ECONOMIC ANALYSIS OF GUAVA (*Psidiunguajava*) PRODUCTION AMONG SMALL HOLDER FARMERS IN SELECTED LOCAL GOVERNMENT AREAS OF KADUNA STATE, NIGERIA

BY

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

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MAY, 2015

DECLARATION

I hereby declare that this thesis titled "**Economic analysis of guava(*Psidiunguajava*) production among small holder farmers in selected local government areas of Kaduna State, Nigeria"** has been written by me and it is a record of my research work. No part of this work has been presented in any previous application for another degree or diploma at any institution. All citations and sources of information are duly acknowledged by means of references.

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CERTIFICATION

This thesis titled "**Economic analysis of guava(*Psidiunguajava*) production among small holder farmers in selected local government of Kaduna State, Nigeria",** by SaniAlhaji LAWALmeets the regulations governing the award of the Degree of Master of Science, Ahmadu Bello University, Zaria, and is approved for its contribution to scientific knowledge and literary presentation.

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

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Abstract

The main focus of the study was to analyze the economic efficiency of guava production among smallholder farmers in Kaduna state. Primary data were collected from 126 respondents using structured questionnaire. The statistical tools used to analyze the data were descriptive statistics, net farm income and stochastic production frontier function model. The result of the analysis shows the average of the respondent as 34 years, the majority of the farmers (85%) were literate while 15% had no formal education. The average household size was 5 persons. Majority of the farmers, (61%) were not members of a cooperative society. About 87% of the respondents do not hadextension visit while 100% of guava farmers have farming experience range from 1-2 years with an average of 1years. The total revenue (TR) was ₦266,926.8 while the total cost (TC) was ₦97,213.07 per hectare of guava farms. The net farm income was therefore ₦169,749.73 per hectare of guava farms. The average rate of return on investment (return per naira invested) is ₦2.75, indicating that for every ₦1 invested in guava production in study area; a profit of ₦1.75 kobo was made. The parameters of the stochastic frontier production function were estimated simultaneously with those of the model of inefficiency effects. Results indicated that of the variables seed, fertilizer and labourwere significant ($P < 0.01$, 0.05and 0.10). The mean technical efficiency for the 126 sampled farmers in the study area was 0.82. The contribution from guava amounted to 68% of total household farm income. The potential impact of guava production on farmers' income was carried out by comparing the profit of guava producing farmers and non-guava producing farmers in the study area. Study revealed that constraints to guava production in the study area were pest and disease (90%), inadequate capital (42%), high cost of inputs such as seeds, fertilizer and labour(31%,3% and 7%) respectively, high cost of transportation (4%) and lack of access to market (31%).It is recommended that farmers should form co-operative association through pooling of resources together for a better expansion, efficiency and effective management of resources and for profit maximization.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Guava (*Psidiumguajava*) belong to the family *Myrtaceae*. It has been cultivated in Nigeria since early 17th century and is one of the most common fruits in Nigeria (Mishra *et al.,* (2000). It has become popular because of its availability almost throughout the year. It occupies an important place immediately after Mango, Banana and Citrus (Malleswari, 1996). Guava is a medium sized tree with about thirty feet height. The tree does not demand any close attention as banana and citrus (Byresh, 2007). Guava is more resistant to drought than most of the fruit trees and withstands summer temperature as high as 46^0C (Taiwo*,*2005). The crop is adaptable to a diversity of soil and climate conditions. It is found to grow satisfactorily in all parts of the country (Annon, 2005).It can be grown in the plains provided sufficient care is taken to shelter the trees against frost, cold, winds particularly in their first two or three year of growth. It also grows well even in zones of scanty rainfall areas such as in the north-eastern part of Nigeria provided irrigation facilities are available. (Anonymous, 2008).

Guava fruit is best relished when perfectly ripe and fleshly plucked from trees. It emits a sweet aroma and is pleasantly sweet and refreshingly acidic in flavor (Abu-Goukh and Bashir, 2003). Guava fruit contains moisture (82%), proteins (7%) and carbohydrate (11%); it also contains three to six times more vitamin C than orange, 10-30 times more than bananas and 50-60 times vitamin C than apple fruit (Mungai, *et al.*, 2000; Nyoro, *et al*., 2004). Except guava, no fruit is available throughout the year (Wilson, 1980). Because of high calorie value, guava fruit has achieved fame as 'poor man's' apple in Nigeria. The "Strawberry Guava" notably contains only 30-40mg of vitamin C per 100mg serving. Vitamin C content in the "Strawberry Guava" is still a high percentage (62%) (blankenship and dole,2003). Guava is very delicious fruit, many favourite and tasty items are made from guava and these products are imported all over the world such as, guava jelly, guava syrup, guava cheese, roll etc (Brown, 1980). A few years ago, guava may have been domesticated but not cultivated commercially.

Guavas are also useful source of calcium, nicotinic acid, phosphorous and soluble fibre. These are very good for immune system and are beneficial in reducing cholesterol and protecting the heart, guava contains no saturated fat sodium or cholesterol. Guava would have become one of the most important fruits with the progress of caning and by product of industries. However, the guava holds out bright promise as one of the remunerative fruit crops all over Nigeria. This is cultivated in Kaduna and being supplied to many part of the country. The fruit is sour and is therefore utilized for processing into different products instead of being consumed as fresh fruit. In Nigeria, many variety grown are fleshy, juicy with agreeable sweet taste and therefore, relished more fresh fruits, a small portion is utilized for preservation. Guava is cultivated in almost all the districts in Kaduna State.

