-0.181
Extension contact	Z_5	-0.10513	0.0962	-1.09
Credit borrowed	Z_6	0.00001	0.00005	0.288
Diagnostic Statistic				
Sigma-square	(σ^2)	0.7603	0.10394	7.314***
Gamma	(γ)	0.006	0.0139	0.450
Log likelihood function	*L/f*	-158.820		
LR test		5.696		
Total Number Of Observation		124		
Mean efficiency		0.61		

*Asterisk indicate significance ***=1%, **=5%, and *=10%.*

4.3.3 Distribution of respondents according to technical, allocative and economic efficiencies of cocoyam farmers in the study area.

Distribution of cocoyam farmers according to technical efficiency estimates

The frequency distribution of the technical efficiency estimates for cocoyam farmers in the study area as obtained from the stochastic frontier model is presented in Table 15. It was observed from the study that 83% of the farmers had technical efficiency (TE) of 0.81 and above while 17% of the farmers operated at less than 0.8 technical efficiency levels. The farmer with the best and least practice had technical efficiencies of 0.84 and 0.24 respectively. This implies that on the average, output fell by 16% from the maximum possible level attainable due to inefficiency. Also, 83% of the farmers were estimated to have technical efficiency exceeding 0.8, indicating there were some 17% technical inefficient farmers in the study area.

The study also suggest that for the average farmer in the study area to achieve technical efficiency of his most efficient counterpart, he could realize about 20 percent (1-0.83/0.84*100) cost savings while on the other hand, the least technically efficient farmers will have about 90 percent (1-0.24/0.84*100) cost savings to become the most efficient farmer. This finding is in line with Okoye, (2005) who observed that average cocoyam farmer in the state would enjoy cost saving of about 32.9 (1-0.65/0.97) percent if he or she attains the level of the most efficient farmer among the respondents in the study area.

4.3.4 Distribution of cocoyam farmers according to allocative efficiency estimates

The Maximum Likelihood (ML) estimates of the stochastic frontier cost function for cocoyam are presented in Table 13. The sigma ($\sigma^2 = 0.76$) and the gamma ($\gamma=0.006$) are quite high and highly significant at 1.0% level of probability. The high and significant value of the sigma square (σ^2) indicate the goodness of fit and correctness of the

specified assumption of the composite error terms distribution (Idiong, 2005). The gamma ($\gamma = 0.006$) shows that 0.6% of the variability in the output of cocoyam farmers that are unexplained by the function is due to allocative inefficiency.

The allocative efficiency estimates presented in Table 15, indicate that it ranged from 0.20 to 1.00; the mean allocative efficiency was 0.61. The result indicates that average cocoyam farmer in the state would enjoy cost saving of about 39.4 (1-0.61/0.99*100) percent if he or she attains the level of the most efficient farmer among the respondents. The most allocatively inefficient farmer will have an efficiency gain of 97.9 (1-0.03/0.99*100) percent in cocoyam production if he or she is to attain the efficiency level of most allocatively efficient farmer in the state. This finding is in line with Okoye, (2005) who observed that the most allocatively inefficient farmer will have an efficiency gain of 89.6 percent in cocoyam production if he or she is to attain the efficiency level of most allocatively efficient farmer in the state

4.3.5 Distribution of cocoyam farmers according to economic efficiency estimates

The frequency distribution of the economic efficiency estimates for cocoyam farmers in the study area as obtained from the stochastic frontier model is presented in Table 15. It was observed from the study that 9% of the farmers had economic efficiency (EE) of 0.81 and above while 91% of the farmers operate at less than 0.8 efficiency level. The mean economic efficiency of the 124 sampled farmers in the study area was 0.51. The farmer with the best and least practice had economic efficiencies of 0.91 and 0.02 respectively. This implies that on the average, output fall by 49% from the maximum possible level due to inefficiency. Also 9% of the farmers were estimated to have economic efficiency exceeding 0.8, indicating there are some 20% economic inefficient farmers in the study area.

The study also suggest that for the average farmer in the study area to achieve economic efficiency of his most efficient counterpart, he could realize about 54 percent (1-0.51/0.91*100) cost savings while on the other hand, the least technically efficient farmers will have about 88 percent (1-0.2/0.91*100) cost savings to become the most efficient farmer. However, the average economic efficiency of the cocoyam farmers was 51percent. This indicates that cocoyam farms were economically inefficient.

