PROFILITABILITY AND EFFICIENCY OF SAMPEA-11 VARIETY OF COWPEA PRODUCTION IN NIGER STATE, NIGERIA

BY

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

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JUNE, 2015

DECLARATION

I hereby declare that this project work titled "Profitability and Efficiency of Sampea-11 Variety of Cowpea Production in Niger State, Nigeria" is a record of research work undertaken by me. It has not been presented for any award in any institution of higher learning. All consulted literature as sources of information were duly acknowledged by means of references.

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Date

CERTIFICATION

This Dissertation titled "Profitability and Efficiency of Sampea-11 Variety of Cowpea Production in Niger State, Nigeria" by Williams NWACHUKWU meets the regulations governing the award of Master in Science degree (M.Sc) in Agricultural Economics, Ahmadu Bello University, Zaria and is approved for its contribution to scientific knowledge and literary presentation.

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DEDICATION

I dedicate this dissertation to Almighty God, my family, friends and well wishers.

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ABSTRACT

The study was conducted to evaluate the profitability and efficiency of SAMPEA-11 variety of cowpea production in Niger State, Nigeria. Specifically, the study described the socioeconomic characteristics of SAMPEA-11 farmers; examined the profitability of SAMPEA-11 production in the study area; estimated the technical, allocative and economic efficiency of SAMPEA-11 production as well as identified the determinants of technical, allocative and economic inefficiency in SAMPEA-11 production. A multi-stage sampling technique was used to select 152 farmers for the study. Data were collected on socioeconomic characteristics, inputs and output quantities as well as their prices. The descriptive statistics were used to describe socioeconomic characteristics as well as inputs and output level of SAMPEA-11 farmers. Gross margin analysis was used to determine the profitability of SAMPEA-11 production. Equally, the estimation of technical, allocative and economic efficiency and their determinants were achieved using stochastic frontier production and cost function. From the results, it was concluded that the enterprise returns on investment is ₦1.22. This means that for every ₦1 spent by the farmer on SAMPEA-11 production, ₦1.22 was realized as profit. Analysis of technical efficiency using stochastic production frontier shows that seed, herbicide and insecticide were significant at 1% level of probability. The elasticity of production (0.7658) was less than 1 indicating a positive decreasing return to scale (DRS) at stage II of the production process where every farmer strives to maximize profit and minimize cost of production. And some socio-economic variables in the model such as age, education, experience and extension were key factors that can increase technical, allocative and economic efficiency in the study area. The farmers' average technical, allocative and economic efficiency is 76%, 64% and 52% respectively which suggest an appreciable use of inputs in productivity. Also, pests, bad roads, insufficient credit, activities of middlemen, and high cost of inputs were major constraints to SAMPEA-11 production. It is recommended that farmers should be encouraged to form viable cooperative societies to enable them access inputs and institutional credit at reasonable costs; increase effort in the development of markets for cowpeas and development of a sustainable value chain; promote intensive collaboration among institutions, governmental extension departments and farmer associations in order to implement SAMPEA-11 farming experiments and best management practices.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Cowpea (*Vigna unguiculata* L. Walp) is a crop with potential to halt hunger for millions in Africa and sustain the livestock revolution underway in developing countries. It is an important food legume, and its use as a leafy vegetable is essential in many African countries. Cowpea plays a critical role in the lives of millions of people in Africa and other parts of the developing world, where it is a major source of dietary protein that nutritionally complements staple low-protein cereal and tuber crops, and is a valuable and dependable commodity that produces income for farmers and traders (Singh, 2002; Langyintuo *et al.* 2003). It sustains the people who live on the very edge of existence and it thrives in hot, dry conditions (Timko *et al.*, 2007). Drought tolerance, short growing period and its multi-purpose use make cowpea a very attractive alternative for farmers who cultivate in marginal, drought-prone areas with low rainfall and less developed irrigation systems, where infrastructure, food security and malnutrition are major challenges (Hallensleben *et al.*, 2009). Cowpea is a valuable component of farming systems in many areas because of its ability to rejuvenate nutrient sapped soils for succeeding cereal crops grown in rotation with it (Carsky *et al.*, 2002; Tarawali *et al.*, 2002; Sanginga *et al.*, 2003).

Early maturing cowpea varieties can provide the first food from the current harvest sooner than any other crop (in as few as 55 days after planting), thereby shortening the "hungry period" that often occurs just prior to harvest of the current season's crop in farming communities in the developing world (Timko *et al.*, 2007). This has attracted scientists and researchers from around the world who are intensifying efforts to deal with threats that inhibit production and long-term storage of cowpea. However, it is hard to imagine a more perfect crop particularly for Africa, where food production lags behind population growth, demand for livestock products is soaring, and climate change is bringing new stresses to already challenging growing conditions (Fatokun, 2010).

As the climate turns up the heat in sub Saharan Africa, there is, growing concern that production of current staples such as maize and rice will fall or even collapse in some growing areas requiring so-called "climate ready crops" like cowpeas to fill the void. SAMPEA-11 was one of the two improved cowpea varieties that was developed and released in 2010 by scientists working at the International Institute of Tropical Agriculture (IITA), Ibadan, in collaboration with the Institute for Agricultural Research of the Ahmadu Bello University, Zaria; the University of Maiduguri, Borno; and the Agricultural Development Programs of Borno, Kaduna, Kano, and Katsina States. SAMPEA-11 is a dual-purpose cowpea variety with large white seeds and a rough seed coat. It has combined resistance to major diseases including septoria leaf spot, scab, and bacterial blight, as well as to nematodes, and tolerance to Nigeria's strain of *Striga gesnerioides* (a parasitic weed that severely lowers yield) (IITA, 2010). It has proven to be superior over the current improved lines being cultivated with a yield advantage of at least 80% over the local varieties (Kamara, 2010).

Productivity and resource allocation are important aspects of increasing food production (Udoh and Falake, 2006). The efficient allocation of resources at the farm level has great implication for national development. Profit maximization may not be the primary aim of small scale farmers for many reasons. But in the long run, farmers are still interested in knowing how much they have given up meeting other goals (Dittoh, 2004). It is therefore believed that the economic analysis of SAMPEA-11 production would enable making policy recommendations for better efficiency and productivity in production.

1.2 Problem Statement

The importance of cowpea in the Nigerian diet cannot be overemphasized. It is one of the major sources of protein in the diets of the rural poor from plants. It is consumed in many forms such as boiling with other ingredients, in making cake (*Akara*) and many other uses. The crop is produced in most parts of the country but higher production is obtained in the northern part of Nigeria. SAMPEA-11 is an improved cowpea variety that is grown for its high yield and for fodder. Scientists at International Institute for Tropical Agriculture (IITA) and the International Livestock Research Institute (ILRI) say new “dual use” cowpea varieties bred to satisfy both human and animal nutrition needs could be generating US$299 million to US$1.1 billion by 2020, given their potential to simultaneously boost livestock production and reduce hunger (Fatokun, 2010).

Despite its usefulness, farmers in the study area are mostly producing this variety on a small scale while some are still producing local varieties that yield lower output per hectare. With food production lagging behind population growth, information on the evaluation of the profitability and production efficiency of SAMPEA-11 and also the factors affecting the inefficiency in the production process is inadequate in the study area. It is based on these problems that the following research questions were addressed by this study:

i. What are the socio-economic characteristics of SAMPEA-11 farmers in the Study area?

ii. What is the profitability of SAMPEA-11 production?

iii. What is the input-output relationship of SAMPEA-11 production?

iv. What are the technical, allocative and economic efficiencies of SAMPEA-11 production?

v. What are the determinants of technical, allocative and economic efficiencies of SAMPEA-11 production?

vi. What are the production constraints faced by SAMPEA-11 producers?

1.3 Objectives of the study

The main objective of this study is to analyze the profitability and efficiency of SAMPEA-11 production among farmers in Niger State while the specific objectives are to:

i. describe the socio-economic characteristics of SAMPEA-11 producers in the Study area;

ii. examine the profitability of SAMPEA-11 production;

iii. examine the input-output relationship of SAMPEA-11 production;

iv. estimate the technical, allocative and economic efficiency of SAMPEA-11 production;

v. identify the determinants of technical, allocative and economic efficiencies of SAMPEA-11 production and

vi. describe the production constraints faced by SAMPEA-11 producers.

1.4 Justification of the Study:

Adequate information on production efficiency and profitability is very imperative for policy makers and researcher so as to guide in decision making process in relation to

SAMPEA 11 variety of cowpea production. Information from this study will therefore be very useful to researchers, students and policy makers in understanding the production efficiency of SAMPEA 11 as well as its profitability. It will add to the existing knowledge in SAMPEA 11 variety of cowpea in Niger State. The study will also serve as a baseline for further research in SAMPEA 11 production in Niger State.

1.5 Research Hypotheses

The following hypotheses were tested in this study:

i. SAMPEA-11 production is not profitable in the study area.
ii. Input-output relationship in SAMPEA-11 production is not statistically significant
iii. The socio-economic characteristics of SAMPEA-11 producers do not significantly influence their efficiency.

CHAPTER TWO

LITERATURE REVIEW

2.1 Evolution, Distribution and Importance of Cowpea

Cowpea (*Vigna unguiculata* L. Walp.) is a member of the Phaseoleae tribe of the Leguminosae family. Members of the Phaseoleae include many of the economically important warm season grain and oilseed legumes, such as soybean (*Glycine max*), common bean (*Phaseolus vulgaris*), and mungbean (*Vigna radiata*). Its humble origin seems to be in northern Africa where it is still cultivated to this day. It sustains the people who live on the very edge of existence and it thrives in hot, dry conditions. The name cowpea probably originated from the fact that the plant was an important source of hay for cows in the southeastern United States and in other parts of the world. Some important local names for cowpea around the world include “niebe,” “wake,” and “ewa” in much of West Africa and “caupi” in Brazil. In the United States, other names used to describe cowpeas include “southernpeas,” “blackeyed peas,” “field peas,” “pinkeyes,” and “crowders” (Timko *et al.*, 2007).

Cowpea most certainly evolved in Africa, as wild cowpeas only exist in Africa and Madagascar. Interestingly, while West Africa appears to be the major center of diversity of cultivated forms of cowpea and was probably domesticated by farmers in this region, the center of diversity of wild Vigna species is southeastern Africa. Some evidence that domestication occurred in northeastern Africa, based on studies of amplified fragment length polymorphism (AFLP) analysis, has also been presented (Coulibaly *et al.*, 2002). The wild cowpea *Vigna unguiculata sp.*, *unguiculata var. spontanea* is the likely progenitor of cultivated cowpea (Coulibaly *et al.*, 2002).

According to Melody (2010), when the cowpea reached the southern United States, it was a perfect marriage of plant, climate, and economic conditions. Southern farmers embraced the pea enthusiastically and through the years many varieties were developed. Many colorful names were given to this favorite legume and while the world probably is familiar with black-eyed peas, other names are much less common. Names like 'Clay', 'Red Ripper', 'Calico', 'Rattlesnake', 'Whippoorwill', 'Rouge et Noire', 'Mississippi Silver', and 'Texas Cream' may evoke delightful taste memories to many "old timers", but the rest of the world is ignorant of the variety available. The 'Clay' pea is a variety that has historical significance as Confederate soldiers carried them in their field sacks, as a non-perishable food source. Today, some groups who re-enact history grow the 'Clay' pea as an authentic food for use in their field provisions. These names reflect traditional seed and market classes that developed over time in the southern United States (Melody, 2010).

According to Tosti and Negri (2002), “Yardlong beans,” a unique cultivar group (Sesquipedialis) of cowpea that produces very long pods widely consumed in Asia as a fresh green or “snap” bean, apparently evolved in Asia and is rare in African landrace germplasm. Cowpea has been cultivated in southern Europe at least since the 8th century BC and perhaps since prehistoric times. Cowpea was introduced to the West Indies in the 16th century by the Spanish and was taken to the USA about 1700. Presumably it was introduced into South America at about the same time (Tosti and Negri, 2002).

Melody (2010) also stated that, cowpeas, Field Peas, Stock Peas and Southern Peas are just a few names by which the *Vigna unguiculata* is known. Brought across the Atlantic to the Caribbean Basin, in the holds of the same ships that carried the tragic passengers who became slaves, it was introduced to the Americas during this dark portion of our history. There are records of its use in Jamaica as early as 1675. It has documented use in Florida in 1700 and North Carolina in 1714 (Melody, 2010). Cowpeas were often known as a "poor man's" food; the landed gentry of the Eastern seaboard preferred the English Pea, *Pisum sativum* and considered the cowpea simply as peas grown to feed the cows (Melody, 2010). George Washington imported 40 bushels of what he called "pease" from Jamaica in 1797 to plant in his fields for forage, but no record exists that he actually sampled them himself. He would probably be shocked to learn that his cattle, slaves and sharecroppers were enjoying such a nutritious diet. Actually, George and his buddies were the same enlightened group who declared the tomato poisonous and unfit for humans, while his poorer but healthier counterparts were eating those with gusto too (Melody, 2010).

Cowpea plays a critical role in the lives of millions of people in Africa and other parts of the developing world, where it is a major source of dietary protein that nutritionally complements staple low-protein cereal and tuber crops, and is a valuable and dependable commodity that produces income for farmers and traders (Singh, 2002: Langyintuo *et al.*, 2003). Cowpea is a valuable component of farming systems in many areas because of its ability to restore soil fertility for succeeding cereal crops grown in rotation with it (Carsky *et al.* 2002; Tarawali *et al.* 2002; Sanginga *et al.* 2003). Early maturing cowpea varieties can provide the first food from the current harvest sooner than any other crop (in as few as 55 days after planting), thereby shortening the “hungry period” that often occurs just prior to harvest of the current season’s crop in farming communities in the developing world.

Cowpea's high protein content, its adaptability to different types of soil and intercropping systems, its resistance to drought, and its ability to improve soil fertility and prevent erosion makes it an important economic crop in many developing regions. The sale of the stems and leaves as animal feed during the dry season also provides a vital income for farmers (FAO, 2000).

2.2 Potentials and Constraints to Cowpea Production

Cowpea is a popular leguminous crop in Africa which is known as 'beans' in Nigeria and 'niebe' in the Francophone countries. The largest production is in the moist and dry Savannas of Sub-Saharan Africa (SSA), where it is intensively grown as an intercrop with other cereal crops like millet, sorghum and maize as well as rice fallows (Ishiyaku *et al*, 2010). Though it is grown in other parts of the world, Nigeria remains the largest producer and consumer of cowpea in the world. According to FAO data (2001-2010), Nigeria produces an average of 2.58 ± 0.31 million metric tons per annum. Nigeria's cowpea demand deficit is met by imports from neighboring countries like Niger and Burkina Faso.