Guava products have great potentials, for example they serve as food for man and are also rich in unsaturated fatty acid and protein, but low in saturated fat and soluble sugars. High level of poly unsaturated fatty acid which lower cholesterol level in blood and particularly with high nutritional significance (Nnandi, 1998). The uses of guava as industrial raw material, for the production of medicine, wine livestock feed, and in gallery has also be documented by some authors and organizations (Nnandi, 1998; Deckers*et al.,* 2001; FAO, 2008). This means that guava products can meet both the food and industrial needs of Nigeria, apart from being an export crop. Guava production to keep pace with increasing demand in the international market, researchers must explore ways of increasing hecterage under cultivation, minimizing production cost and ensuring efficient utilization of resources in other to increase production to meet consumer demand both locally and internationally.

1.2 Problem Statement

Nigeria's agricultural sector has over the year witnessed tremendous decline in its contribution to the national development, contributing 40.2% of gross domestic product (GDP), in 2011 and 39.2% in 2012 (CBN, 2012). This has affected adversely the traditional role agriculture plays in the economy of Nigeria as a foreign exchange earner, and as a source of income and employment generation for farmers (Balogun, 2008).

Horticultural crop (guava) production in Nigeria has been hampered by the policy and fiscal constraints of the governments. It has received very little attention in the national perspective plan for agricultural development (Oseni, 2004). In addition, Nigeria has only one horticultural research institute, National Horticultural Research Institute (NIHORT) established in 1975 for all horticultural crops (guava, mango, cashew, and pawpaw). NIHORT has developed many improved varieties of fruits that farmers could adopt in order to improve their income generation and output level.

Although, numerous technologies have been developed as a means to extend guava shelf-life and quality. Many farmers have adopted theses production technologies and are now investing in guava production enterprise in commercial scale. However, information on the level of production and profitability on this economic crop is lacking. This study therefore intends to provide answers to the following research questions:

i. What are the socio-economic characteristics of guava farmers?
ii. How profitable is guava production in the study area?
iii. What is the technical, allocative and economic efficiency of guava production in the study area?
iv. What are the determinants of efficiency in guava production?
v. What is the contribution of guava production to household income?
vi. What is the potential impact of guava production to farmers’ income?
vii. What are the constraints to guava production in study area?

1.3 Objective of the Study

The main objective of this study was to analyze the economics of guava production among small holder’s farmers in Kaduna state. The specific objectives were to:

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

ii. determine the profitability of guava production in the study area;

iii. estimate the technical, allocative and economic efficiency of guava production

in the study area;

iv. estimate the determinants of efficiency in guava production in the study area;

v. determine the contribution of guava production to household income;

vi. determine the potential impact of guava production to farmers income and

vii. identifybe the constraints to guava production in the study area.

1.4 Justification of the Study

The study focused on the economic analysis of guava production among smallholder farmers in selected local government areas of Kaduna State. This study is expected to provide valuable information on profitability and production efficiency of growing guava to enable farmers consider its production as a viable option. The findings of this study when completed would be useful to farmers especially guava producers and other farmers specialized in other area of tree crops production.This would help farmers and other agencies by identifying problems faced guava producersfor improvements. Similarly, the study would provide invaluable information to the government of Kaduna State, as a basis for policy formulation for guava production in the State, It is hoped that this work would be of assistance to researchers and add to the existing knowledge in guava production among small holder farmers in Kaduna state.

CHAPTER TWO

LITERATURE REVIEW

2.1Economic Importance of Guava

The fruit of guava is very rich in Vitamin C, which is substantially higher than what is found in citrus (Alagumani, 2005). It is also a good source of Vitamin A and other important elements. The fruit contains a large amount of citric, lactic, malic, oxalic and acetic acids and trace amount of formic acid (Alagumani, 2005).

The ripe fruit of guava is usually eaten as dessert. It can also be utilized in many ways for making jellies, jam, paste, juice, baby foods, puree, beverage base, syrup, wine and other processed products (Basseto*et al.*, 2005). It may be eaten sliced with cream and sugar and as ingredient in cakes and pies. It is also used in dishes like “sinigang” (Silva *et al.,* 2005). Some parts of guava tree have medicinal and commercial uses. The bark and leaves are used in childbirth to expel the placenta. The leaves can be made into tea and astringent decoction which can cure stomachache and act as vermifuge. When crushed or chewed, it is used for toothache treatment; pounded leaves may also be applied locally for rheumatism; can also be used for dyeing and tanning (Millins*et al*., 2000). The bark is sometimes used in complex cosmetics for hystero-epilepsy. Its wood is moderately strong and durable indoor and useful for handle and in carpentry and turnery (Silva *et al.,* 2005).

Guava fruit is best relished when perfectly ripe and freshly plucked from trees. It emits a sweet aroma and is pleasantly sweet and refreshingly acidic in flavor. It is wholly edible along with the skin which is papery thin and almost merges with the pulp (Shivanand 2002). Guava is considered as one of the most delicious and luscious fruits. The fruit is richer in many respects like proteins, carbohydrates, minerals etc. than that of apple and contains 50-60 times vitamin C than the apple fruit. It is next to the India goose berry in vitamin C content. Except guava, no fruit is available throughout the year. Because of high calorie value, guava fruit has achieved fame as “Poor man’s apple” in our country. Since human body is not capable of storing vitamin C in a small quantity and must be taken daily for proper health. The daily requirement of vitamin C for an adult is 50-70 milligrams which can be met by including one or two guava fruits in daily diet (Sephen*et al.,* 2002).

Mishra *et al.,* (2000), said that, shell of ripe fruit makes an excellent salad and delicious pudding and is preeminently a fruit for jelly making and preparing many other kinds of preparations like jams, jelly, ice-cream, guava paste etc. It can also be canned in sugar syrup or made into fruit butter. These are delicious in taste, tonic, cooling and laxatives. Immature fruits also act as astringent and are used in the treatment of diarrhea and dysteny (Alice, 2014). The guava juice may be used in the preparation of sherbets, ice-creams. The juice keeps well and could be used as substitutes for orange or tomato juice in feeding babies. The products of guava are largely in demand not only within the country but also outside and therefore the potential of foreign markets can be exploited.