Table 15: Frequency Distribution of Technical, Allocative and Economic Estimates from the Stochastic Frontier Model

Efficiency Level	Technical Frequency	%	Allocative Frequency	%	Economic Frequency	%
< 0.2	0	0	11	8.87	12	9.68
0.21-0.40	3	2.42	8	6.46	21	16.94
0.41-0.60	4	3.23	41	33.06	41	33.06
0.61-0.80	14	11.29	28	22.58	39	31.45
0.81-1.00	103	83.06	36	29.03	11	8.87
Total	124	100	124	100	124	100
Minimum	0.24		0.03		0.02	
Maximum	0.84		0.99		0.91	
Mean	0.83		0.61		0.51	

4.4 Constraints to Cocoyam Production in the Study Area.

The problems faced by cocoyam farmers in the study area were ranked according to their severity as stated by the farmers (Table 16). Pest and disease was the most severe constraint of cocoyam producers with about 59% of cocoyam farmers attesting to this fact. Cocoyam as a crop is susceptible to attack by numerous insects and diseases throughout the life cycle and the effective control of these is inevitable if reasonable yield is expected. This causes discoloration of the leaf, leaf patches, shrinking of the seed and seed dormancy were responsible for pre-harvest and post-harvest losses which automatically represent a serious decline in quality and substantial reduction in price. This finding agrees with Ugbajah and Uzuegbuna (2012) opined that pest and disease is responsible for causative factors of decline in cocoyam production in Ezeagu Local

Government Area of Enugu State implications for sustainable food security. Though, the farmers employed some coping strategy such as wood ash, neam plant extract and insecticides to ameliorate the problem of pest and disease.

About 28% of the respondent was also more severe with lack of capital to expand their production. This affects cocoyam production in the study area, because the meager savings the farmers might have made or the funds generated from relatives is not sufficient to satisfy various activities in cocoyam production. Credit is a very strong factor that is needed to acquire or develop any enterprise; its availability could determine the extent of production capacity. It agrees with findings of Nasiru, (2010) who noted that access to micro-credit could have prospect in improving the productivity of farmers and contributing to uplifting the livelihoods of disadvantaged rural farming communities. The some coping strategy employed by the farmers was through personal savings and borrowing from friends to finance their production.

High cost of inputs like seed, fertilizer and labour were severe constraint of cocoyam producers with about 7%. According to the respondents, due to high cost of improved seed they make use of seeds from their previous harvest which is not reliable and can jeopardize improved and sustainable productivity. This finding is in line with Ekong (2003)), opined that most farmers have little or no access to improved seeds and continues to recycle seeds that have become exhausted after generations of cultivation. Also, Farmers perceived that high cost of fertilizer constraints, according to the respondent fertilizer is made available when farmers are far into the production period, sometimes at the middle of the raining season and family labour was predominant in the study area and that is why there was acute shortage of labour. According to the farmers, during active period of production-every household would have been engaged in his family farm work. The demand for labour is normally very high and expensive during

the peak period of land clearing, ridging, harvesting, processing and weeding. Ugbajah and Uzuegbuna (2012) opined that labour shortage (58%) was responsible for causative factors of decline in cocoyam production in Ezeagu Local Government Area of Enugu State. the coping strategy by cocoyam farmers involve use of family land and purchase of fertilizer while 2% of the respondents said access to market was the major constraint faced in the study area. The coping strategy employed was to use nearby market immediately after harvest.