In line with the aforementioned, the African Agricultural Technology Foundation (AATF) is coordinating a public private partnership to develop improved varieties of cowpea that can withstand the pod borer (*Maruca Vitrata*) and enhance farmers' grain and fodder production. The project, which started in 2008 is accessing and inserting the cry1Ab gene (Bt gene) into selected cowpea varieties to protect the crop against the Maruca pod borer. Confined field trials are currently in their fourth year at the Institute for Agricultural Research, Ahmadu Bello University, Samaru, Zaria. The developers expect to have the first Maruca-resistant cowpea (Bt cowpea) seed available to farmers around 2017 subject to approvals from regulatory agencies; the identification of effective and stable Maruca-resistant lines; and efficient transfer of the resistance to traditional varieties through conventional breeding. Similarly, this approach can be exploited to increase the nutritional composition of cowpea such as protein, micronutrients and vitamins. This will definitely lay the foundation for developing novel value added cowpea products (Mohammed *et al.*, 2013).

2.3 Consumer Preferences of Cowpea Varieties

Extensive studies have been done on cowpea grain preferences in West and Central Africa. Starting in 1997, Bean/Cowpea Center for Research in Security Prices (CRSP) researchers collected cowpea price and quality data, showing that consumers, almost everywhere in West and Central Africa, want larger cowpea grain size. Cowpea grain size varies widely within and among the studied markets, but it is well below the grain size of the premium U.S. cowpeas (minimum grain size 25 grams per hundred grains). Average grain size across markets in West and Central Africa varies from 12 to 20 grams per hundred grains (Jamal, 2005).

According to Ibro *et al.* (2005), consumers are also sensitive to insect damage. Studies suggest that African consumers want a price discount from the first bruchid hole visible in a sample of grain. Estimated discounts in Senegal, Cameroon, and Ghana ranged from 0.17–2.3 percent on average annual cowpea price per bruchid hole. Preferences for other visual cowpea characteristics were more localized. Preferences for testa colour and texture and hilum color depend heavily on the type of foods prepared with it. In those areas where cowpeas are de-hulled to make various fried foods (e.g., *kosaï*, *moin-moin*, *dan wake*), there is a premium for rough-textured cowpeas that are more easily de-hulled.

Colour is most important where cowpeas are cooked whole. For instance, in some areas where rice and cowpeas ("rice and beans" is the *pidgin* term) are a regular part of the diet, consumers prefer red cowpeas because the red color contrasts with the white rice (Ibro *et al.,* 2005).

Data on preferences for biochemical characteristics such as sucrose content, protein content, and cooking time comes mainly from studies conducted in Senegal and Niger. These studies suggest that consumers are willing to pay for sweeter-tasting cowpeas, higher protein, and shorter cooking time (Faye *et al.*, 2006). It is interesting to note that industrial processors also prefer high-protein cowpeas; but the protein is desired in order to substitute cowpeas for soybeans in certain processed foods (Faye *et al.,* 2006).

2.4 Improved Varieties of Cowpea in Nigeria

A number of improved varieties have been developed by the International Institute of Tropical Agriculture (IITA), combining diverse plant types with resistance or tolerance to several diseases, insect pests, and parasitic weeds and possessing other good agronomic traits (Chikoye, 2010). The varieties IT89KD-288 and IT89KD-391 which were developed by scientists working at Institute for Agricultural Research (IAR) of Ahmadu Bello University, Zaria in collaboration with International Institute for Tropical Agriculture (11TA) Ibadan, and the Agricultural Development Programs (ADPs) of Borno, Kaduna, Kano, and Katisina States have proven to be superior over the current improved lines being cultivated. They could be used to overcome the challenges faced by cowpea farmers in the country. For instance, IT89KD-288 (SAMPEA-11) is a dual–purpose cowpea variety with large white seeds and a rough seed coat. It has combined resistance to major diseases including Septoria leaf spot, and bacterial blight, as well as nematodes and tolerance for Nigeria’s strain of *Striga gesnerioides* (a parasitic weed that severely lowers yield). “It also has a yield advantage of at least 80% over the local varieties” (Kamara, 2010).

The nematode resistant variety is an equally good variety for sowing with cereals or as a relay crop with maize in the moist and humid savanna zones, and for high grain production in the dry season. Scientists recommend that the variety be planted in mid-July in the Sudan savanna, early to mid- august in the northern guinea savanna, and by the end of August in the southern Guinea savanna. However, if there is certainty of rains up till the end of October, 1T89KD-288 can be planted in September.

1T89KD-391 (now SAMPEA-12) is also a dual-purpose cowpea variety but it has medium –to- large brown seeds with a rough seed coat. These are preferred seed characteristics for commercial production in northeast Nigeria. 1T89KD-391 is a welcome improvement over SAMPEA 7, Ife brown, IT90K-76 and IT90K-82-2 which are the main improved brown-seeded varieties available. It has been tested extensively in this area and is well accepted by the farmers. It performs well as sole crop and could also be planted as a relay crop with maize in the guinea savanna (Hakeen, 2010).

Several on-station and on-farm trials have shown that 1T89KD-391 (now SAMPEA- 12) produces double the yields of local cultivars. According to Paul (2010), farmers who use traditional varieties earn about US$251 per hectare, while those who are growing the improved cowpea are getting US$390 or US$439 more per hectare with proper crop management. 1T89KD-391 produces high-quality grains that are used by farmers for food and fodder. Currently, efforts are being made through the project on legumes funded by Bill and Melinda Gates Foundation to make available seeds of these improved varieties by setting up community-based seed production schemes (Atser, 2010).

2.5 Concept of Profitability

According to James and John (2005), profitability is the the ability of a given investment to earn a return from its use. However, the term 'Profitability' is not synonymous to the term 'Efficiency'. Profitability is an index of efficiency; and is regarded as a measure of efficiency and management guide to greater efficiency. Though profitability is an important yardstick for measuring the efficiency, the extent of profitability cannot be taken as a final proof of efficiency. Sometimes satisfactory profits can mark inefficiency and conversely, a proper degree of efficiency can be accompanied by an absence of profit. The net profit figure simply reveals a satisfactory balance between the values received and value given. The change in operational efficiency is merely one of the factors on which profitability of an enterprise largely depends. Moreover, there are many other factors besides efficiency, which affect the profitability (James and John, 2005).

2.5.1 Profitability

Despite the numerous constraints faced by farmers in the production process, like the small size of farm holdings and the use of rudimentary inputs, studies of farming establishments across the country show that farming is generally a profitable enterprise for small scale farmers. Profitability measures the ability of farmers to cover their costs and is an important concept, because it provides incentives for entry into and longevity in the farming business. While many studies of Nigerian farms across the country report profitability, profit margins are often very small.

In general, Nigerian farmers can be described as rational profit maximizers who respond to price instruments (Ajani, 2000). In the Southwest, several crop production enterprises were found to yield positive returns and they include food crop production in Ekiti State (Peke, 2008), rain fed upland rice production in Oyo and Osun states (Oladeebo, 2006), as well as cassava production in Ogun (Adeyemo, Oke, and Akinola, 2010), and Osun (Fanegan, 2010) states. Several studies from the North Central region also revealed profitable farm enterprises. Egwuda's (2001) study of lowland rice producers in Kogi State revealed a profit of 37 kobo for every one naira invested on average for the 120 farmers surveyed. Yam production in Kogi State was also found to be a profitable venture (Adejoh, 2009; Ekunwe *et. al.*, 2008). Adejoh (2009) reported a profit of 53 kobo for every one naira invested in yam production in the state. Yam farming was also profitable in the South South as Oviasogie (2005) found yam based cropping systems to be profitable in Edo State particularly for farmers who practiced mixed cropping.

According to Ibro (2008), in his study on value chain of cowpeas in Kano State, Nigeria, suggested that cowpea vending is a profitable business and greater profits could be achieved by enlarging the scale of operation. Studies of profitability in the North East and North Central of Nigeria revealed relatively high profit margins. For instance, Musa, Vosanka, Inuwa, and Mohammed (2010) also observed a total cost of production of ₦26, 225.00 per hectare while returns was estimated at ₦153, 250.00 for gross income, with gross margin estimated at ₦66, 005.00 in cowpea production in Dongo, Taraba State. Also, Abah and Tor (2012) reported a gross margin of ₦39,983.37 per hectare in their study to determine the gross margin of cowpea farmers in Nasarawa State.

Agricultural productivity has slowed dramatically since the advent of the oil boom and the Nigerian farming sector can no longer meet the country's food needs. This is due to the fact that Nigerian farming is dominated by barely literate subsistence and semi-subsistence smallholders with poor access and limited ability and willingness to adopt production-enhancing inputs. While there were exceptions, a regional analysis of the efficiency of farmers revealed that most farmers were producing significantly below their production frontiers. Finally, many farming enterprises were found to be profitable, even though profit margins were generally low.

2.5.2 Profitability analysis

Profitability analysis is a common tool used by many managers of different enterprises to make decisions on whether to participate in the enterprise or not. Many studies have been conducted concerning profitability of different enterprises in different fields. For instance, Haruna *et al.*'s 2009 study of cowpea farmers in Gombe state revealed a net return of 2.10 naira for every naira invested. Similarly a study of Fadama food crop farmers in Bauchi revealed a return on naira invested of 3.14 naira (David et al. 2009). Farms in the northwest have been found to be similarly profitable as a number of studies reveal some profitable crops in this region including cowpea and maize in Katsina State (Zakari 1997), cowpea in Kebbi State (Abubakar 2006), and groundnuts in Kano State, with farmers making a profit of 0.47 naira for every naira invested (Yaro 1999). Zakari's 1997 study in Katsina revealed a return of 72k per naira spent for maize, and 38k per naira spent for cowpea. For cowpea production in Kebbi State, the three-crop mixture (cowpea/ pearl millet/sorghum) was the most profitable cropping pattern.

2.5.3 Value and profitability

There are many words to describe the meaning of value. According to the Webster dictionary, value can be described as relative worth, merit or importance; it can also be described as monetary or material worth or the worth of something in terms of the amount of other things for which it can be exchanged or in terms of some medium of exchange (Zulu, 2011).

In this work, the definition of value will be in terms of market value. Market value refers to the monetary worth of cowpeas i.e. the worth of cowpeas in terms of the amount of other things for which it can be exchanged or in terms of some medium of exchange. Profitability is simply the revenue earned from cowpeas produced less the cost of production.

2.5.4 Profitability of cowpea production

Despite the fact that little is known about profitability of cowpeas production in Niger State, there are still some studies that suggest cowpea production is profitable. For example a study that was carried out on the value chain of cowpeas in Kano State in Nigeria suggested that cowpea vending is a profitable business and greater profits could be achieved by enlarging the scale of operation (Ibro, 2008). These vendors are part of the supply chain of cowpeas in Kano and they were found to be profitable. However the study did not determine the profitability of farmers who produce and supply the cowpeas. Mishili (2009) also suggested that pulses have high market value in his study on the value of pulse production in West Africa. In the Collaborative Research Support Programme (CRSP) report on beans and cowpeas, farmers were encouraged to grow these pulses one of the reasons being their high market value (Mishili, 2009). These studies all suggest that cowpea production is profitable but they did not consider the factors that influence profitability of cowpeas production.

2.5.5 Factors affecting profitability

There are many factors that may have an effect on profitability of any enterprise. In crop production most of the factors that affect profitability are the production costs, farm gate price, fertilizer usage, seed variety, tillage methods, labor, land tenure, power sources, extension services, remittances and farmer characteristics (Ibro, 2008). Most of these factors have been considered in many studies on profitability. Some studies found some of these factors to have significant effect on profitability whereas other studies found that these factors have insignificant effect on profitability.

For instance a study that was done on the profitability of sorghum in Tanzania found that the farm size, production costs, farm location, interaction between production costs and farm gate price as well as the interaction between the varieties used and fertilizer applied were significant. Surprisingly, farm size was negatively influencing the gross margin contrary to the literature. However, the interaction between Production cost and farm gate price was positive and significant while farm gate price alone was not significant (Zulu, 2011).

Bagamba (1998) in studying the profitability of bananas found that the total farm size, total farm income, off-farm income, age of the farmer, weevil damage, interaction with government extension agents, gender of the farmer, distance from the farm to the tarmac, years spent in school and number of cattle owned had a significant effect on the profitability of banana production. Similarly in a study that was carried out on the market value of rice in Malaysia, the farm size, production costs, seed variety, tillage methods and power sources, farm price were found to be significant. In these studies, some factors were common in affecting profitability of each of these enterprises; however, some of the factors were specific in affecting a particular crop. Thus these factors affect the profitability in different ways depending on the enterprise in question.

2.5.6 Common methods of profitability analysis

There are many methods that can be used to determine the profitability of an enterprise as well as identify the factors that influence profitability. Some of these methods include gross margin analysis and net farm income. However, gross margin analysis appears to be a common method used to determine profitability, this method of determining profitability has been used in many studies. Ahmad (2004), in studying the factors affecting the profitability and yield of carrot production in two districts of Punjab included a partial budgeting model that was used to determine profitability of carrot growing. This methodology included a gross margin analysis which was used to determine the costs of various inputs and the profitability of carrot cultivation. According to Ahmad (2004), the gross margin was used because of its accuracy in estimating profit. Factors affecting yield in his study were determined by carrying out a regression analysis using a Cobb-Douglas production function which was used due to its ease in computation and interpretation. In a research conducted by Erbaugh (2008), on the profitability of sorghum farming in Tanzania, a gross margin analysis was also used to determine the profitability of sorghum. A regression model was then carried out in order to test factors that might have influenced gross margin and hence profitability of sorghum production. The gross margin variable was regressed on the farm size used to produce sorghum, farm gate price, farm production costs, farm location, the interaction between production costs and farm gate prices, seed variety used, technology used such as fertilizer, the interaction between seed variety and fertilizer applied and production technology used.

Gilbert (2001) carried out a study in which he compared gross margin analysis to total revenue in terms of which method was better in estimating profit. He concluded that gross margin was a more accurate estimate of profit compared to total revenue. From these studies the most accurate and common method of estimating profits is gross margin analysis, where as the most common method of identifying factors that influence profitability is multiple regression in which gross margin is regressed on different factors expected to affect profitability.