Silva *et al*., (2005), noted that guava would have become one of the most popular fruits with the progress of canning and by-product of industries. However, the guava holds out bright promise as one of the remunerative fruit crops all over India. This is cultivated in Bihar and being introduced in many other parts of the country. In tropical countries guava is generally found in wild state and the fruit is sour and is therefore utilized for processing into different products instead of being consumed as fresh fruit. In India on the other hand many of the variety grown are fleshy, juicy with agreeable sweet taste and therefore relished more as fresh fruits. A small portion is utilized for preservation.

Guava Producing Countries

Currently, Nigeria is the world's number ten producers of guava in the world, accounting for up to 795000metric tones annually (FAO, 2011). The table below shows the top twenty (20) guava producing countries in the world.

Table 1: Top twenty (20) guava producing countries in the world

Rank	Countries	Production (MT)
1	India	15188000
2	China	4519380
3	Indonesia	3277250

4	Thailand	2131140
5	Pakistan	1888450
6	Mexico	1827310
7	Brazil	1249520
8	Bangladesh	889176
9	Philippines	800551
10	Nigeria	795000
11	Kenya	636585
12	Egypt	598084
13	Viet Nam	595800
14	Yemen	471544
15	Peru	355431
16	United Republic of Tanzania	330000
17	Madagascar	300574
18	Democratic republic of Congo	263185
19	Columbia	244581
20	Ecuador	200534

Source: FAO, 2011

2.2 Concept of Efficiency

The decrease output of food production over the years may not only be connected with deviations of farmer's practices from technical recommendations, but also with the use of resources at sub-optimal levels which ultimately leads to technical and allocative inefficiency (Coelli and Battese, 1996). An underlying premise behind much of research in efficiency is that farmers are not making efficient use of existing technology, then efforts designed to improve efficiency would be more cost-effective than introducing new technologies as a means of increasing agricultural output (Belbase and Grabowski, 1985: Huynh, 2008: Adeleke. 2008).

Production efficiency has two components: technical and allocative efficiency. Technical efficiency is the extent to which the maximum possible output is achieved from a given combination of inputs or the ability of a firm to obtain maximum output from a given set of input. Allocative efficiency is the ability of a firm to use inputs in optimal proportions given their respective prices and production technology (Coelli*et al*., 1998). Technical inefficiency occurs when the level of production for the firm is less than the frontier output and it increases when timing and methods of application of production inputs are mismanaged. Allocative inefficiency increases when the ratio of marginal products of input is not the same to the ratio of market prices (Bashkh, 2007).

2.3 Productivity and Efficiency

Productivity and efficiency are two different concepts except under the assumption of constant returns to scale. According to Fried *et al.* (2008), productivity of a producer is the ratio of its output to its inputs. This measure is easy to calculate if a producer uses a single input to produce a single output. But when multiple inputs are used to produce several outputs, the outputs in the numerator and inputs in the denominator have to be combined in some economically sensible fashion, so that productivity remains the ratio of two scalars. Differences in production technology scale of operation, operating efficiency and the operating environment in which production occurs are the most common causes of variations in productivity either across producers or through time (Thirtle*et al*., 2009).

Technical efficiency of a producer is a comparison between observed and optimal values of its outputs and inputs (Conradie*et al*., 2009). This can be done either from the output side or input side. On the output side observed output is compared to potential output obtainable from the inputs while from the input angle observed input levels are compared to minimum potential input required to produce the output. In either perspective, the optimum is defined in terms of production possibilities (Kirsten *et al*., 2009).

It is also possible to define the optimum in terms of the behavioral goal of the producer. In this case, efficiency is measured by comparing observed and optimum cost, subject to any appropriate constraints on quantities and prices. In these comparisons, the optimum is expressed in value terms and efficiency is allocative. Some authors distinguish other dimensions of efficiency beyond these two (Gonzalez-Vega, 1998; León, 2001; Alpízar, 2007). Gonzalez-Vega (1998), for example, considers five additional categories, describing them in terms of the actions on which production units should embark in order to achieve the greatest possible efficiency:

i. Technological efficiency: to choose the best available technology (production function) to Produce each output;

ii. Dynamic efficiency: to promptly absorb innovations in products and processes;

iii. Approach efficiency: to select appropriate technologies according to the nature and

magnitude of any challenge faced in the market;

iv. Pure technical efficiency: not to use more inputs than necessary to produce a given

amount of output, given the technology;

v. Scale efficiency: to find the correct level of production with the aim of taking advantage of economies of scale; and

vi. Joint production efficiency: to determine the most attractive combination of output, given the opportunity to generate economies of scope.

It is important to note that the measurement of technical efficiency assumes that the factors of production used are homogeneous. It is not much of a problem if all firms use heterogeneous inputs in fixed proportions. However, if firms are different in the composition of their inputs, according to their quality, then a firm's technical efficiency will reflect both the quality of its inputs and the efficiency in their management. As a result, if technical efficiency is defined with respect to a given set of firms and a given set of factors of production, measured in a specific way, any differences across firms in the quality of the inputs will affect the measure of efficiency (Liebenberg *et al*., 2010).

2.4 Economic Efficiency

Economic efficiency has two components: technical and allocative efficiency. Technical efficiency refers to the ability to avoid wastage either by producing as much output as technology and input usage allow or by using as little input as required by technology and output production. Technical efficiency has, therefore, both an input conserving and output promoting argument. According to Koopmans (1951) and Linh (2007), a producer is technically efficient if an increase in any output requires a reduction in at least one other output or an increase in at least one input, and if a reduction in any input required an increase in at least one other input or reduction in at least one output. Therefore, a technically efficient producer could produce the same output with less of at least one input or could use the same input to produce more of at least one output.