Table 16: production constraints faced by cocoyam farmers

Constraining factors	Frequency	Percentage	Rank	Coping strategy
Pest and diseases	113	59	5	Use of wood ash, neam plant extract and insecticides.
Inadequate capital	53	28	4	Personal savings and borrowing from friends.
High cost of inputs (seed, fertilizer, land size and labour)	13	7	3	Use of family land and purchase of fertilizer
Weeding	08	4	2	Use of family labour to augment hired labour
Access to market	04	2	1	Use of nearby market immediately after harvesting
Total	191 □	100		

□ Multiple responses.
Ranking according to severity 1=least severe, 2=moderately severe, 3=severe, 4=more severe and 5=most severe.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

This study focused on the profitability and production efficiency of cocoyam among smallholder farmers in Kaduna state. Three villages were randomly selected from three Local Government Areas and 124 farmers were selected in this area. The purpose of the study was to examine the profitability and production efficiency of cocoyam among smallholder farmers in Kaduna state, Nigeria, and to achieve this, the study came up with four main objectives. These were to: describe the socio-economic characteristics of cocoyam farmers, determine the cost and return associated with cocoyam production, determine the technical, allocative and economic efficiency in cocoyam production and to describe the constraint faced by smallholder cocoyam famers in the study Area.

Primary data were collected from 124 respondents through the use of random sampling techniques with the aid of structured questionnaire. The statistical tools used to analyze the data were descriptive statistics, stochastic production frontier function model, net farm income and profit function model. A descriptive analysis of the sample farmers was done to understand and describe the socio-economic factors influencing cocoyam production and as well as income made from the production in the study area.

The results of the socio-economic analysis shows that (34%) of the respondents fall within the age range of 30-39years, the majority of the farmers (50%) had no formal education. the household size ranged from 6-10 persons with29.8%. Majority of the farmers, (73%) were not members of a cooperative society.

The average costs incurred and revenue obtained per hectare for cocoyam were estimated to determine the profitability or otherwise of cocoyam production in the study area (table 5). The total revenue (TR) was 290076.7 while the total cost (TVC + TFC)

was 171,760. The net farm income was therefore 118316.7. The average rate of return on investment (return per naira invested) is 1.69, indicating that for every ₦1 invested in cocoyam production in study area; a profit of 69 kobo was made. Thus, it could be concluded that cocoyam production in the study area though on a small scale, was economically viable.

The stochastic frontier production function was estimated for technical, allocative and economic efficiency. It was observed from the study that 83% of the farmers had technical efficiency (TE) of 0.81 and above while 17% of the farmers operate at less than 0.8 efficiency level. The mean technical efficiency for the 124 sampled farmers in the study area was 0.83. The farmer with the best practice has a technical efficiency of 0.84 while 0.24 was for the least efficient farmers. This implies that on the average, output fall by 16% from the maximum possible level due to inefficiency. The mean allocative efficiency was 0.61. The result indicates that average cocoyam farmer in the state would enjoy cost saving of about 39% while allocatively inefficient farmer will have an efficiency gain of 98% to attain the level of most efficient farmer among the respondents. The mean economic efficiency was 0.51. The farmer with the best practice has an economic efficiency of 0.91 while 0.02 was for the least efficient farmers. This implies that on the average, output fall by 49% from the maximum possible level due to inefficiency.

Finally, among the constraints identified in the study area, the majority of the respondent attested to the fact that pest and diseases and inadequate capital were major constraints faced.

5.2 Conclusion

Based on the findings of this study, it could be concluded that cocoyam production in the study area is profitable by returning 69 kobo to every ₦1.00 spent. Given that cocoyam is an important staple food in Nigeria, any attempt to increase its productivity would be a right step towards the resolution of food crisis.

The implication of the study is that technical and allocative efficiency in farm production among the farmers could be increased by 27 and 49%, respectively through better use of available resources given the current state of technology. This can be achieved through improved farmer-specific factors. These results call for policies aimed at encouraging new entrants especially the youths who are agile and stronger to grow cocoyam and the experienced ones to remain in farming.

5.3 Contribution of the Study to Knowledge

1. The study revealed that cocoyam production in the study area is profitable with net farm income of ₦118316.7 despite the problems identified.
2. The study revealed pest and diseases and inadequate capital as major constraints affecting cocoyam, thereby leading the crop into extinction.
3. It was revealed that cocoyam farms were economically inefficient in the study area having an economic efficiency of fifty-one (51) percent.
4. The study revealed that cocoyam farmers in the study area achieved technical efficiency of 83 percent.