2.6 Definition and Types of Efficiency

Fried, Lovel and Schmidt (2008) have defined efficiency as a comparison between observed and optimal value of output and input. Efficiency is improved if more outputs are generated without changing inputs, or if the same outputs are generated with fewer inputs. According to Bravo-Ureta and Rieger (1991), substantial resources can be saved through efficiency measurement. The importance of efficiency was highlighted by Ajibefun (2008) and Freid *et al.* (2008): "Firstly, it is a success indicator and performance measure by which production units are evaluated. Secondly, the exploring of hypothesis relating to the sources of efficiency differential can only be possible by measuring efficiency and separating its effects from the effects of the production environment. Thirdly, identification of sources of inefficiency is important to the public and private organization policies designed to enhance performance" (Ajibefun, 2008). In general, efficiency indicates the inputs – output relationship of the production function which defines the possible combinations of inputs and the resulting outputs (Hollingsworth and Peacock, 2008). Recent measurement of farmer efficiency has been based on the seminal paper by Farrell (1957), who decomposed economic efficiency into its technical and allocative components. Economic efficiency or total efficiency is the product of technical and allocative efficiencies (Coelli, 1996, Coelli *et al.*, 2005). Technical efficiency refers to the ability of a producing unit to obtain maximum (optimal) output from a given amount of inputs. Formally, the level of technical efficiency is measured by the distance of farm production from the optimal production frontier. Allocative (or price) efficiency refers to the ability of the firm to choose its inputs in a cost-minimizing manner (Murillo-Zamorano, 2004; Chavas and Aliber, 1993). For allocative efficiency to hold, farmers must equalize their marginal returns with true factor market prices. Allocative efficiency in input selection involves selecting that mix of inputs (such as land, labour and capital) which produce a given quantity of output at minimum cost (given the input prices which prevail) (Coelli *et al.*, 2005).

2.6.1 Measuring farm efficiency

Some approaches in measuring farm efficiency are briefly presented here. Farm efficiency can be measured using Data Envelopment Analysis (DEA) or Stochastic Frontier (SF) methods, which involve mathematical programming and econometric methods, respectively (Coelli *et al.*, 2005). These techniques are broadly categorized into two approaches: parametric and non-parametric. The parametric SF approach and the non-parametric DEA approach (Sarafidis, 2002) are the most popular techniques used in efficiency analysis. Alene *et al*. (2006), stated that additional alternatives, such as

Parametric Distance Functions (PDF), have also been available since their development by Shephard (1953, 1970), although they are not as popular as the former methods.

The two methods have their advantages and disadvantages. The advantages of the SF approach are that it takes into account random errors and random variables and permits statistical tests of hypotheses pertaining to production structure and degree of inefficiency (Coelli, Prasada and Battese, 1998). The SF approach is also appropriate for agricultural application, especially in developing countries where the data are heavily influenced by measurement errors and the effects of weather (Bekele, 2003). The main criticism of the SF model, as pointed out by Coelli *et al.* (1998), is the absence of general a prior justification for the selection of any particular distributional form for the random variables.

Assumptions regarding the functional form of the production function or distribution of error term are not needed in DEA (Andreu and Grunnewald, 2006). Thus, the question of mis- specifying the frontier does not arise, which is one of the advantages of DEA when compared to SFA. DEA can be applied for multi-output and multi-input data. Another advantage of DEA is that it works well with small samples (Pasiouras, Sifodaskalakis and Zopounidis, 2011). A disadvantage of the DEA approach is that it does not take into account the possible influence of measurement errors and other noise upon the frontier; all deviations from the frontier are assumed to be the result of technical inefficiency (Coelli *et al.*, 1998; Sarafidis, 2002). This limitation can be overcome by applying the bootstrap procedure to correct the bias in DEA estimators of technical efficiency and establish their confidence interval (Simar and Wilson, 1998, 2000).

Coelli *et al.* (2005) explained two types of orientation measures: input-orientated measures and output-orientated measures. The input-orientated technical efficiency measures indicate the amount by which input quantities can be proportionally reduced without changing the output quantities produced. The output-orientated measure answers the question of the amount of output quantities to be proportionally expanded, using the same quantities of input.

2.6.2 The stochastic frontier production function

In the Stochastic frontier analysis (SFA), the error term is assumed to have two component parts V and U. The V covers the random effects (random errors on the production and they are outside the control of the decision unit) while the U measures the technical inefficiency effects, which are behavioural factors that come under the control of the decision unit. They are controllable errors if efficient management is put in place. The stochastic frontier analysis is generally preferred for agricultural research for the following reasons: the inherent variability of agricultural production due to inter play of weather, soil, pests, diseases and environmental factors and many firms are small family owned enterprises where keeping of accurate records is not always a priority hence available data on production are subject to measurement errors. The application of the stochastic frontier model for efficiency analysis include: Aigner *et al.*, (1977) in which the model was applied to U.S. agricultural data. Battese and Corra (1977) applied the technique to the pastoral zone of eastern Australia. More recently, empirical analysis has been reported by Bravo-Ureta and Pinheiro (1993).

The stochastic frontier production function model is specified as $Y= f(X_i,\beta)+e$, where Y is output in a specified unit, X denotes the actual input vector, β is the vector of production function parameters and e is the error term that is decomposed into two components, V and U. The V is a normal random variable that is independently and identically distributed with zero mean and constant variance σ^2. It is introduced to capture the white noise in the production, which are due to factors that are not within the influence of the producers. It is independent of U which is a non-negative one sided truncation at zero of the normal distribution (Tadesse and Krishnamoorthy, 1977). It measures the technical inefficiency relative to the frontier production function, which is attributed to controllable factors (technical inefficiency). It is half normal, identically and independently distributed with zero mean and constant variance. The variance of the random errors (σ_v^2) and that of the technical inefficiency effects (σ_u^2) and overall model variance (σ^2) are related thus: $\sigma^2 = \sigma_v^2 + \sigma_u^2$, and the ratio $\gamma = \sigma_u^2/\sigma_v^2$ is called Gama. Gama measures the total variation of output from the frontier, which can be attributed to technical inefficiency.

The technical efficiency of an individual firm is defined in terms of the ratio of the observed output Yi to the corresponding frontier output Y_i^*. The Y_i^* is maximum output achievable given the existing technology and assuming 100% efficiency. It is denoted as: Y_i^* = f(Xij,β) +V. That is TE= Yi / Y_i^*. Also the TE can be estimated by using the expectation of Ui conditioned on the random variable (V-U) as shown by Battese and Coelli (1988). That is TE = f(Xi,β) + V-U / f(Xi,β) +V and that $0 \leq TE \leq 1$.

2.7 Factors Affecting Farm Efficiency

Some of the factors influencing technical efficiency include age of the farmer, years of experience, education of household head, risk aversion, farm size, land fragmentation, extension services, access to credit, ownership of oxen, labour, household size, gender and seed. These factors are discussed next.

2.7.1 Age of the farmer

Increasing age is expected to lead to a reduction in the level of technical efficiency. Older farmers will have less physical efforts to put into their farming. Ajibefun and Abdulkari (2004), Ajibefun (2006), Ogundele (2003), and Otitoju and Arene (2010) have stated that age of farming household heads have an inverse relationship with productivity of farmers in Nigeria. They argued that this was understandable since it was expected that as a farming household head becomes older, the farmer's productivity would decline. Similar results were obtained by Gul *et al.* (2009) for Turkey and Dhehibi, Lachaal, Elloumil and Messaoudi (2007) for Tunisia. Younger farmers are more knowledgeable about new practices and may be more willing to bear risk owing to longer planning horizons (Polson & Spencer, 1991). However, other researchers have found that age increases technical efficiency (Msuya, Hisano and Nariu, 2008); Amos, 2007). It is believed that experience increases with age and resource endowment, hence giving an increase in efficiency.

2.7.2 Years of farming experience

Years of farming experience increase as the age of the farmer increases. Studies conducted in the humid forest and moist savannah agro-ecological zones of Nigeria showed that productivity was positively associated with more experience in farming (Ajibefun and Abdulkadri 2004; Ajibefun, 2006; Idjesa, 2007; Ogunniyi and Ojedokun, 2012). Farming experience has positive effect on the farmer's efficiency (Yusuf and Malomo, 2007; Abdulai & Eberlin, 2001). Gul *et al.* (2009) and Ogisi, Chukwuji, Christopher and Daniel (2012) also found that farming experience has a positive effect on technical efficiency among cotton farmers in Cukurova region, Turkey and rice farmers in Nigeria, respectively.

2.7.3 Education of household head

The education of the household head should have a positive effect on farm efficiency (Ogisi *et al.*, 2012). Education enhances the adoption of innovations and thus increases efficiency. In the same vein, Ogunniyi and Ojedokun (2012) have pointed out that education was key to enhancing productivity among farming households in the humid forest, dry savannah, moist savannah and guinea savannah agro-ecological zones of Nigeria. Similar results were reported by Khai and Yabe (2011), Kamruzzaman and Hedayetul Islam (2008) and Jordaan (2012). A negative relationship exists between education and technical inefficiency (Ogundari and Ojo, 2007; Koc, Gul and Parlakay, 2011). The importance of a farmer’s education cannot be overemphasized.

2.7.4 Farm size

Stochastic frontier production function was applied by Ajibefun, Battese and Daramola (2002), to study the determinants of technical efficiency in small-holder food crop farming. Their results show that large farm size enhanced productivity among farmers in the dry savannah and humid forest agro-ecological zones of Nigeria. Tanko and Jirgi (2008) examined the economic efficiency among small-holder arable farmers in Kebbi State, Nigeria. The stochastic frontier results suggested that farm size had a positive significant influence on farmers’ efficiency. Similar results were reported by Gul *et al.* (2009). On the contrary, Haji (2007) found that farm size had a negative influence on technical efficiency. Jordaan (2012) found that area harvested for raisin farmers had a positive relationship with technical efficiency.

2.7.5 Land fragmentation

There are two typical cases where fragmentation of landholding is likely to occur. When communal property land is divided among commoners, and when private property land is inherited jointly by co-heirs (Bentley, 1987). Gul *et al.* (2009) found that an increase in the number of land parcels had a negative effect on technical efficiency. In areas where land is fragmented, farmers walk long distances to the farms and hence labour input on the farm is reduced because of the time wasted in walking to the farms, resulting in inefficient input application (especially farmyard manure) and farm work supervision. Wadud and White (2000) studied the farm household efficiency of rice farmers in Bangladesh and the results showed that land fragmentation had a negative impact on technical efficiency. Msuya *et al.* (2008) also found similar results for farmers in Tanzania. Land fragmentation thus impairs agricultural efficiency.

2.7.6 Extension services

Extension services, if properly implemented, should increase the efficiency of farmers, since farmers would obtain the knowledge of using innovations that will improve their productivity. One of the important factors in the establishment of profitable agricultural enterprises is the availability of appropriate technology and extension services. Bekele (2003) stated that most extension services in Africa are oriented toward solving technical problems and are ill equipped to address farm management or social issues that are necessary for technology transfer and adoption. Studies have shown that increase in extension contact has a positive influence on technical efficiency (Akinbode *et al.*, 2011, Kamruzzaman and Hedayetul, 2008; Ogisi *et al.*, 2012).

2.7.7 Access to credit

Access to credit will increase the farmer's ability to purchase improved inputs, farm implements and adopt innovations. Findings from Venter *et al.* (1993) suggested that credit was much more important to emerging commercial farmers who have adopted modern technologies than to subsistence and sub-subsistence farmers in South Africa. Tanko and Jirgi (2008) investigated the effects of agricultural credit on the output and profitability of egg farms in Abia State, Nigeria: the results revealed that agricultural credit had a positive and significant effect on profit. Agricultural credit and production efficiency in sorghum based cropping enterprises in Kebbi state, Nigeria was also examined by Tanko and Jirgi (2008). The findings showed that farmers that produced with credit were technically more efficient. A similar result was reported by Abdulai and Eberlin (2001) and Maseatile (2011) for small-scale farmers in Lesotho. Jordaan (2012) found that formal and informal credit has a positive relationship with technical efficiency among raisin producers in Eksteenskuil, South Africa.

2.7.8 Household size

Yusuf and Malomo (2007), and Binam *et al.* (2003) reported that household size has a negative influence on technical efficiency. According to the researchers, in a situation where the family size is large with only a small fraction of the family members contributing to farm labour, inefficiency in labour use can be expected. On the other hand, Abdulai and Eberlin (2001) reported that large families have a positive influence on technical efficiency, when a large proportion of family members contribute to farm work.

2.7.9 Membership of cooperative society

Membership of a cooperative society should have a positive influence on technical efficiency of farmers. Membership of cooperative societies gives members of the cooperative more access to inputs and information on how to improve farm management practices (Obare *et al.*, 2010; Nyagaka *et al.*, 2010).

2.7.10 Sex

Sex has a negative influence on efficiency (Yusuf & Malomo, 2007; Binam *et al.*, 2003; Otitoju & Arena, 2010). Sex was represented by a dummy variable 1 if farmer is male and 0 if otherwise. More men were found to be technically efficient than their female counterpart; the reason is that farming is labour intensive and is highly gender biased.

2.7.11 Seed

Seed has a positive relationship with technical efficiency (Chirwa, 2007). Maseatile (2011) reported that seed quality has a positive influence on technical efficiency of maize farmers in Lesotho. The quality of seed when complemented with other inputs increased crop yields, hence improving efficiency.

2.7.12 Fertilizer

The use of fertilizer has a positive and significant relationship with technical efficiency (Chirwa, 2007). Jordaan (2012) however, reported that sufficient fertilizer has a negative relationship with technical efficiency, while timely fertilizer application has a positive relationship with technical efficiency. According to the researcher, the negative influence of sufficient quantity of fertilizer applied shows that improved performance does not merely depend on fertilizer application by the farmers in Eksteenskuil, South

Africa. The application of the right quantities of fertilizer occurs in combination with other management decisions.

2.7.13 Assets

Assets have a positive impact on technical efficiency of farmers (Haji, 2007). Farmers with higher asset values are likely to purchase and use farm inputs adequately, hence improving their efficiency.