Another definition exits which looks at relative technical efficiency. A producer is fully efficient on the basis of available evidence if and only if the performance of other producers does not show that some inputs or outputs can be improved without worsening some of its other inputs or outputs. With this definition, there is no need for recourse to prices and other assumptions of weights which are supposed to reflect the relative importance of the different inputs and outputs (Cooper *et al.,* 2004). The measurement of technical efficiency is important. According to Alvarez and Arias (2004), technical efficiency reduces production costs and makes a firm more competitive.

The allocative efficiency index measures a production unit's ability to choose the input combination that minimizes cost given the best available technology. It is the ratio between the minimum costs if it were technically efficient. Because allocative efficiency implies substituting or intensifying the use of certain inputs based on their prices, inefficiencies may stem from unobserved prices, from incorrectly perceived price or from lack of accurate and timely information (Chang *et al.,* 2011).

2.5 Review of Factors Influencing Efficiency

Literature suggests many factors which affect the efficiency of farmers. These are classified into conventional and non-conventional factors. Non-conventional factors capture the impacts of macroeconomic variables such as public investment and agro-ecological variables. Conventional factors are traditional choice variables in the farmers‟ production decision process. According to Pender *et al*., (2004), the conventional inputs include tractor use intensity, fertilizer usage, labour use intensity and stock of livestock. On the other hand, non-convectional inputs include calorie availability, irrigation, agricultural research, sagricultural export, instability and land quality. Deininger and Olinto (2000) and Pender *et al.* (2004) also identified fertilizer, cattle ownership, access to credit, supply of extension, human capital (education, age, and gender of house head), family size and proportions of dependents as explanatory variables to efficiency. The plot level factors such as the size of the farm, tenure, distance of the field from the residence in one way or another affects productivity (Xu*et al.*, 2009).

Ownership of livestock especially oxen is likely to help framers prepare their fields early and also allows them to increase the area of land cultivated. Furthermore livestock acts as buffer zone and improves farmers' access to credit and fertilizer markets. In an effort to identify strategies to increase agricultural productivity and reduce land degradation, Pender *et al*. (2004) used econometric analysis on cross sectional data in Uganda. The study findings showed that ownership of livestock (especially oxen), agro- climatic zones, primary sources of income, age of house head, ownership of land and participation in agricultural extension activities positively affected productivity. This study also shows that investments such as irrigation facilities are more likely to improve productivity.

Population density has a bearing on the way farmers employ their inputs. Studies show that farmers in high density populated areas tend to use intensive methods of crop production. For example Pender *et al*. (2004) show that household in more densely populated areas were found to adopt some labor intensive land management practices which enabled them to increase crop production per hectare.

Farm size also affects the productivity. Pender *et al.,* (2004) showed that farm size was negatively related to productivity in Uganda. In Zambia, Brambilla*et al*. (2009)

used cross-sectional post-harvest survey data to investigate the dynamic impacts of cotton marketing reforms on farm output. This study showed that small farms are more efficient. Liebenberg *et al.,* (2010) agrees that for small scale the production is normally small but in terms of productivity or production per hectare they perform better than larger plots.

Trade performance has some impact on the agricultural productivity. If farmers can access local and export markets, literature shows that productivity can go up because whatever is produced would be bought on the market. Using cross section time series data for 28 sub Saharan African countries, Ajao (2008), estimated an agricultural production function in an attempt to examine sources of agricultural specific crop productivity growth and stagnation. The results showed that the coefficient on agricultural export was positive and statistically significant. However, Pender *et al.,* (2004) found little evidence on the impact of access to markets on agricultural intensification and crop productivity. Although education as human capital is important for increasing household income, it was not found to be a solution to the problem of low productivity in Uganda (Pender *et al.*, 2004). Similar results were reported by Deininger and Olinto (2000) using panel data of the post harvest survey. However the study which aimed at examining the relatively lackluster performance of the country's agricultural sector following liberalization concluded that education enables farmers to overcome market imperfections as reflected in the fact that more educated farmers demand higher amounts of fertilizer and credit per hectare.

2.6 Stochastic Frontier Analysis

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

$Y_i = f(x_i.\beta) + e_i$..1

$e_i = v_i – u_i$..2

Where:

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

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

β = a vector of the parameters to be estimated

e_i = composite error term

v_i= random error outside farmer's control

u_i =technical inefficiency effects

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

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

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

Where,

ln = the natural logarithm

Y = output of guava (ha)

βo = constant term

β_1- β_3 = regression coefficients

X_1 = quantity of seed (kg)

X_2 =quantity of fertilizer (kg)

X_3 = total labour used (man days)

X_3 = quantity of agrochemical (litres)

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

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

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

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

Where,

U_i = inefficiency effects of individual farmers

Z_1 = Age of farmer (years)

Z_2 = Household size (number)

Z_3 = Education (years)

Z_4 = Amount of credit (amount of credit obtained)

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

Z_6 = farm income (Naira)

δ_0 = constant

δ_1- δ_6 = Parameters to be estimated.

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

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

The stochastic frontier cost function is defined by:

C = F (Wi, Yi; α) expeii = 1,2 ….n ---5

Where,

C = Represents the minimum cost associated with guava production

W= Vector of input prices

Y = Guava output

α = Vector of parameters

ei = Composite error term

Using Sheppard's Lemma we obtain

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

This is a system of minimum cost input demand equations (Bravo – Ureta and Evenson, 1994; Xu and Jeffrey, 1995 and Bravo-Ureta and Pinheiro, 1997). Substituting a farm's input prices and quantity of output in equation (6) yields the economically efficient input vector Xc.. With observed levels of output given, the corresponding technically and economically efficient costs of production will be equal to X_{it} P and X_{ie}, respectively. While the actual operating input combination of the farm is Xi P. The three cost measures can then be used to compute the technical (TE) and economic efficiency (EE) indices as follows;

$$TE = (X_{it}.\ P) / (X_i.\ P) \text{ -- } 7$$

$$EE = (X_{ie}.\ P) / (X_i.\ P) \text{ -- } 8$$

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

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

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

$Y^* = f(X_i; \beta) - u$ --- 10

Where U can be estimated as

$$E(u_i / \varepsilon_i) = \frac{б\lambda}{1 + \lambda^2} \quad \frac{f^*(\varepsilon_i \lambda / б) - \Sigma i\lambda}{1 - f^*(\varepsilon_i \lambda)} \quad \ldots\ldots 11$$