5.4 Recommendations

From the findings of this study, the following recommendations are made:

i. Since cooperative membership was a significantly determinant of technical efficiency, cocoyam farmers should join cooperative societies, so as to be able to

benefit from the government and non-governmental organization through increased credit access, input supply and farm advisory services.

ii. The most severe problems encountered in cocoyam production are pest and disease. This constraint constitutes serious impediments to cocoyam production and need to be addressed adequately before cocoyam production can be improved in the study area. It is recommended that agro based industries and non-governmental organization should be encouraged by the local government to support research and production of cocoyam products for commercial purposes.

iii. Majority of the farmers financed their production through personal savings and relatives which are mostly not adequate for appreciable production. Agricultural loan facilities should be made accessible to cocoyam producers to ensure timely and adequate utilization of agricultural inputs for improvement in farm production efficiency.

iv. Fertilizer is one of the inputs that positively and significantly influence cocoyam production in the study area. Therefore, government should ensure timely and adequate supply of fertilizer to farmers through its e-wallet programme at affordable prices in order to enhance the production of this crop.

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APPENDIX

QUESTIONNAIRE FOR COCOYAM PRODUCTION STUDY

A. SOCIO –ECONOMICS CHARATERISTICS

1. Name of farmer……

2. Sex: Male ( ) Female ( )

3. Age (years)……

4. Marital status: Married ( ) Single ( )

5. Highest level of Education:

(a) No Formal Education ( ) (b) Primary school Education ( ) (c) Secondary School

Education ( ) (d) Tertiary Education ( )

6. Family Size (All the number of the people depending on you for living)…….

(a) No of Adult Male ( ) (b) No of Adult female ( ) (c) Children >15yrs ( ) (d)
Children <15yrs ( )

7. How long have you been in cocoyam farming?(Years of experience)……

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

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

10. What benefit did you derive as a member?

11. What is your major source of capital for cocoyam farming?

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

d. Money Lenders (Borrow) ( )

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

a. commercial bank( ) b. Bank of Agriculture ( ) c. Cooperative Society ( ) d.
Money Lenders ( ) e. Friends and Family ( ) f. Others (specify)……

13. How much did you borrow to finance last production? (Fill for the source you indicated in Q .12)

SOURCE OF LOAN	AMOUNT(₦)	INTERST RATE (%)
Commercial Bank		
Bank of Agriculture		
Cooperative Societies		
Money Lenders		
Friends And Family		
Others (Specify)		

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

15. If Yes, How many times in last one year?

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

17. Of what benefit were the techniques learnt to you to the success of your farm? .....

18. Have you been trained on Cocoyam farming? Yes ( ) No ( )

19. If Yes, which organization conducted the training?

20. Was the training beneficial to you?

a. Not beneficial ( ) b. somehow beneficial ( ) c. beneficial ( ) d. very beneficial ( )

B. INFORMATION ON INPUTS

(1) Farm size (Ha)

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

Plot NO	Plot Size (Ha)
1	
2	
3	

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

Plot	**Mode of Acquisition**				
	(a) Inheritance	(b) Lease	(c) Borrowed	(d) Gift	(e) Purchased
1					
2					
3					

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

(II) Variable inputs (Last production Cycle)

(ii)Seed (Kg)

Plot No	Quantity of Seed(Kg)	Cost (₦)
1		
2		
3		

(iii).Fertilizer.

Plot No	Fertilizer type	Quantity(Kg)	Cost(₦)
1			
2			
3			

(iv). Agrochemical.

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

(v) Labour input

(a) Land preparation

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

(b)Planting

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

(c) Fertilizer Application

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

(e) First Weeding

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

(f) Second Weeding

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

(g).Replacement of dead cocoyam seed planted

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

(h)Harvesting

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

(i) Information on cocoyam output

Plot No	No. of output produced(Kg)	Total Qty sold	Price/Unit
1			
2			
3			

21. Where do you sell your produce?

a. Farm gate ( ) b. Rural market ( ) c. Urban market ( )

22. When do you sell your produce?

a. immediately after harvesting ( ) b. Few months after harvest ( ) c. Off season ( )

CONSTRAINTS OF COCOYAM PRODUCTION

S/n	Constraints	Ranking according to severity 1=least severe, 2=moderately severe, 3= severe, 4= more severe, 5= most severe.	Coping Strategy
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Thanks for your Attention