2.8 Factors Affecting Cost and Economic Efficiency

2.8.1 Age

Age has a positive and significant relationship with a farmer's economic efficiency (Mbanasor and Kalu, 2008). Khan and Saeed (2011) also found that age has a positive and significant relationship with the economic efficiency of tomato farmers in Northern Pakistan. The older the farmer, the more experienced he is expected to be, which aids in decision making. On the contrary, other researchers have reported a negative relationship between age and allocative efficiency (Okoye *et al.*, 2006; Akinbode *et al.*, 2011).

2.8.2 Years of farming experience

The number of years of farming experience has a positive and significant relationship with a farmer's economic efficiency (Mbanasor and Kalu, 2008; Obare *et al.*, 2010). Okoye *et, al*. (2006) reported that farming experience has a positive relationship with the allocative efficiency of small-holder cocoyam farmers in Anambra State, Nigeria. Similarly, Jordaan (2012) reported that experience has a positive influence on cost efficiency among raisin producers in Eksteenskuil, South Africa. This implies that the higher the level of experience of the farmer, the higher his cost efficiency level will be.

2.8.3 Education of household head

The education of the household head has a positive and significant relationship with economic efficiency (Hassan, 2008; Khan and Saeed, 2011). According to Akinbode *et al.* (2011), education contributes to effective management of resources by farmers, which, in turn, influences the farmers' efficiency. Okoye *et al.* (2006), however, reported a negative relationship between education and allocative efficiency. Mbanasor and Kalu (2008) have also found a negative relationship between education and economic efficiency. The explanation for the negative relationship between education and economic efficiency could be because of the fact that most farmers rely on their years of experience to attain economic efficiency rather than education (Mbanasor and Kalu, 2008). According to Ojo and Ajibefun (2000), education is expected to have a positive correlation with the adoption of innovation and hence increase efficiency.

2.8.4 Farm size

Ogunniyi and Ojedokun (2012) found that farm size has a positive significant relationship with economic and allocative efficiency among rice farmers in Kwara State, Nigeria. Farmers with larger farm sizes are expected to be more cost efficient owing to the advantage of economies of scale, as the unit cost of output decreases with increased production. A contrary result was obtained by Mbanasor and Kalu (2008) who found that farm size has no significant positive relationship with the economic efficiency of commercial vegetable farmers in Akwa Ibom State, Nigeria. Okoye *et al.* (2006) and Jordaan (2012) found a negative relationship between size of farm and cost efficiency. Larger farm sizes are associated with lower levels of cost efficiency. The negative relationship may be the result of the characteristics of small-scale farmers who have little experience of operating on large pieces of land.

2.8.5 Land fragmentation

Msuya *et al.* (2008) examined the productivity variation among smallholder maize farmers in Tanzania. The researchers found that land fragmentation has a negative influence on the cost efficiency of the farmers. Fragmentation of farm lands leads to an increase in transport cost for farm inputs and it also leads to inefficient utilization of labour and other farm inputs and ultimately allocative inefficiency (Hamidu, 2000).

2.8.6 Extension services

Mbanasor and Kalu (2008) found that the number of extension visits had a significant positive relationship with economic efficiency of commercial vegetable farmers in Akwa Ibom State, Nigeria. Similar results were obtained by Obare *et al.* (2010) and Khan and Saeed (2011). Through extension visits, farmers become better informed about farm management practices, planning and new technologies, hence improving their efficiency.

2.8.7 Access to credit

Access to credit has a positive and significant relationship with a farmer's allocative and economic efficiency (Okoye *et al.*, 2006; Mbanasor and Kalu, 2008; Obare *et al.*, 2010; Khan and Saeed, 2011). Credit access enables farmers to purchase farm inputs adequately and in good time, hence credit improves allocative and economic efficiency.

2.8.8 Membership of cooperatives

Membership of cooperative organizations is expected to have a positive influence on allocative efficiency (Obare *et al.*, 2010). Farmers who belong to cooperatives are better informed on resource use and farm planning which enables them to utilize resources more efficiently.

2.8.9 Ownership of oxen

The ownership of oxen is an important livelihood source to rural people in Nigeria and in most developing countries. The use of oxen as draught animals is becoming popular in the northern parts of Nigeria. Camels are also used for ploughing and transport of products from the farm to the store house and to the market. Both oxen and camels are used for land preparation and weeding, farmers who do not own animal traction and who have to hire from those who have stand at a disadvantage. Such farmers may have their farm operations delayed, thus their yields and efficiency may be affected negatively (Mohammed and Hoffmann, 2006).

2.8.10 Labour

Farmers in northern Nigeria utilize both family and non-family labour (Jirgi & Baba, 2000; Dikwal & Jirgi, 2000). Labour is an important factor in explaining output (Sani *et al.*, 2003). Khai and Yabe (2011) found that intensive labour in rice cultivation has a positive impact on cost efficiency.

2.8.11 Seed

Seed and planting materials have a significant influence on cost of production. Increases in prices of planting materials will increase the total cost of production (Ogundare and Ojo, 2007; Mbanasor and Kalu, 2008).

2.8.12 Fertilizer

The use of fertilizer has a positive and significant relationship with economic and allocative efficiency (Okoye *et al.*, 2006; Ogunniyi and Ojedokun, 2012). This emphasizes the importance of fertilizer in crop production, as pointed out by Okoye *et al.* (2006): if a farmer fails to buy fertilizer for his or her crops, output loss may be severe. Van der Merwe (2012) found that farmers in Eksteenskuil, South Africa, who use a combination of fertilizer types, have the highest probability of being cost efficient.

2.8.13 Assets

Assets have a positive impact on the allocative and economic efficiency of farmers (Haji, 2007). Assets give farmers the ability to purchase farm resources and use them adequately, hence, improving their allocative and economic efficiency.

2.9 Review of Empirical Studies on Efficiency Measurement Approaches and Efficiency Levels

Farm efficiency can be measured using Data Envelopment Analysis (DEA) (non-parametric) or Stochastic Frontier (SF) (parametric) methods, which involve mathematical programming and econometric methods, respectively (Sarafidis, 2002; Coelli *et al.*, 2005; Alene *et al.*, 2006). The advantages and disadvantages of the two approaches are mentioned:

Particularly, Simar and Wilson (1998, 2000, and 2007) have mentioned that DEA efficiency scores are serially correlated and biased when used in the two-stage DEA approach. Simar and Wilson (2007) recommend the use of double bootstrapping procedure in the two-stage DEA in order to obtain unbiased and consistently reliable estimates. According to Hesterberg, Monaghan, Moore, Clipson and Epstein (2003), Bootstrapping is a numerical sampling technique where the data sampled are resampled with replacement. This means that you acquire a sample. Place sample values back and then select another sample. In this way you get sample data from which you can generate summary statistics for each resamples. Various descriptive statistics such as mean, median, mode, variance and correlation can be bootstrapped. With the use of a computer the student or researcher can create many resample. Bootstrapping statistics allows the student or researcher to analyze any distribution and make inferences. The sampled data becomes the population and the resampled data are the samples. The advantages of bootstrapping include: verifying assumptions of normality and equality of variances for the population is unnecessary; inferences are valid even when assumptions are not verified; there is no need to determine the underlying sampling distribution for any population quantity and interpretations and results are based upon many observations. Disadvantages include: powerful computers are necessary; randomness must be understood; computers have built-in error and large sample sizes must be generated (Rochowicz, 2011). Several researchers have applied the DEA and SF approaches to estimate efficiency. Some of the studies are reviewed next.

Wadud and White (2000) studied the farm household efficiency of rice farmers in Bangladesh. They compared the SF and DEA methods. The results from the DEA revealed that the mean technical efficiencies estimated for the Constant Returns to Scale (CRS) and Variable Returns to Scale (VRS) assumptions are 0.79 and 0.86, which indicate that there was some inefficiency among rice farmers in the study area. The scale efficiency index of the sampled farmers ranged from 0.62 to 1.00. The mean scale efficiency was 0.92. Most of the farms exhibited mildly decreasing returns to scale under the SF, but increasing and dominantly decreasing returns to scale under the DEA approach. A comparison of the efficiency scores between the SF and DEA models showed that the VRS DEA is greater than that obtained from the SF and that estimated from CRS DEA approach. Greater variability exists in the CRS DEA and VRS DEA efficiency scores than the SF model. The researchers concluded that there was considerable inefficiency among the farmers and that agricultural output could be enhanced through the improvement of technical efficiency without resorting to technical improvements.

The production efficiency of the smallholders' vegetable-dominated mixed farming system in eastern Ethiopia was evaluated by Haji (2007). He used a non-parametric DEA approach and Tobit regression to determine the variables influencing efficiency. The results obtained from the DEA model showed that TE indices ranged from 34% to 100% for the farmers in the sample with an average of 91%. The TE scores for each Decision Making Unit (DMU) were the same under the CRS and VRS DEA model. The mean scale efficiency was nearly 1 for each DMU, implying the absence of scale inefficiency. Stokes *et al.* (2007), using DEA, investigated the efficiency of a group of Pennsylvanian dairy farms to determine factors that contributed to efficiency in production and business management. The results indicated that out of the 34 DMU examined, 6 were DEA-efficient while 28 were not efficient. The 6 efficient DMUs have efficiency scores equal to 1.

Factors affecting TE among coffee farmers in Cote d'Ivoire was investigated by Binam *et al.* (2003). A DEA model was used to compute the farm-level technical efficiency measures of 81 peasant farmers. The results revealed that the TE scores ranged from 2 to

100% with an average of 36% when using CRS, while TE scores using VRS ranged from 5 to 100% with an average of 47% for the farms in the sample. This implies that, if a farmer in the sample were to achieve the TE level of his or her most efficient counterpart, then the average farmer could realize a 64 and 53% cost saving under CRS and VRS assumptions, respectively.

Bayda (2003) evaluated North Dakotan farm production efficiency and financial performance over time. Farm-level efficiency and productivity measures were derived using DEA and Malmquist Total Factor Productivity (TFP) indices for panel data of 130 North Dakotan farms over 7 years. The researcher considered farm technical efficiency (TE) scores under the assumption of CRS, VRS and scale efficiency (SE) using a DEA multiple-input, multiple output model. His results showed that the TE score under the assumption of CRS ranged from 0.05 to 1.00, with an average of 0.75. Under the VRS, the TE scores also ranged from 0.05 to 1.00 However, the TE scores under this assumption were slightly higher than the TE scores under CRS with an average of 0.79. The average SE was 0.96. The results indicated that most farms operated at an efficient scale and, therefore, no significant improvements in SE could be achieved by most of the farms in the sample by changing the scale of their operation. Results from the Malmquist TFP indicated a 1.7% productivity growth per year, which is moderately attributed to technical change.

The technical and scale efficiency of rice farms in West Java was investigated by Brázdik (2006) who identified determinants affecting farms' efficiency. The researcher used a DEA (input-oriented) model to estimate the technical efficiency scores; the results showed that the TE ranged from 0.60 to 0.77 (under the assumption of the time varying production possibility frontier). The average scale efficiency was 0.90. Farmers could reduce their inputs from 23% to 42% while maintaining the same output. Decreasing returns to scale existed among 77% of the farms. Size-efficiency relation analysis showed an inverse relationship between farm size and productivity. Technical inefficiency was caused by the employment of technically inefficient production mixes and not because of size of farming operations.

Gul *et al.* (2009) analyzed the technical efficiency of cotton farms in Çukurova region in Turkey. The researchers used an input-oriented DEA approach to generate technical efficiency estimates. The results showed a mean TE of 0.72 and 0.89 under the CRS and VRS, respectively. The mean scale efficiency was 0.79 and the TE ranged between 0.23 and 1. Sixteen farms under CRS and 26 farms under VRS had efficiency scores of 1, implying that the farms were fully efficient. Technical efficiency during the economic reform in Nicaragua was investigated by Abdulai and Eberlin (2001). The researchers used the translog SF model to examine the TE of maize and beans farmers. The results showed that the average efficiency levels were 69.8% and 74% for maize and beans, respectively. Farmers in the different regions under the study area exhibited different efficiency levels.

Wilson *et al.* (2001) studied the influence of management characteristics on the TE of wheat farmers in eastern England. Using panel data for the 1993-1997 crop years, the researchers utilized the SF production function to achieve the objective of the study. The results indicated a minimum and maximum TE of 50% and 98%, respectively with a mean value of 87%. Bekele (2003) analyzed the effect of farm size on technical efficiency of the Moretna-Jirru District in central Ethiopia. Using the SF approach, the researcher found that among the 8 inefficiency factors postulated to influence technical efficiency of wheat and teft, 5 of them were found to be statistically significant at 1% and 5% test levels. These were land parcels, distance between parcels, number of oxen owned, family size and income per household.

Chirwa (2007) examined the sources of technical efficiency among smallholder maize farmers in southern Malawi. The researcher employed the SF model to achieve the objectives of his study. The results depicted that the coefficients of land, capital, labour, fertilizer, seed, seed fair-quality and seed quality-good included in the production function were positive, but only labour was statistically significant. The mean TE level among the respondents was 46.23%. Measurement and sources of technical inefficiency in the Tunisian citrus growing sector was investigated by Dhehibi *et al.* (2007) using the SF model. The findings showed that the average TE was 86.23% with a minimum of 27% and a maximum of 98%. Hassan (2007) estimated the cost efficiency of wheat farmers in Bangladesh using SF analysis. The results showed an average economic efficiency of 76% among the farmers. This implies that wheat output could be increased by 24% with the existing technology and levels of inputs.

Kamruzzaman and Hedayetul Islam (2008) applied SFA to investigate the TE of wheat growers in some selected sites of Dinajpur district of Bangladesh. The findings indicated that the TE ranged from 40% to 90% with a mean of 70%. Educational level and frequent contact with extension workers had a positive influence on TE of wheat practicing farmers. Obare *et al.* (2010) studied the allocative efficiency of Irish potato producers in Nyandarua north district, Kenya, using SFA. The researcher found a mean allocative efficiency of 0.57 among the farmers, and that the potato production in the study area was characterized by decreasing returns to scale.