Where

$f^*(.)$ and $f^*(.)$ are normal density and cumulative distribution functions respectively,

$\lambda = б_u / б_v$

$\varepsilon = V_i - U_i$ and

Y^* is the observed output adjusted for statistical noise

When ε_i, б and λ estimates, are replaced in equations (9) and (10), it will provide estimates for U and V. The term V is a symmetric error, which accounts for random variations in output due to factors beyond the control of the farmer e.g. weather, disease outbreaks, measurements errors, etc. The term U are non-negative random variables representing inefficiency in production relative to the stochastic frontier. The random error Vi is assumed to be independently and identically distributed as $N(o, \delta v^2)$ random variables independent of the U is which are assumed to be non-negative truncation of the $N(o, \delta u^2)$ distribution (i.e. half-normal distribution) or have exponential distribution.

2.7 Farm Profitability Analysis

This involves estimation of costs and returns of production. Gomez (1975) and Adeleke, *et al*., (2008) developed a farm level model to evaluate alternative cropping mixtures and patterns. These involves as follows: (i) profitability: this is measured as the differences between value of yield and cost of production, and (ii) Net return: this involves the difference between value of yield and cost of inputs, including hired labour. In choosing economic indicators on the basis of production factors affected by potentials innovation. Abedullah and Mushtaq (2007) suggested the use of the following: (i) the gross margin and returns to variable cost, where only capital is affected. (ii) Yield/labour ratio, where only labour is affected, and (iii) Gross margin, return to variable costs and monetary return to labour, where capital and labour are affected.

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

As with any economic analysis, the profitability of an investment is based on a comparison of the returns and cost of the investment. Another way to add value on the production side would be to reduce processing costs by increasing the efficiency (and thus the profitability) of production (Masters *et al*., 2005). Hence, the profitability of crop production depends on reducing the farming cost as much as possible, and at the same time maximizing the income from the sale of crop.

Profitability in some farm business exists because they are managed more efficiently than others. The reward for doing the job better is usually profit. The prospect of earning and maintaining profitability serves as the incentives for creativity and efficiently among farmers. Profitability stimulates risky ventures and drives farmers to develop ways of cutting cost and improving technology always in an effort to satisfy consumer interest (Troke, 2008). Profitable agriculture is dependent on productive soil and guava production is not an exception.

Net farm income is the difference between gross income (revenue) and total cost of production. (Olukosi and Erhabor, 2008). It is used to show the levels of costs, returns and net profit that accrue to farmers involved in production. The technique emphasizes the costs (fixed and variable cost) and returns of any production enterprise. Olukosi and Ogungbile (2006) have examined two major categories of costs involved in crop production. These are fixed and variable cost. Fixed costs (FC) refer to those costs that do not vary with the level of production or output while variable cost (VC) refers to those costs that vary with output. The total cost (TC) is the sum of total fixed cost (TFC) and total variable cost (TVC).

2.7.1 Factors affecting profitability

The characteristics of resource-poor farmers can be examined from the view point of the pattern of the use of farm resources such as land, labour, and capital (Banta *et al,* 2008). .

Land: land is the most important input of small farmers, but it is generally not believed to be abundant relative to other production inputs (Banta *et al.,* 2008). It is estimated that only less than 40% of the 71million hectares of cultivable land is currently under cultivation, it also stressed that the apparent abundance of land in Nigeria is being limited by population pressure, livestock expansion, desertification and deforestation(Banta *et al.,* 2008). Land is a fixed resource whose area can be expanded only at slightly prohibitive costs through drainage of swamp, reclamation from water, and improvements designed to make non-cultivable land suitable for cultivation.

Labour: labour is very important in the production process. Where labour is limited, it is expected that production of goods will be low and hence the profitability. in areas where partial mechanization is possible inform of animal traction and hired tractor, human labour is still required to about 70% of all the operations for planting, weeding and harvesting (Olukosi and Erhabor, 2003).

Capital: there is very low capital investment in farming tools and equipment which consists of hoes and cutlasses. Expenditures on purchase input like fertilizers, pesticides, and improved seeds and seedlings usually constitute a minor component of the total cash expenditure (Olukosi and Erhabor, 2003). Capital is considered as total investment available for use. Low capital investment on an enterprise affects its profitability.

Management: good management practice and efficient combination of all other factor of production ensures good profit, as an input, it coordinates other factors of production. Management is concerned primarily with the organization of production and other operation of farm firm so as to achieve certain objectives, one of which is profit maximisation (Olukosi and Erhabor, 2003).

Farm size: the size of the farm also influences profitability. Availability and cost of acquisition of land will determine farm size. The more the land is put into cultivation, the more the yield (other things being equal).

Time: time can also affect profitability. Early planting result in good yield. The time of marketing of the product is also of vital importance and a measure determinant of profitability. Time is the period needed to realize any goal and allows re-evaluation and adjustment of one's choice (Olukosi and Erhabor, 2006).

Fertilizer: organic manure dropping from roaming cattle are commonly used by small farmers especially in the northern part of the country. the use of inorganic fertilizers has been on the increase as a result of the following; awareness created by operation feed the nation (OFN), national accelerated food production project (NAFPP), the establishment of agricultural development programmers' (ADPs), the large irrigation project and the heavy subsidy on fertilizer (Banta *et al*., 2008).