Nyagaka *et al.* (2010) studied the technical efficiency in resource use of smallholder Irish potato farmers in Nyandarua north, Kenya. The researchers applied a dual Stochastic Parametric Decomposition Technique to derive the technical efficiency indices, and a two limit Tobit model to examine the influence of socio-economic characteristics and institutional factors on the technical indices. The researchers found that the average technical efficiency was 67%. Education, access to extension, access to credit, membership of farmers' associations and innovations had positive significant effects on technical efficiency. Labour, seed, fertilizer and pesticides had positive influences on the output of the Irish potatoes. According to the researchers, the positive influence of education on technical efficiency implied that more educated farmers were able to perceive, interpret and adopt improved technology. The positive relationship between extension and technical efficiency indicated how important extension was in motivating and educating farmers about existing technology, thereby enhancing efficiency. The researchers added that access to credit enabled farmers to overcome liquidity constraints which enhanced their ability to purchase farm inputs, hence improving efficiency.

Ogisi *et al.* (2012) studied the efficiency of resource use by rice farmers in Ebonyi State, south east Nigeria using the DEA approach. The results revealed that about 6% of the farmers attained technical efficiency of 100%. The technical efficiency ranged from 20% to 100%. Goni *et al.* (2007) analyzed the resource use efficiency in rice production in the Lake Chad area of Borno State, Nigeria. Production function analyses which incorporated the conventional neoclassical test of economic and technical efficiencies were used as the analytical technique. Findings depicted that the farmers were relatively inefficient in the use of all the resources. Generally, however, inputs such as seed, land and fertilizer were underutilized. Otitoju and Arene (2010) studied the constraints and determinants of technical efficiency in medium-scale soybean production in Benue State, Nigeria, using the Stochastic Frontier approach. The findings showed that the average technical efficiency was about 73%. Akinbode *et al.* (2011) applied the SFA to examine the technical, allocative and economic efficiencies of *ofada* rice farming in Ogun State, Nigeria. The results revealed mean technical, allocative and economic efficiencies of 0.73, 0.93 and 0.67, respectively. This showed that there was inefficiency in the technical, allocative and economic areas.

CHAPTER THREE

METHODOLOGY

3.1 Description of the Study Area

Niger State is located in the middle belt of Nigeria which covers a total land area of 76,470 km^2, or about 10 percent of Nigeria's total land area, out of which about 85% is arable (Niger State Bureau of Statistics, 2011). This makes the state the largest in the country with a population of 3,950,249 (National Population Commission, 2006). Using 3.4% growth rate as allowed by National Population Commission, Niger State stands at 4,991,927 (2013 projection). Niger State is located between latitudes 8°20' N and 11°30'N and longitudes 3° 30'E and 7°20'E. The state is bounded in the North by Zamfara State, in the North-West by Kebbi State, in the South by Kogi State, in the South-West by Kwara State and in the North-East and South-East by Kaduna State and the Federal Capital Territory, respectively. Furthermore, the State shares a common international boundary with the republic of Benin at Babanna in Borgu Local Government Area of the State (Niger State Bureau of Statistics, 2011).

The State experiences two distinct seasons: the dry and wet seasons. The annual rainfall varies from about 1,200mm in the south to 1,600mm in the north. The duration of the rainy season ranges from 150 to 210 days or more from the north to the south. Mean maximum temperature remains high throughout the year, hovering at about 32°C, particularly in March and June. The lowest minimum temperatures occur usually between December and January when most parts of the state come under the influence of the tropical continental air mass which blows from the North. Dry season in Niger State commences in October.

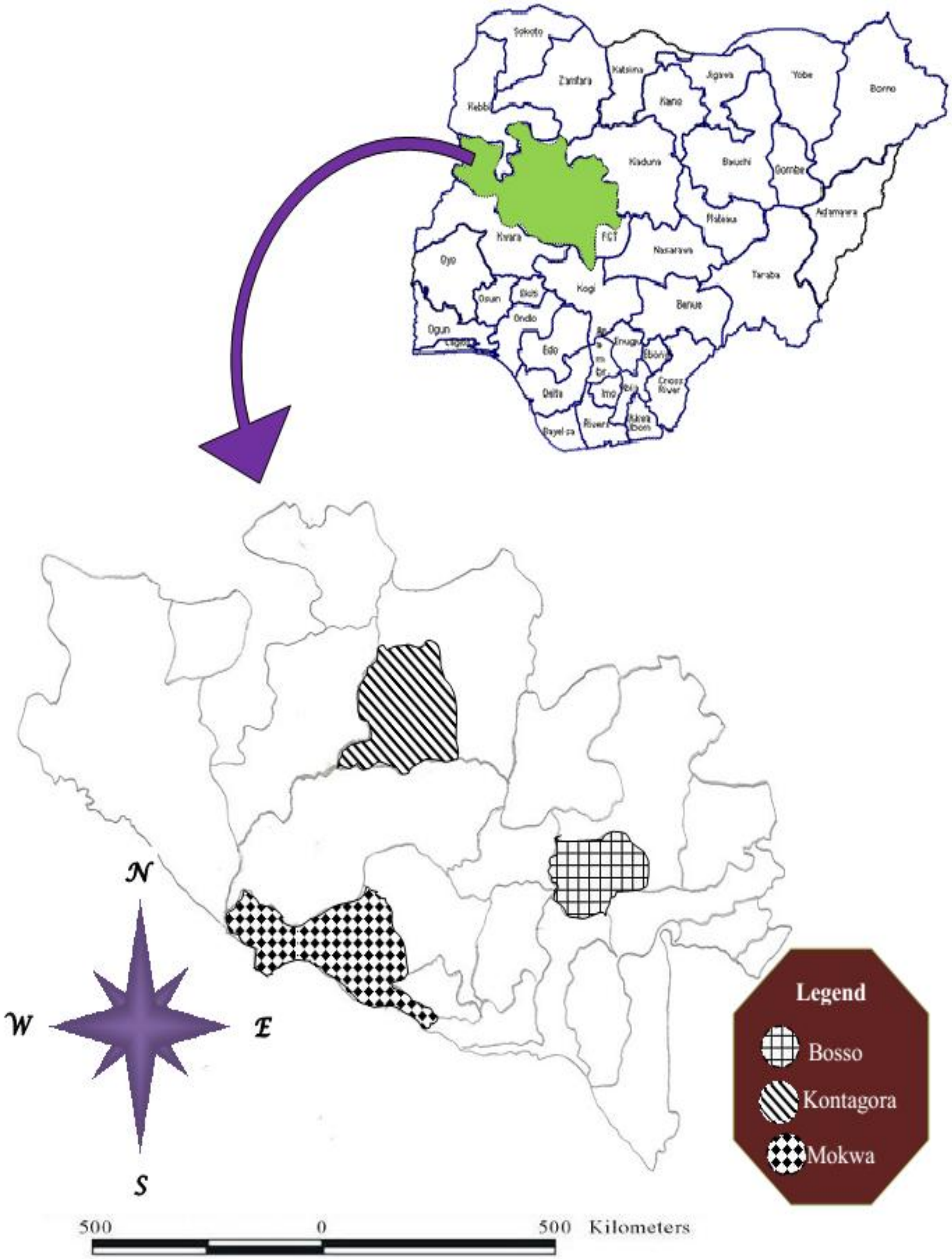

Figure 1: Map of Nigeria showing the study area

3.2 Sampling Procedure and Sample Size

A multi-stage sampling technique was adopted for this study. Three Local Government Areas in the State (Bosso, Kontagora and Mokwa) were purposively selected in the first stage based on their high involvement in cowpea production. In the second stage, 2 villages from each of the local government areas were purposively selected based on high concentration of cowpea production and accessibility. These villages include: Beji and Maikunkele in Bosso L.G.A.; Rafin Gora and Auna in Kontagora L.G.A.; Bokani Tapu and Kpaki in Mokwa L.G.A. Hence a total of 6 villages were selected for the study. From the reconnaissance survey conducted with the extension agents of Niger State Agricultural Development Project (NADP), 15% of the farmers were randomly selected from each of the six villages. In all, a total of 152 respondents as shown in Table 3.1 were selected for the study.

Table 3.1: Distribution of respondents in the study area

LGA's	Villages	Sampling Frame	Sample Size (15%)
Bosso	Beji	127	19
	Maikunkele	181	27
Kontagora	Rafin Gora	205	31
	Auna	154	23
Mokwa	Bokani Tapu	235	35
	Kpaki	108	16
Total	**6**	**1010**	**152**

Source: NADP, 2014

3.3 Data Collection Techniques

Data for this study were collected from primary sources, using structured questionnaire. The questions were structured to elicit answers on the objectives of the study. The data collected during field survey were on the socioeconomic characteristics such as age, gender, household size, farm size, farming experience, access to credit, and level of education. Data on SAMPEA-11 production, cost and returns, constraints to SAMPEA-11 production were also collected.

3.4 Analytical Techniques

The analytical tools that were employed to achieve the objectives and hypotheses of the study include descriptive statistics, gross margin analysis, stochastic frontier production function analysis (SPF), multiple regression analysis and inferential statistic (T-test).

3.4.1 Descriptive statistics

The descriptive statistics such as frequency distribution, mean, percentage, minimum, maximum, standard deviation were used to achieve objectives i and vi of the study.

3.4.2 Gross margin analysis

Gross Margin was used under the assumption that fixed cost component is negligible as in the case with subsistence farming and that the analysis is for short term. Bashir (2004) used gross margin in his study to determine the costs of various inputs and the profitability of carrot cultivation in two districts of Punjab because of its accuracy in estimating profit. Also, Gilbert (2001) carried out a study in which he compared gross margin analysis to total revenue in terms of which method was better in estimating profit. He concluded that gross margin was a more accurate estimate of profit compared to total revenue. From these studies the most accurate and common method of estimating profit is gross margin analysis and this was used to achieve objective ii. It is expressed as:

$$GM = \sum P_{Yi} Y_i - \sum P_{Xj} X_j \qquad (1)$$

Where:

GM = Gross margin (₦);

P_{Yi} = Unit price of the output of SAMPEA-11 (₦)

Y_i = Yield of SAMPEA-11 (kg/ha);

P_{Xj} = Unit price of jth input (₦)

X_j = Total quantity of the jth input

Σ = Summation sign.

Operating Ratio of the farm: The operating ratio is directly related to the farm variable input usage. The lower the ratio, the higher the profitability of the farm business. It is expressed as:

$$OR = \frac{TOC}{GI} \text{ --(2)}$$

Where:

OR = Operating Ratio, TOC = Total Operating Cost and GI = Gross Income

3.4.3 Multiple regression analysis

Multiple regression analysis was employed to achieve objective iii of the study which is expressed as follows:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + e \text{ --3}$$

Y = Yield (kg/ha)

β_0 = Constant

$\beta_1 - \beta_6$ = Parameters to be estimated

X_1 = Quantity of seed (kg/ha)

X_2 = Quantity of herbicide (liters/ha)

X_3 = Quantity of insecticide (liters/ha)

X_4 = Fertilizer (Kg/ha)

X_5 = Labour (man-days/ha)

e= error term

3.4.4 Stochastic frontier production function analysis

The stochastic frontier function was used by Onu *et al.* (2000) and Parikh and Shah (1995) as derived from the error model of Aigner, Lovell and Schmidt (1977). It was employed to achieve objective iv and v of this study. The Cobb-Douglas production function was fitted to the frontier model of SAMPEA-11 production. The model was estimated using the maximum likelihood method. The stochastic frontier production function is expressed as:

$Y_i = f(X_i, \beta_i) + e_i$---4

$e_i = V_i - U_i$ ---5

Where:

Y_i = Yield of the i^{th} farm

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

B = A vector of the parameters to be estimated

e_i = Compressed error term

V_i = Random error outside farmer's control

U_i = Technical inefficiency effects

The empirical stochastic frontier production model that was employed to estimate the technical efficiency and its determinants is specified as follows:

$In\ Y1 = \beta_0 + \beta_1 InX_{1i} + \beta_2 InX_{2i} + \beta_3 InX_{3i} + \beta_4 InX_{4i} + \beta_5 InX_{5i} + V_i - U_i$------------------------6

Where;

Subscripts ij refers to the jth observation of ith farmer,
In = Logarithm to base e,

Y = Yield (kg/ha)

β_0 = Constant

$\beta_1 - \beta_4$ = Parameters to be estimated

X_1 = Quantity of seed (kg/ha)

X_2 = Quantity of herbicide (liters/ha)

X_3 = Quantity of insecticide (liters/ha)

X_4 = Fertilizer (Kg/ha)

X_5 = Labour (man-days/ha)

V_i = Random noise (white noise)

U_i = Inefficiency effects which are non-negative with half normal distribution

It is assumed that inefficiency effects are independently distributed and Uij arises by truncation (at zero) of the normal distribution with mean Uij and variance δU^2 where Uij is specified as;

$U_i = \delta_0 + \delta_1 InZ_{1i} + \delta_2 InZ_{2i} + \delta_3 InZ_{3i} + \delta_4 InZ_{4i} + \delta_5 InZ_{5i} + \delta_6 In\ Z_{6i}$---------------------------7

Where;

Ui = Technical inefficiency of the ith farmer

δ_0 = Constant

$\delta_1 - \delta_6$ = Parameters to be estimated

Z_1 = Farmer's age (years)

Z_2 = Household size of ith farmer (number)

Z_3 = Years of formal education of the ith farmer (years)

Z_4 = Years of farming experience of the ith farmer in crop production (years)

Z_5 = Years spent in cooperative society (years)

Z_6 = Number of contacts with extension agents (measured as number of contacts in a year)

Allocative Efficiency (AE)

The allocative efficiency also known as cost efficiency and its determinants was estimated using the cost frontier dual to the production frontier specified as:

$Ln(C_i) = \alpha_0 + \sum \alpha_i lnP_{ij} + \gamma ln(Y_i^*)$---8

The stochastic frontier cost function can be expressed as follows:

$lnC_i = \alpha_0 + \alpha_1 lnX_1 + \alpha_2 lnX_2 + \alpha_3 lnX_3 + \alpha_4 lnX_4 + \alpha_5 lnX_5 + \alpha_6 lnX_6 + V_i + U_i$ ----------------9

Where:

C_i = Total cost of production (₦)

α_0 = Intercept

X_1 = Cost of seed (₦)

X_2 = Cost of herbicide (₦)

X_3 = Cost of insecticide (₦)

X_4 = Cost of fertilizer (₦)

X_5 = Cost of labour (₦)

X_6 = Output of SAMPEA-11 (Kg)

$\alpha_1 – \alpha_6$ = Vector of parameters to be estimated

V_i = Random variability in the cost of production that cannot be influenced by the farmer

U_i = The deviation from the cost frontier attributed to cost inefficiency.

Economic Efficiency (EE): Economic efficiency or total efficiency is the product of technical efficiency (TE) and allocative efficiency (AE) (Coelli, 1996, Coelli *et al.*, 2005). Based on the technical and allocative efficiency, the economic efficiency was estimated using the following equation:

$EE_i = TE_i * AE_i$---10

Where:

EE_i = Economic efficiency,

TE_i = Technical efficiency, and

AE_i = Allocative efficiency

3.4.5 Inferential statistic

Inferential statistics such as T-test was used to test the hypothesis 1.

T-test statistic for H_{01}: GI = TVC

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{(S_1^2/n_1) + (S_2^2/n_2)}} \text{ -- } 11$$

Where:

$\bar{x}_1$ = Mean of gross income

$\bar{x}_2$ = Mean of total cost

S_1^2 and S_2^2 = variance of gross income and variance of total cost

n_1 = sample size of gross income

n_2 = sample size of total costs.

3.4.6 Variable description:

Age (Z_1)**:** It is a continuous independent variable indicating how old the household head is. This was measured in years and it is believed that experience increases with age and resource endowment, hence giving an increase in efficiency.

Household size (Z_3)**:** This is a continuous independent variable; large family size is normally associated with a higher labor endowment that will enable a household to accomplish various agricultural activities on time.

Level of education (Z_3)**:** This is a discrete variable indicating the educational status of the household head in terms of the number of years spent in school. This was measured in years and an increase in the level of education is expected to increase yield in SAMPEA-11 production of the farmer.

***Farming experience (Z$_4$)*:** This was measured in years. It is hypothesized that increase in years of farming experience will increase production of the farmers.

***Years in cooperative society (Z$_5$)*:** This was measured by the number of years spent in cooperative societies. Membership of a cooperative society is expected to have a positive influence on technical efficiency of farmers.

***Extension contact (Z$_6$)*:** This was measured by the number of contacts with the extension agents within the cropping season. Extension services, if properly implemented, should increase the efficiency of farmers, since farmers would obtain the knowledge of using innovations that will improve their productivity.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Socio-Economic Characteristics of the Respondents

A total of 152 farmers were involved in the study. Socioeconomic characteristics of SAMPEA-11 farmers were considered in this study because of their perceived effects on the agricultural activities of farmers. Table 4.1 summarizes socio-economic characteristics of the households.

4.1.1 Age distribution of the respondents

Farmers within the age bracket of 20 – 45 years (75%) were more involved in SAMPEA-11 production in the study area while about 25% of the respondents were within the age bracket of 46 - 58 years and above. The mean age of the farmers was 39 years which implies that the farmers are still in their economically active age that can make positive contribution to agricultural production. According to Mbanasor and Kalu, (2008), age has a positive and significant relationship with a farmer's economic efficiency. Khan and Saeed (2011) found that age has a positive and significant relationship with the economic efficiency of tomato farmers in Northern Pakistan. The older the farmer, the more experienced he is expected to be, which aids in decision making.

4.1.2 Education of household head

The study reveals that 12.5% of the respondents never attended any formal education, 30% of the respondents had primary education, and 26% had secondary education while 32% had tertiary education. In all 87.5% of the total respondents had one level of educational attainment or the other, implying that they are literate as shown in Table 4.1.

Table 4.1: Socio-economic characteristics of the respondents

Characteristics	Frequency	Percentage
Age of the farmer (Years)		
20 – 32	54	35.53
33 – 45	60	39.47
46 – 58	30	19.74
59 and above	8	5.26
Mean = 39		
Education of household head		
No formal education	19	12.50
Primary	46	30.26
Secondary	39	25.66
Tertiary	48	31.58
Household size		
1 – 7	24	15.79
8 – 14	86	56.58
15 and above	42	27.63
Mean = 10		
Farming Experience (Years)		
1 – 9	63	41.45
10 – 18	79	51.97
19 and above	10	6.58
Mean = 11.7		
Farm Size (Ha)		
0.1 – 1.0	28	18.42
1.1 – 2.0	100	65.79
2.1 and above	24	15.79
Mean = 2.2		
Cooperative society (years)		
0	93	61.18
1 – 5	30	19.74
6 – 11	12	7.89
12 and above	17	11.18
Mean = 6		
Extension Contact		
1 – 3	139	91.45
4 – 7	11	7.24
8 and above	2	1.31
Total	**152**	**100.00**

Source: Computed from field survey data, 2014.

Their educational status is enough to provide them with the ability to read, write, handle and interpret messages relating to their farm operations in the instruction manuals on input and machinery uses, and also enable them to appreciate extension services. Sullumbe, (2004) opined that education is a major determinant of the Nation's economy. He further argues that the level of formal education attained by an individual goes a long way in shaping his personality, attitude to life and adoption of new and improved practices. According to Akinbode *et al*. (2011), education contributes to effective management of resources by farmers, which, in turn, influences the farmers' efficiency.

4.1.3 Household size

The distribution of household sizes of the respondents reveals that about 16% of the respondents had household sizes of between 1 and 7. Also, 56.6% of the respondents had household sizes between 8 and 14 while 27.6% of the respondents had household sizes above 14. Although large family size can sometimes be an asset to the farmers in terms of available work force/labour, often times a farmer is faced with the challenges of providing social and welfare facilities such as feeding, education, shelter, health care and other living expenses for such a large number of dependants. These expenses account for low saving at the end of every harvest season aside the fact that most farm produce are consumed by the large household members. In a related study, Achem *et al.* (2013) also found low overall output from cassava farmers as a result of large family size.

4.1.4 Farming experience of the respondents

Majority (52%) of the farmers in Table 4.1 fell within the range of 10 – 18 years of farming experience; 41% of the respondents fell within the range of 1 - 9 years, while about 7% of the respondents had 18 years and above with a mean of 11.7 years experience in farming. The study shows that the managerial ability of the farmers can be inferred to be reasonably good. The number of years of farming experience has a positive and significant relationship with a farmer's economic efficiency (Mbanasor and Kalu, 2008; Obare *et al.*, 2010). Okoye *et al*. (2006) reported that farming experience has a positive relationship with the allocative efficiency of small-holder cocoyam farmers in Anambra State, Nigeria. This implies that the higher the level of experience of the farmer, the higher his cost efficiency level will be.

4.1.5 Farm size

Table 4.1 shows that majority (66%) of the respondents devoted farmlands ranging from 1.1 – 2.0 hectares, while only 16% devoted 2.1 hectares and above with a mean of 2.2 hectares of land devoted to SAMPEA-11 production. This indicates that the respondents were small-scale farmers. Factors such as long distances to farm site, high cost of land, high cost of labour and low income level could be responsible for this phenomenon. Ogunniyi and Ojedokun (2012) found that farm size had a positive significant relationship with economic and allocative efficiency among rice farmers in Kwara State, Nigeria. Farmers with larger farm sizes are expected to be more cost efficient owing to the advantage of economies of scale, as the unit cost of output decreases with increased production.

4.1.6 Cooperatives society

Majority (61%) of the respondents did not belong to any cooperative organization; about 20% of the respondents had stayed between 1-5 years, 8% had stayed between 6-11 years while 11% had stayed above 11 years with a mean of 6 years spent in cooperative organization by the respondents. The study as shown in Table 4.1 reveals that less than half (39%) of the respondents were members of cooperative societies and had spent various years with a mean of 6 years spent in cooperative organization. Naturally, being members of associations can afford farmers the chance to benefit from financial institutions and /or lending agencies since such requirement is the determinant factor. Farmers who belong to cooperatives are better informed on resources use and farm planning which enables them to utilize resources more efficiently. Membership of cooperative organizations is expected to have a positive influence on allocative efficiency (Obare *et al.*, 2010).

4.1.7 Extension contact

Findings from the study (Table 4.1) revealed that extension contact in a year was between 1-3 contacts for majority (92%) of the respondents, 7% of the respondents had extension contacts between 4-7 times while 1.3% of the respondents had extension contact of 7 contacts and above per year. Through extension visits, farmers become better informed about farm management planning and new technologies, hence improving their efficiency in production. Mbanasor and Kalu (2008) in their study found that the number of extension visits had a significant positive relationship with economic efficiency of commercial vegetable farmers in Akwa Ibom State, Nigeria.

4.2 Profitability Analysis of SAMPEA-11 Production

Though, profitability is an important yardstick for measuring efficiency, the extent of profitability cannot be taken as a final proof of efficiency. Sometimes satisfactory profits can mark inefficiency and conversely, a proper degree of efficiency can be accompanied by an absence of profit. The net profit figure simply reveals a satisfactory balance between the values received and values given (James and John, 2005). The profitability analysis (Gross Margin) (Table 4.2) reveals that the total variable cost (TVC)/ha incurred by the respondents averaged ₦56,328.41/ha, with an average gross income (GI) of ₦125,105.77/ha, which resulted to a gross margin (GM) of ₦68,777.36/ha. A confirmation of profitability of SAMPEA-11 production is shown by the gross margin (GM) of ₦68,777.36/ha and an operating ratio of 0.45 with returns on investment as ₦1.22, indicating that ₦1.22 was realized for every ₦1 a farmer invested in SAMPEA-11 production. Studies of profitability in the North East of Nigeria revealed relatively high profit margins. For instance, Haruna *et al*.'s (2009) study of cowpea farmers in Gombe State revealed a net return of 2.10 naira for every naira invested. Similarly a study of Fadama food crop farmers in Bauchi revealed a return on naira invested of 3.14 naira (David *et al*. 2009). Farms in the northwest have been found to be similarly profitable as a number of studies reveal some profitable crops in this region including cowpea and maize in Katsina State (Abdulsallam, 1997) and cowpea in Kebbi State (Abubakar 2006).

Table 4.2: Gross margin of SAMPEA-11 per hectare cultivated

Description of Items	Average Quantity	Unit Price (₦)	Value (₦)/ha
Gross Income (GI)			**125,105.77**
Inputs			
Seed (Kg)	20.45	122.38	2,502.35
Herbicide (Litres)	5.32	982.59	4,995.52
Insecticide (Litres)	20.61	1008.12	20,298.65
Fertilizer (Kg)	187.17	68.83	12,882.99
Labour (Man-Days)	38.22	435.64	16,648.90
Total Variable Cost (TVC)			**56,328.41**
Gross Margin (GM)			**68,777.36**
Returns to Investment			**1.22**
Operating Ratio			**0.45**

Source: Computed from field survey data, 2014.

4.2.1 Test of hypothesis for profitability of SAMPEA-11 production

The hypothesis which states that SAMPEA-11 production is not profitable was tested using a t-test statistics as shown in Table 4.3. The t-statistics (36.85) was statistically significant at 1% level of probability critical value of α = 1.9744. Thus, hypothesis (i) Bwas rejected and it was inferred that SAMPEA-11 production was profitable in the study area.

Table 4.3: T-test of profitability of SAMPEA-11 production in Niger State

Variable.	Income	Total variable cost
Mean	129372.8947	28117.9183
Variance	1101874408.3067	45637252.4183
Observations	152.0000	152.0000
Hypothesized Mean Difference	0.0000	
Df	163.0000	
t Stat	36.8519	
P(T<=t) one-tail	0.0000	
t Critical one-tail	1.6543	
P(T<=t) two-tail	0.0000	
t Critical two-tail	1.9744	

Source: Computed from field survey data, 2014.

4.3 Input-Output Relationship in SAMPEA-11 Production

Ordinary least squares (OLS) estimates for input-output relationship in SAMPEA-11 production as shown in Table 4.4 reveals that the coefficient of the inputs had positive and statistically significant relationship with the output of SAMPEA-11 at 1%, 5% and 10% levels of probability except and fertilizer (X_4). This implies that increase in these input variables will lead to increase in the output of SAMPEA-11 by the magnitude of their respective coefficients. Furthermore, the coefficient of multiple determination (R^2) shows that the input variables explained 60% variations in the output of SAMPEA-11 farmers while the remaining 40% may be due to error terms and other factors that may not be accounted for by the farmers. Also, the null hypothesis which states that, there is no statistically significant input-output relationship in SAMPEA-11 production was rejected, since the test statistic (F-value of 11.3402) was significant at 1% level of probability.

Table 4.4: Ordinary least squares (OLS) estimates for input-output relationship in SAMPEA-11 production

Variables	**Coefficients**	**Standard Error**	**t Stat**
Intercept	97.0906***	38.7455	2.5059
Seed (X_1)	7.1187**	3.2917	2.1626
Herbicide (X_3)	53.2464***	15.8611	3.3570
Insecticide (X_4)	6.7735**	2.9905	2.2650
Fertilizer (X_5)	0.0911	0.2781	0.3275
Labour (X_6)	3.0176*	1.7643	1.7104
Adjusted R^2	0.5952		
F Statistics	11.3402***		
Observations	152		

Source: Computed from field survey data, 2014.

4.4 Stochastic Frontier Analysis

4.4.1 Stochastic frontier production function analysis of SAMPEA-11

The MLE of the Cobb-Douglass stochastic frontier model with half-normal distribution assumption made on the efficiency error term is presented in Table 4.5. From the study, the estimate of sigma-squared (σ^2) is 0.76 and significantly different from zero at 1% level of probability. This indicates goodness of fit and correctness of the distribution form assumed for the composite error term. Gamma measures the total variation of output from the frontier, which can be attributed to technical inefficiency. The gamma estimate which was 0.26 and significantly different from zero at 1% level of probability shows of 26% variation in output resulting from the technical inefficiencies of the farmers.

Typical of the Cobb–Douglas production function, the estimated coefficients for the specified function can be explained as the elasticities of output of the explanatory variables. The estimate of the parameters of the stochastic production frontier indicated that the elasticity of output with respect to seed (X_1) was positive and statistically significant at 1% level of probability. An increase of 1% in seed will result to an increase in output by 0.284%; the production elasticity of herbicide (X_2) was positive and statistically significant at 1% level of probability implying that 1% increase of herbicide will result in an increase in output by 0.205%; also the production elasticity of insecticide (X_3) was positive and it was statistically significant at 1%. This implies that an increase of 1% in insecticide will result in an increase in output by 0.185%.