2.8 Theoretical Framework

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

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

Variation in output by different producers, caused by technical inefficiencies can be captured through specification of production function. Technical efficiencies can be estimated using Stochastic Frontier Approach (SFA) or Data Envelopment Analysis (DEA), which is non-parametric approach. DEA assumes that there are no random effects in production. The current study therefore employed the stochastic production frontier approach because most farmers operate under uncertain condition (Abedullah and Ahmad, 2006). Review of literature revealed that Cobb-Douglas and Translog production function are the widely used forms in agriculture. However, Translog production function specification suffers from multicollinearity problem as a result of the square and interaction terms of the inputs used (Hussain*et* *al*., 2012). The current therefore estimated a Cobb-Douglas production function, specified as: $Y_i = (x_i \beta) + v_i - u_i$

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

$v_i$is the systematic error component which captures random deviations from the frontier, caused by factors beyond the farmers' control such as temperature and natural hazards. It is assumed to be independently and identically distributed with a mean of zero and constant variance –N (0, σ_v^2) and independent of $u_{i,.}$$u_i$is a non-negative error component that captures deviations from the frontier caused by controllable factors. It represents the inefficiencies in production. It is assumed to be half normal, identically and independently distributed with a mean of zero and constant variance –N (0, σ_v^2).

Cobb-Douglas functional form is used in this study because the coefficient estimated directly represents elasticity of production (Abedullah and Ahmad, 2006). Cobb-Douglas production function is adequate in the representation of the production process since we are only interested in the efficiency measurement, and not production structure (Taylor and Shonkwiler, 1986). Furthermore, Cobb-Douglas production function has been widely applied in estimating farm efficiencies (Ahmad *et al.,* 1999; Kebede, 2001; Hassan and Ahmad, 2005; Abedullah and Ahmad, 2006; Ogundari and Ojo, 2007; Abedullah and Mushtaq, 2007; Oladeebo and Fajuyigbe, 2007; Narala and Zala, 2012; Hussain*et al.,* 2012).

2.9 Empirical Studies

2.9.1 Socio-economic characteristics of arable crop producers

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

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

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

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

2.9.2 Cost and returns analysis

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

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

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

2.9.3 Technical, allocative and economic efficiency

2.9.3.1 *Technical Efficiency*

By applying their model of technical inefficiency effects using panel data on Indian paddy rice producers, Battese and Coelli (1995) found a positive relationship between the degree of inefficiency and the producer's age, and a negative relationship between the degree of inefficiency and the educational level of the producer. Coelli and Battese (1996) used the same approach to analyse the factors affecting the technical inefficiency of Indian farmers, and found the mean technical efficiency levels to be 0.74 and 0.71, respectively, for the villages of Aurelle, Kanzara and Shirapur. They also found a negative correlation between technical inefficiency and variables such as farm size and the level of education and age of the farmer.

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

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

2.9.3.2 *Allocative Efficiency*

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

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

Kuosmanen*et al*. (2006) continue by taking advantage of the law of one price, which is theoretically asserted to hold in the competitive market. The authors, while acknowledging that the input price vector is often not observed, consider the whole price domain instead of separate single input price vectors. The derived domain includes relative price restrictions, which allow them to obtain an upper bound of efficiency via maximization in terms of input prices that are endogenously chosen from the domain.

2.9.4 Production constraints faced by small holder farmer

Research finding on the constraints to the effective performance of agricultural and rural development project revealed that, most past policies, strategies and interventions failed to achieve their objectives as a result of poor design (Tomori*et al*., 2005). In Nigeria, most of those policies were not successful due to "top down" policy in which development are forced on people regardless of their felt needs (Forsund*at al.,*1980).

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

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

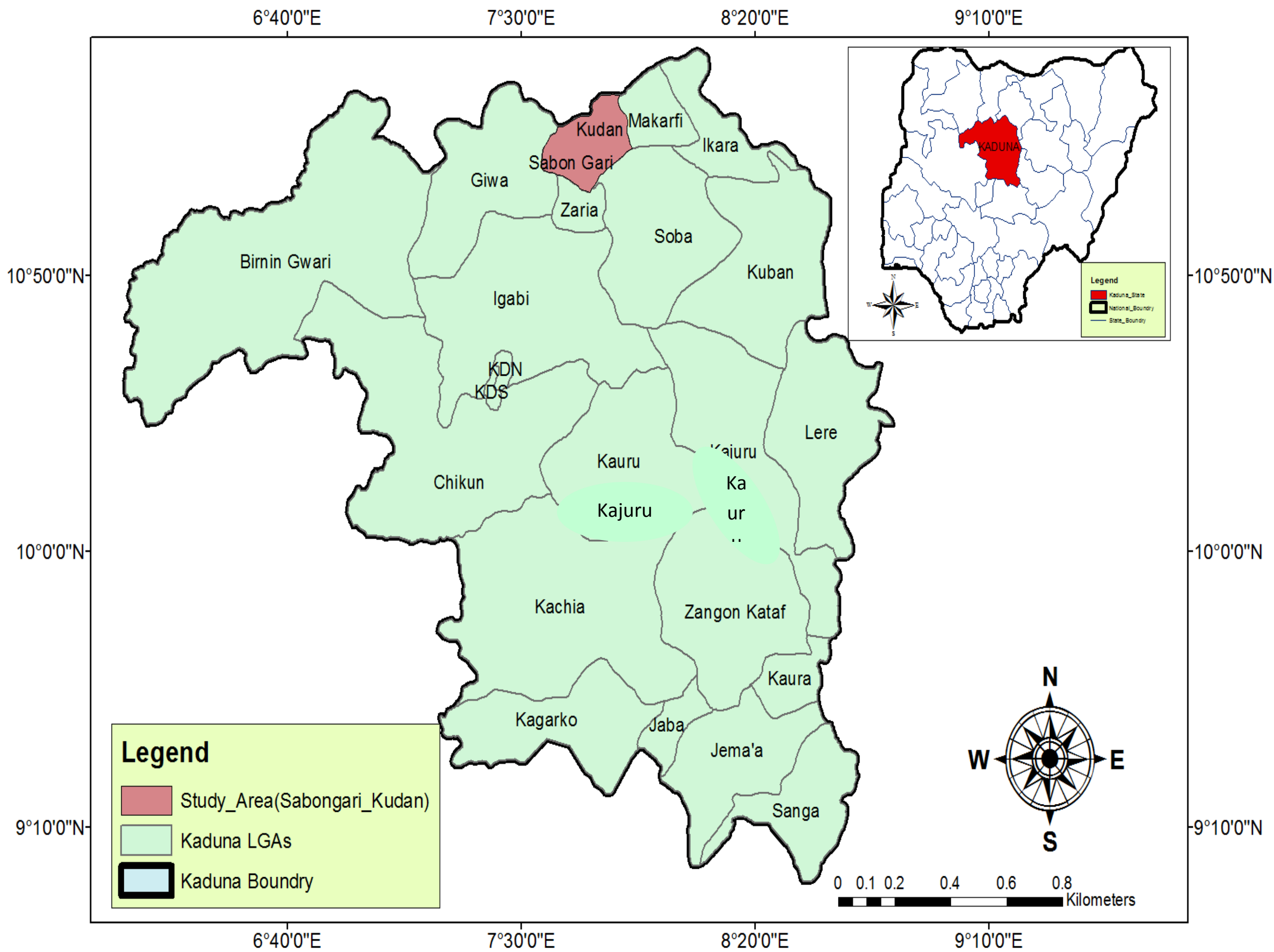
CHAPTER THREE

METHODOLOGY

3.1 Description of the Study Areas

The study was conducted in Kaduna state. The state is in the northern part of Nigeria and located between 10^{o} 20^{1} N to 10.33^{o} N and longitudes 7^{o} 45^{1} to 7.75^{o}E (Kaduna State Government, 2010). It shares common border with Abuja FCT in the south-east and six other states, namely; Katsina, Kano, Zamfara, in the north. Nassarawa and Plateau state in the north-east and Niger state in the north-west. The state occupies an area of approximately 68,000 square kilometers or 7% of Nigeria's land mass. The mean annual rainfall shows a marked decrease from South to North (1,524mm to 635mm). Two distinct seasons, rainy and dry witnessed in the state. The relative humidity is constantly below 40 degrees except in few wet months when it goes up to an average of 60 degrees. The duration of dry season is 5-7 months which normally starts from October; the major crops which grown in the state includes; maize, sorghum, millet, rice, ground nut, yam, cocoyam, sweet potato, sugar cane, watermelon, mango and guava.

The state has a population of 6,066,562 (NPC, 2006). Based on annual population growth rate of 3.2%, the projected population of the state is about 7474.369 million people in 2013.The state is made up of 23 Local Government Areas and three (3) senatorial zones namely; Zone 1, Zone 2, and Zone 3. The people of the state engage in agricultural production activities, including irrigated and non-irrigated farming system.



SOURCE: Kaduna State Government, 2014
Figure 1: Map of the Study Area in Kaduna State.

3.2 Sampling Procedure and Sample Size

A multi-stage sampling procedure was used for the study. The first stage involved the purposive selection of SabonGari and Kudan Local Government Areas due to their significant involvement in guava production. Secondly 6 villages were purposively selected three from each Local Government Area, based on their intensity in guava production. Finally, Simple random sampling was employed in selecting farmers from each of the villages. Sixty percent (60%) of the sampling frame (210) were used as the sample size. Thus, 126 farmers were randomly selected while the information from the non-guava farmers (Mango and citrus) were randomly collected with equal numbers of guava farmers in the study area. In all 252 respondents from both guava and non-guavawere used for the study.

Table 2: Population and sample size of farmers

LGA's	Villages	Guava farmers		Non-guava farmers	
		*Sampling frame	Sample size	*Sampling frame	Sample size

Kudan	U/Shekarau	40	24	42	25
	Dufa-Dufa B	40	24	54	32
	Jaja	60	36	38	23
S/Gari	Kwakwaramanu	30	18	36	22
	Dufa-Dufa A	25	15	18	11
	Dansa'a Village	15	9	22	13
Total		210	126	210	126

Source: Reconnaissance survey, 2013.

3.3 Data Collection

Primary data were used for this study. These were collected with the aid of structured questionnaire. The information were collected on (a) farmers' socio-economic characteristics such as age, gender, household size, educational status, farming experience, amount of credit received, numbers of extension contact, years spent on the cooperative, farm size, income. (b) Constraints faced by the farmers. (c) socio-economic factor influencing profitability of the farmers. (d) Costs and total return information. (e) Input-output information. (f) Based on reconnaissance survey it was discovered that guava farmers are new entrants into the production with about two years of farming experience. Therefore, the study considered the second year of production, since it is a perennial crop, while jumbo white variety of guava was used for the study with expected economic life-span of 25 years.

3.4 Analytical Techniques

The tools of analysis include: Descriptive statistics, Benefit cost ratio, stochastic production frontier

3.4.1 Descriptive statistics

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

3.4.2 Benefit Cost Ratio Analysis

Benefit cost ratio was used to achieve objective ii.

Benefit-Cost Ratio Analysis

It is defined as "ratio of present value of the streams of benefits to the present value of streams costs" (Case, 1996). Cost and revenue analysis of various crops requires consideration of several elements. The total cost of production is the sum of fixed and variable costs. The fixed cost of guava was estimated by calculating the initial establishment costs until its start fruiting. The main costs involved are land development, planting material,labour, machinery and land rent. The fixed costs were considered as the initial capital investment (Norman, 1985).

$$\text{Benefit cost Ratio} = \sum_{K=1}^{n} AK/ (1+i)^{K/} A_o$$

Where,

$\sum_{K=1}^{n} AK/ (1+i)^K$ is sum of present value of future net cash flows

and A_o is the initial investment or sum of expected cash outflows.