Table 4.5: Maximum likelihood estimates results of stochastic frontier production

Variables	Coefficients	Standard Error	T-ratio
Constant	4.5763^{***}	0.3102	14.7535
Seed (X_1)	0.2844^{***}	0.0718	3.9589
Herbicide (X_2)	0.2054^{***}	0.0653	3.1471
Insecticide (X_3)	0.1850^{***}	0.0733	2.5232
Fertilizer (X_4)	0.0163	0.0581	0.2806
Labour (X_5)	0.0747	0.0810	0.9217
Variance parameters			
Sigma-squared (σ^2)	0.7604^{***}	0.0983	7.7355
Gamma (γ)	0.2642^{***}	0.0238	11.1008
Likelihood Ratio Test	14.6646		
Number of observations (n) = 152			

Source: Computed from field survey data, 2014.
$^{***}P<0.01$ $^{**}P<0.05$ $^{*}P<0.10$

4.4.1.1 Elasticity of production and return to scale

A firm's production function could exhibit different types of returns to scale in different ranges of output. Typically, there could be increasing returns at relatively low output levels, decreasing returns at relatively high output levels, and constant returns at one output level between those ranges (Distribution Theory, 2009). The Cobb-Douglas production function was estimated using Maximum Likelihood Estimates (MLE) and the coefficients estimated represented individual elasticities. The elasticities associated with all inputs were less than one in SAMPEA-11 production as shown in Table 4.6. This implies that, a unit increase in the respective inputs would result in less than a proportionate increase in SAMPEA-11 output. The sum of the elasticities also known as

Return to Scale (RS) was 0.7658, this implies positive decreasing return to scale (DRS) at stage II of the production process where every farmer strives to maximize profit and minimize cost of production.

Table 4.6: Elasticity of production and return to scale in SAMPEA-11 production

Variables	**Elasticity of Production**
Seed (X_1)	0.2844
Herbicide (X_2)	0.2054
Insecticide (X_3)	0.1850
Fertilizer (X_4)	0.0163
Labour (X_5)	0.0747
Return to Scale (RTS)	**0.7658**

Source: Computed from field survey data, 2014.

4.4.2 Stochastic frontier cost function analysis of SAMPEA-11

The estimated parameters for the stochastic frontier cost function for SAMPEA-11 production presented in Table 4.7 reveals that the variance parameter estimate for sigma-squared σ^2 was (0.06) and statistically significant at 1% level of probability indicating the presence of a one-sided error component (V_i) in the model. The coefficient estimate for gamma (γ) was 0.90 and was statistically significant at 1% level which implies that about 90% of the variations in the total cost of production of SAMPEA-11 were due to differences in their cost efficiencies.

The coefficient of seed (X_1) was positive and statistically significant at 10% level of probability indicating a positive relationship with total cost of production which implies that a unit increase in the cost of seed will increase the total cost of production by 0.0934. The coefficient estimates of herbicide (X_2) and pesticide (X_3) were positive and were statistically not significant at all levels implying that herbicide and pesticide were not contributing much to the total cost of SAMPEA-11 production. Contrary to an *a priori* expectation, the coefficient of fertilizer (X_4) was negative and statistically significant at 5% level of probability indicating an inverse relationship with the total cost of production which may be due to its misspecification in the model. Also the coefficient estimate of output (X_6) was positive and statistically significant at 1% level of probability which implies that a unit increase in output will increase the total cost of production by 0.4093. However an increase in SAMPEA-11 output may not result in an increase in total cost of production if the increase is generated by an efficient use of the presently available production inputs.

Table 4.7**:** Maximum likelihood estimates result of stochastic frontier cost function

Variables	**Coefficient**	**Standard-Error**	**T-ratio**
Constant	6.4540***	0.8668	7.4461
Cost of Seed (X_1)	0.0934*	0.0506	1.8452
Cost of Herbicide (X_2)	0.0045	0.0121	0.3689
Cost of Insecticide (X_3)	0.1107	0.0731	1.5141
Cost of Fertilizer (X_4)	-0.0721**	0.0302	-2.3875
Cost of Labour (X_5)	-0.1623	0.1485	-1.0929
Output (X_6)	0.4093***	0.1256	3.2587
Variance Parameters			
Sigma-squared (σ^2)	0.5947***	0.0065	9.1772
Gamma (γ)	0.8999***	0.0013	692.2308
Likelihood Ratio Test	6.7824		
Number of observations (n) = 152			

Source: Computed from field survey data, 2014.
***P<0.01 ** P<0.05 *P<0.10

4.4.3 Frequency Distribution of Technical, Allocative and Economic Efficiency

4.4.3.1 Frequency distribution of technical efficiency of SAMPEA-11 farmers

The frequency distribution of technical efficiency levels for SAMPEA-11 farmers in the study area is presented in Table 4.8. The mean technical efficiency was 0.76, which suggests that on average for SAMPEA-11 farms, the observed output was 24% less than the optimum output. This implies that SAMPEA-11 farmers on the average were not technically efficient (0.76) and were 24% less from the maximum possible level due to technical inefficiency on which they can improve by employing the best practices and existing technologies. The results indicate that technical efficiency (TE) indices range from 16% to 98% for farms in the sample, with an average of 76%. This means that if the average farmer in the sample was to achieve the TE level of its most efficient counterpart, then the average farmer could realize a 22% cost savings (i.e., 1 - [76/98]). A similar calculation for the most technically inefficient farmer reveals cost savings of 84% (i.e., 1 – [16/98]). In comparison with previous efficiency studies, Ojo *et al.*'s (2009) study of onion farmers in Sokoto revealed a TE of 0.95, while Usman *et al*.'s (2010) study of sesame farmers reported a much lower mean TE of 0.57.

Table 4.8: Technical, allocative and economic efficiency distribution

	Technical Efficiency		**Allocative efficiency**		**Economic Efficiency**	
Efficiency Level	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
0.10–0.24	6	3.95	16	10.53	23	15.13
0.25–0.49	25	16.45	41	26.97	48	31.58
0.50–0.74	23	15.13	76	50.00	64	42.11
0.75–1.00	98	64.47	19	12.50	17	11.18
Total	**152**	**100.00**	**152**	**100.00**	**152**	**100.00**
Minimum	**0.16**		**0.20**		**0.14**	
Maximum	**0.98**		**0.87**		**0.91**	
Mean	**0.76**		**0.64**		**0.52**	

Source: Computed from field survey data, 2014.

4.4.3.2 Frequency distribution of allocative efficiency of SAMPEA-11 farmers

The frequency distribution of allocative efficiency levels for SAMPEA-11 farmers in Table 4.8 revealed that the farmer with best practice has an allocative efficiency of 0.87(87%) and 0.20 (20%) was for the most allocatively inefficient farmer. The mean allocative efficiency for the respondents in the study was 0.64. This implies that SAMPEA-11 farmers on the average were allocatively inefficient (0.64) and were 36% less from the maximum possible level due to allocative inefficiency. In a similar study, Tanko and Jirgi's 2008 study of arable crop farmers in Kebbi State revealed an overall AE of 0.59.

4.4.3.3 Frequency distribution of economic efficiency of SAMPEA-11 farmers

Economic efficiency is the product of technical and allocative efficiency indices. The combined effect of technical and allocative factors showed that the average economic efficiency level for this sample was only 52%, with the most economic inefficiency level of 14% and the most economic efficiency level of 91% (Table 4.8). These figures indicate that if the average farmer in the sample were to reach economic efficiency (EE) level of its most efficient counterpart, then the average farmer could experience a cost saving of 43% (i.e., 1 - [52/91]). The same computation for the most economically inefficient farmer suggests a gain in economic efficiency of 85% (i.e., 1 – [14/91]). This implies that SAMPEA-11 farmers on the average are economically inefficient (0.52) and were 48% less from the maximum possible level due to economic inefficiency.

4.5 Determinants of Technical, Allocative and Economic Efficiency

4.5.1 Determinants of technical efficiency

The existence of technical inefficiency paves way to find out the sources of inefficiencies among SAMPEA-11 farmers in the study area. Socio-economic variables were considered and estimated in the model and the results are presented in Table 4.9. The hypothesis that there are no inefficiencies was rejected at the 1% level of significance. Positive or negative signs on the coefficients indicate that increase in the variable increases or decreases inefficiency respectively. The signs and coefficients in the inefficiency model are interpreted in the opposite way, such that a negative sign means the variable increases efficiency and vice versa. The result of the inefficiency model shows that the coefficient estimates for education, household size and membership of cooperative society were not statistically significant. This implies that these characteristics did not contribute to technical efficiency in SAMPEA-11 production.

The estimated coefficient for age (Z_1) was negative and statistically significant at 10% level of probability. This implies that farmers who are older tend to be more efficient in SAMPEA-11 production. This is in line with Msuya *et al.* (2008) and Amos (2007) who found that age increases technical efficiency. It is believed that experience increases with age and resource endowment, hence giving an increase in efficiency. On the contrary, Ajibefun and Abdulkari (2004), Ajibefun (2006), Ogundele (2003), and Otitoju and Arene (2010) have stated that age of farming household heads have an inverse relationship with productivity of farmers in Nigeria. They argued that this was understandable since it was expected that as a farming household head becomes older, the farmer's productivity would decline. The coefficient estimate for farming experience (Z_4)

was negative and statistically significant at 1% level which implies that farmers with more farming experience tend to be more efficient in SAMPEA-11 production. This is in line with the findings of Yusuf (2007) who posits that, experience is the first determinant of profitability because it can inform farmers to adjust to changing economic conditions and adopt the most efficient cultural practice. Years of farming experience increase as the age of the farmer increases. Studies conducted in the humid forest and moist savannah agro-ecological zones of Nigeria showed that productivity was positively associated with more experience in farming (Ajibefun and Abdulkadri, 2004; Ajibefun, 2006; Idjesa, 2007; Ogunniyi and Ojedokun, 2012). Gul *et al.* (2009) and Ogisi, Chukwuji, Christopher and Daniel (2012) also found that farming experience has a positive effect on technical efficiency among cotton farmers in Cukurova region, Turkey and rice farmers in Nigeria, respectively. The estimated coefficient of extension contact (Z_6) was negative and was statistically significant at 10% level of probability, implying that farmers with more extension contacts tend to be more efficient in SAMPEA-11 production. This is in consonance with the findings of Akinbode *et al.* (2011), Kamruzzaman and Hedayetul (2008); Ogisi *et al.* (2012) that, increase in extension contact has a positive influence on technical efficiency. Extension services, if properly implemented, should increase the efficiency of farmers, since farmers would obtain the knowledge of using innovations that will improve their productivity.

Table 4.9: Determinants of technical efficiency

Variable	Coefficient	Standard Error	T-ratio
Constant	0.2650	0.1941	1.3648
Age (Z_1)	-0.0079*	0.0041	-1.9103
Education (Z_2)	-0.0067	0.0093	-0.7190
Household Size (Z_3)	0.0134	0.0141	0.9537
Farming experience (Z_4)	-0.0073***	0.0028	-2.6071
Years in cooperative society (Z_5)	0.0340	0.0855	0.3976
Extension contact (Z_6)	-0.0623	0.0404	-1.5429

Source: Computed from field survey data, 2014.
***P<0.01 ** P<0.05 *P<0.10

4.5.2 Determinants of allocative efficiency

According to Jordaan (2012), most of the variables hypothesized to influence cost efficiency were not significant in explaining the cost efficiency of raisin farmers in Eksteenskuil, South Africa. He argued that the timely and sufficient application of important production inputs was hardly being achieved by the raisin farmers because they had only limited resources at their disposal. Farmers tend to apply whatever quantities of inputs are available to them or the quantities of inputs they can afford.

The determinants of allocative efficiency (Table 4.10) show that coefficient estimates of educational level, household size, years in cooperative society and extension contact had negative signs and only extension contact was statistically significant at 1% level of probability; implying that higher educational level, household size, longer years in cooperative society and extension contact would decrease the total cost of production and thereby reduce allocative inefficiency. The coefficient estimate of years in cooperative society (Z_5) was in consonance with *a priori* expectation; years in cooperative organizations are expected to have a positive influence on allocative efficiency (Obare *et* *al.*, 2010). Farmers who belong to cooperatives are better informed on resources use and farm planning which enables them to utilize resources more efficiently. In the same manner, age was positive and statistically significant at 5% level of probability implying that an increase in this variable will lead to decrease in allocative efficiency. This goes in line with the findings of Okoye *et al.*, (2006) and Akinbode *et al.*, (2011) that reported a negative relationship between age and allocative efficiency.

Table 4.10: Determinants of allocative efficiency

Variable	**Coefficient**	**Standard Error**	**T-ratio**
Constant	0.5859	0.7746	0.7564
Age (Z_1)	0.0042^{**}	0.0021	2.0072
Education (Z_2)	-0.0002	0.0067	-0.0269
Household Size (Z_3)	-0.0044	0.0062	-0.7051
Farming experience (Z_4)	-0.0024	0.0043	-0.5545
Years in cooperative society (Z_5)	-0.0282	0.0467	-0.6035
Extension contact (Z_6)	-0.0236^{***}	0.0012	-19.6667

Source: Computed from field survey data, 2014.
$^{***}P<0.01$ $^{**}P<0.05$ $^{*}P<0.10$

4.5.3 Determinants of economic efficiency

The determinants of economic efficiency of SAMPEA-11 farmers as shown in Table 4.11 reveals that the coefficient estimates of household size (Z_3), years in cooperative society (Z_5) were positive but were not statistically significant. The coefficient estimates for age (Z_1), education (Z_2), farming experience (Z_4) and extension contact (Z_6) were negative and only age; education and extension contact were statistically significant at 1% and 5% level of probability. These were consistent with *a priory* expectation and it indicates that an increase in these variables will increase economic efficiency of SAMPEA-11 farmers. This result is in line with Mbanasor and Kalu (2008) who found that the number of extension visits had a significant positive relationship with economic efficiency of commercial vegetable farmers in Akwa Ibom State, Nigeria. Similar results were obtained by Obare *et al*. (2010) and Khan and Saeed (2011). Through extension visits, farmers become better informed about farm management planning and new technologies, hence improving their efficiency. Furthermore, the adjusted R^2 shows that the inefficiency determinants explain 49% variations in the economic efficiencies of SAMPEA-11 farmers in Niger State. Also, the null hypothesis that the socio-economic characteristics of SAMPEA-11 producers do not significantly influence the efficiency of the farmers was rejected, since the test statistics with an F-statistic of 16.0259 was significant at 1% alpha level given a p value of 0.000.

Table 4.11: Ordinary least square estimates of the determinants of economic inefficiency

Variable	**Coefficient**	**Standard Error**	**T-ratio**
Constant	0.5859^{**}	0.2746	2.1336
Age (Z_1)	-0.0294^{**}	0.0141	-2.0851
Education (Z_2)	-0.0173^{***}	0.0067	-2.5821
Household Size (Z_3)	0.0291	0.0142	2.0492
Farming experience (Z_4)	-0.0059	0.0043	-1.3721
Years in cooperative society (Z_5)	0.0018	0.0467	0.0385
Extension contact (Z_6)	-0.0959^{**}	0.0404	-2.3738
Adjusted R^2	0.4870		
F-Statistics	16.0259^{***}		

Source: Computed from field survey data, 2014.
$^{***}P<0.01$ $^{**}P<0.05$ $^{*}P<0.10$

4.6 Constraints to SAMPEA-11 Production

Constraints could be seen as difficulties experienced by the respondents cultivating SAMPEA-11 in the study area. The major constraints to the effective production of

SAMPEA-11 as identified by the respondents were ranked and presented in Table 4.12. Insect attack was indicated by 33% of the respondents as one of the major constraint to production which contributes to management difficulties during the production period and storage. The insects attack both the foliage and the developing pods resulting in the reduction of quality and quantity of SAMPEA-11. Financial constraints were mentioned by 21% of the respondents. Financially constrained farmers usually make use of what is available to them in other to survive in their enterprise which often times, may lead to producing below expectation or crop failure in some cases. Eighteen percent (18%) of the respondents complained about the activities of middlemen which ranked third. Middlemen usually take advantage of financially constrained farmers by buying their produce at cheap rates to sell at a higher rate thereby making more profits than the farmers. This attests to the fact that inadequate capital to expand their production and exploitation by the middlemen is slowing down their production and reducing their profit margin. High cost of fertilizer and agro-chemicals were reported by 16% of the respondents ranking fourth from the distribution. These usually occur at the peak of the season when demands are high from the farmers which as a result leads to the adulteration of these inputs dubious marketers that would invariably reduce the efficacy of these inputs. As a result, these inputs especially insecticides performs below expectation which translates to crop failure. Transportation problems as a result of inadequate road networks linking the rural and the urban areas were reported by 8% of the respondents which ranked fifth. A farmer incurs more costs per bag in transporting his/her few bags to urban markets making less profit compared to the middlemen who hire heavy trucks that are less expensive per bag because of the bulk transportation. Lack of market outlet was reported by 4% of the respondents ranking sixth in the distribution and this may be as a result of the domino effect of the previous constraint which can invariably reduce the chances of attaining their production goals.

Table 4.12: Distribution of Constraints faced by SAMPEA-12 Producers

Constraints	**Frequency**	**Percentage**	**Rank**
Insect attack	96	33.33	1st
Financial constraint	60	20.83	2nd
Activities of the Middlemen	52	18.06	3rd
High cost of fertilizer and agro-chemicals	45	15.63	4th
Bad roads	23	7.99	5th
Market outlet	12	4.17	6th
Total (n)	**288**	**100**	

Number (n) > 152 implies multiple responses

4.7 Test of Hypotheses

The tested hypotheses from the study are presented in Table 4.13. The first hypothesis which states that SAMPEA-11 production is not profitable was tested using a t-test statistics as shown in Table 4.13. The t-statistic (36.85) was statistically significant at 1% critical value of $\alpha = 1.6543$ signifying that SAMPEA-11 production is a profitable enterprise. Therefore the null hypothesis was rejected in favour of the alternative hypothesis. Secondly, from the Ordinary Least Squares (OLS) estimates, F Statistic (11.3402) was statistically significant at 1% level given a p value of 0.0000 as shown in Table 4.13. This implies that there is a significant relationship between the physical inputs and the output of SAMPEA-11. Therefore, the null hypothesis is rejected. Finally, the third hypothesis was tested using the Gamma-statistic as one of the variance parameters from the stochastic production function model. The gamma estimate (0.2642) in Table 4.13 was statistically significant at 1% level of probability which implies that there is significant relationship between efficiency and socioeconomic characteristics of SAMPEA-11 farmers in the study area. Therefore, the null hypothesis is rejected.

Table 4.13: Test of hypotheses

Hypotheses	**Test-Statistics**	**Value**	**H_0**
Hypothesis i	T-test	36.8519^{**}	Reject
Hypothesis ii	F-test	11.3402^{***}	Reject
Hypothesis iii	Gamma	0.2642^{***}	Reject

Note:

Hypothesis i = SAMPEA-11 production is not profitable in the study area, Hypothesis ii = Input-output relationship in SAMPEA-11 production is not statistically significant, Hypothesis iii = The socio-economic characteristics of SAMPEA-11 producers do not significantly influence their efficiency.

***P<0.01 ** P<0.05, **H_0 =** Null Hypothesis

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Summary

The empirical study was to evaluate the economics of SAMPEA-11 variety of cowpea production in Niger State, Nigeria. The findings revealed that the respondents were literate with mean age of 39 years; majority (57%) of the respondents had household sizes between 8 and 14 people and majority (52%) of the respondents had 10 – 18 years of farming experience. About 66% of the respondents cultivated 1.1 – 2.0 hectares which indicates that the respondents were small-scale farmers. The mean of 6 years in cooperative society was recorded with 61% of the respondents not belonging to any cooperative organization; extension contact of 1-3 contacts per year by majority (92%) of the respondents was revealed. The total variable cost (TVC)/ha incurred by the respondents averaged ₦56,328.41/ha, with an average gross income (GI)/ha of ₦125,105.77/ha which resulted to a gross margin (GM) of ₦68,777.36/ha. The profit earned from SAMPEA-11 was statistically significant at 1% level of probability, therefore, the null hypothesis was rejected and the alternative hypothesis was accepted.

A Cobb-Douglas stochastic production frontier approach was estimated by maximum likelihood estimation method to obtain ML estimates and inefficiency determinants. The MLE results revealed that technical efficiency of small scale SAMPEA-11 farmers varied due to the presence of technical inefficiency effects in SAMPEA-11 production. The results further revealed all the inputs (seed, herbicide, pesticide, fertilizer and labour) were positively signed implying that an increase in these variables will lead to an increase in the output of SAMPEA-11 by a percentage corresponding to the coefficient of the variable. Quantity of seed used, herbicide, and insecticide were significant at 1% level of probability. The determinants of technical inefficiency for the production of SAMPEA-11 were age, educational level, household size, farming experience, membership of cooperative society and extension contact. These variables except household size and membership of cooperative society were negatively signed indicating a negative effect on technical inefficiency, hence, a positive effect on technical efficiency. The results of the inefficiency model showed that age and farming experience significantly increased the farmers' technical efficiency.

Cost of seed, herbicide, and insecticide and output were the variables that affect total cost of production positively which indicates an increase in the cost of any of these variables will lead to increase in the total cost of production of SAMPEA-11. This implies that cost of SAMPEA-11 production is affected by these variables. The coefficient estimates for the cost of fertilizer and of labour were negative indicating an inverse relationship with the total cost of production. The determinants of allocative inefficiency in SAMPEA-11 production were identical to that of technical inefficiency. All the coefficient estimates of the determinants except age and extension contact were negatively signed indicating a positive effect on allocative efficiency. Economic efficiency which is the product of technical and allocative efficiency was estimated from which the general efficiency distribution of the respondents revealed that the mean technical, allocative and economic efficiencies were 0.76, 0.64 and 0.52, respectively. Invasion of pests, bad roads, inadequate capital, activities of middlemen, and high cost of inputs were identified as the major constraints by the respondents.

5.2 Conclusion

The study revealed that in spite of the abundant potentials of cowpea production in the study area, available resources were not fully tapped. SAMPEA-11 producers in the study area possess a lot of agricultural know-how, skill and expertise in farming under difficult conditions and constraints. It was also revealed that SAMPEA-11 production in the study area was profitable. This means that the area has great potential to increase SAMPEA-11 production and farmer's income, if effort are made for the widespread adoption of new technologies and identified constraint are addressed. The null hypotheses were rejected and also seed, herbicide and insecticide have positive impact on output of the farmers. The elasticity of production (0.7658) was less than 1 indicating a positive decreasing return to scale (DRS) at stage II of the production process where every farmer strives to maximize profit and minimize cost of production. Results showed that SAMPEA-11 farmers were not fully efficient in their resource allocation and therefore there is allowance for efficiency improvement by addressing some important policy variables that could positively influence farmers' levels of efficiency in the area. Age, education, farming experience and extension contact were determining factors contributing positively to technical, allocative and economic efficiency while pests, bad roads, insufficient credit, activities of middlemen, and high cost of inputs were major constraints to SAMPEA-11 production in the study area.

5.3 Contribution of the Study to Knowledge

i. The study revealed that SAMPEA-11 production in the study area is profitable with the gross margin of ₦68,777.36/ha despite the constraints identified. The average rate of returns is ₦1.22, indicating that for every ₦1 a farmer invested ₦1.22 was realized as profit with an operating ratio of 0.45.

ii. The efficiency distribution of the respondents from the study revealed that the mean technical, allocative and economic efficiencies were 0.76, 0.64 and 0.52 respectively.

iii. The study discovered that pests, bad roads, inadequate capital, activities of middlemen, and high cost of some inputs (fertilizer and agrochemical) were the major constraints to SAMPEA-11 production in the study area.

5.4 Recommendations

Based on the findings of this study, the following recommendations were made:

i. Farmers in the study area need to form viable cooperative societies to enable them access improved inputs especially appropriate inorganic fertilizers, herbicide, pesticides and institutional credit at reasonable costs.

ii. Promote intensive collaboration among institutions, governmental extension departments and farmer associations in order to implement farming experiments and best management practices (e.g., optimizing input application of fertilizers, herbicide and insecticide).

iii. In light of the above recommendation it would be beneficial to increase effort in the development of markets for cowpeas and development of a sustainable value chain. Value addition to cowpeas should also be considered as well as production of raw materials from cowpeas that could be used in industry.

iv. Soft and long term loans should be made available to farmers to reduce the pressure on them to sell immediately after harvesting their produce in order to settle their debts when prices are relatively low due to glut. This will check the excesses of the middlemen who usually take advantage of such farmers.

v. Efforts should be made by the State and Federal Government as well as donor institutions to make farming less labour intensive through introduction of mechanization to avert inefficiencies resulting from use of labour in the state.

vi. Investments in rural education through effective extension delivery program in the current political and economic environment in Nigeria will provide farmers with the skills essential to increasing efficiency.

5.5 Area of Further Research

Further studies should be carried out using adequate models and panel data (if possible) to verify the magnitude and major sources of the differences in the effects of determinants of technical efficiency of SAMPEA-11 in the various cowpea producing zones of the state and the country at large with a view of designing policies based on each zone's peculiarities.

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APPENDIX

QUESTIONNAIRE

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

TOPIC: PROFITABILITY AND EFFICIENCY OF SAMPEA-11 VARIETY OF COWPEA PRODUCTION IN NIGER STATE, NIGERIA

The questionnaire comprises of four sections A to D

A. **SOCIO-ECONOMIC CHARACTERISTICS**.

1 Gender/Sex: (a) male (b) female

2 Age: --

3 Number of years spent on educational---

4 Marital status (a) Married (b) single (c) Widowed (d) Divorced

5 Size of household at time of interview (excluding visitors)----------------------------

6 Main occupation: (a) Farming (b) Trading (c) Formal employment (d) Casual work (e) Others (specify)--

7 How many years cowpea farming experience do you have?---------------------------
----

8 How do you acquire your land? (a) Inheritance (b) Purchase (c) Rent (d) Borrow

9 Do you engage in off-farm occupation? (Indicate the type(s) of occupation)--------

10 Do you have contact with extension agent? Yes ( ) No ( )

11 If yes, how many times does the extension agent visit you in a year?-----------------

12 How many times have you visited the extension agent in a year-----------------------

13 Are you a member of any cooperative association? Yes ( ) No ( )

14 If yes, for how long have you been a member?----------------------------------(years)

15 Is credit readily available to you? Yes ( ) No ( )

16 If yes, from where do you source your credit? (a) Banks ( ) (b) Money Lenders ( ) (c) Cooperatives ( ) (d) Friends and relatives ( ) (e) Others specify-------------------

B. PRODUCTION INFORMATION ON SAMPEA-11

17 Size of total farm land you own--(ha)

18 Size of plot devoted for cowpea production--(ha)

19 Is the land sufficient for your needs? Yes ( ) No ( )

20 Do you have access to inputs from government agencies Yes ( ) No ( )

21 How many litres of herbicides did you purchase for your farm?------------------(lts)

22 How many litres of insecticides did you purchase for your farm?----------------(lts)

23 How many kg of seeds did you purchase for your farm?---------------------------(kg)

24 How many bags (kg) of fertilizer did you purchase for your farm?--------------(kg)

25 What is the main source of labour for SAMPEA-11 production? a) Family labour (b) Hired labour (c) Both

26 Activity labour demands in SAMPEA-11 production for last season

Activity	**Type of worker**					
	Human		Work bulls		Tractor	
	No.	Days	No.	Days	No.	Days
Land preparation						
Planting						
Fertilizer application						
weeding						
Spraying						
Harvesting						
Threshing (drying, packaging and storage)						
Transport to market						

27 Do you practice mixed cropping or crop rotation? Yes ( ) No ( )

28 If Yes, which other crop(s) do you grow?--

C. MARKETING INFORMATION

29 When do you sell your produce? Immediately ( ) Delayed to peak price ( ) Others (specify)---

30 Where do you sell your produce? At home ( ) Farm gate ( ) Market ( )

31 Does the selling price affect your level of production? ( ) Yes ( ) No
If Yes, in what way? Increase in production ( ) Decrease in production ( )
Increase in income ( ) Decrease in income. ( ) Other (specify)…………………….

32 In what form did the income realized spend? Home expenditure ( ) Children's Education ( ) Acquiring farm input(s) ( ) Building house ( ) Others (specify)……………………………………………………………………….

33. Costs and Returns in the production of sampea-11 variety of cowpea

Please fill in the table below

Variable Inputs	**Price/unit or day (₦)**	**Total (₦)**
Seeds		
Land preparation		
Planting		
Weeding		
Herbicides		
Pesticides		
Spraying		
Harvesting		
Threshing		
Tranportation		
Output		
Number of bags Harvested (100kg)		

D. PROBLEMS ENCOUNTERED/SUGGESTIONS

34. What are your major production problems?

Thank you.