The variable costs of production contain land leveling, FYM, fertilizer, fungicides and pesticides. Also labour for hoeing, spraying, farmyard manure and fertilizer application, pruning and other management practices. These costs are known as working capital defined; as the capital required funding the production cycle (Nix, 1979).

Benefits/Yield of Guava

The physical output of the main product and its market price was used for computing the value of output.

The discounting methodology was used to evaluate the cost and return in perennial crop like guava orchards because growing fruit trees is a long-term investment activity. The first few years of guava involve only costs and no return. A basic approach is to estimate the annual net present worth by discounting both future costs and returns (Ahmad *et al*., 1993).

Generally, guava trees do not start bearing fruit till the eight months of their life. The reasonable production starts from 2 years after plantation and will be improving for upto six years and then decline. The revenue from guava was obtained by the sale price of the physical product in the market.

In orchards where expenditure involved and profits obtained spread over a number of years, the flow of future costs and returns are also important. The following three significant techniques considering the time value of money over the life of investment were used:

Depreciation and interest

For estimating annual cost, the depreciation has been worked out at 4 per cent per annum at the fixed investment (i.e. establishment cost) by applying straight line method or direct method, assuming the life of orchard about 25 years. Further, interest has been taken at 12 per cent per annum on operational cost.

Amortization of fixed cost

The annual amortization of cost was computed from the investment made on establishment of guava orchard, assuming that the rate of interest 12 per cent per annum and the expected life of guava orchard to be 25 years. Thus, annual amortization was worked out by using the compounding cost formula and by adding it to maintenance cost for estimating the annual cost of cultivation of guava orchard of respective farmers.

$$I = B \frac{i}{1-(1+i)n}$$

Where,

I = Annual cost (₦),

B = Present fixed cost (₦),

i = Interest rate (12 % per annum), and

n = Economic life of the orchard (in years).

3.4.3 Stochastic Production Frontier Analysis.

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

$Y_i = f(x_i.\beta) + e_i$……………………………………………………………………………………… ……17

$e_i = v_i - u_i$……………………………………………………………………………………………………18

Where:

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

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

β = a vector of the parameters to be estimated

e_i = composite error term

v_i= random error outside farmer's control

u_i =technical inefficiency effects

$lnY = \beta o + \beta_1 lnX_1 i + \beta_2 lnX_2 i + \beta_3 lnX_3 i + \beta_3 lnX_3 i + \beta_4 lnX_4 i + (Vi\text{-}Ui)$……………19

Where:

ln = the natural logarithm

Y = output of guava (kg)

βo = constant term

β_1- β_3 = regression coefficients

X_1 = quantity of seed (kg)

X_2 =quantity of fertilizer (kg)

X_3 =quantity of agrochemical (litres)

X_4 = total labour used (man- days)

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

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

$-U_i = \delta_0 + \delta_1 1nZ_1 + \delta_2 lnZ_2 + \delta_3 lnZ_3 + \delta_4 lnZ_4 + \delta_5 lnZ_5 + \delta_6 lnZ_6$…………………………………20

Where:

$-U_i$ = Technical effects of individual guava farmer

Z_1 = age of farmer (years)

Z_2 = household size (number)

Z_3 = formal education (years)

Z_4 = farming experience (years)

Z_5 = access to extension services (number visit)

Z_6 = cooperative association (years)

δ_0 = constant

δ_1-δ_6 = Parameters to be estimated.

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

$C = F(W_i, Y_i; \alpha)$ expeii = 1,2 ….n ---21

Where:

C = Represents the minimum cost associated with guava production

W= Vector of input prices

Y = Guava output

α = Vector of parameters

ei = Composite error term

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

$\ln C = \beta_0 + \beta_1 \ln X_1 i + \beta_2 \ln X_2 i + \beta_3 \ln X_3 i + \beta_4 \ln X_4 i + (Vi+Ui)$……………………….22

Where,

ln = the natural logarithm

C = Total cost of output (₦)

X_1 = cost of seed (₦)

X_2 = cost of fertilizer (₦)

X_3 = cost of labour (₦)

X_4 = cost of agrochemical (₦)

β_0 = constant term

β_1- β_3 = regression coefficients

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

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

$U_i = \delta_0 + \delta_1 1nZ_1 + \delta_2 lnZ_2 + \delta_3 lnZ_3 + \delta_4 lnZ_4 + \delta_5 lnZ_5 + \delta_6 lnZ_6$......................................23

Where:

U_i = Allocative effects of individual guava farmer.

Z_1 = age of farmer (years)

Z_2 = household size (number)

Z_3 = formal education (years)

Z_4 = farming experience (years)

Z_5 = access to extension services (number contacts)

Z_6 = Cooperative association (years)

δ_0 = constant

δ_1-δ_6 = Parameters to be estimated.

Economic Efficiency

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

EE = TE * AE…………………………………………………………. …………24

Where;

EE= Economic Efficiency

TE= Technical Efficiency

AE= Allocative Efficiency

3.5 Measurement of Dependent and Independent Variables

Ten explanatory variables measured as continuous and discrete variables were hypothesized for determinants of guava production.

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

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

(iii) Household size: This means the total number of people in the house which includes the wives, children and dependents that reside within the same house. Since food requirements increases with the number of person in the household and also because land and finance to purchase agricultural inputs are limited. Increasing family size, according to Brown (2004), tends to exert more pressure on consumption than the labour it contributes to production. The larger the family size the more favorably disposed will be the members to participate in guava production operation. The estimated coefficient of household size was expected to have negative sign on the technical inefficiency model. This was measured as numbers of people living together and eating from same pot. The *a priori* expectation for household size was expected to be negative; this implies that the household size of the farmer is increasing technical efficiency.

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

(v). Farming experience: Farming experience is an experience gain with age while carrying out farming operations. Since the major occupation of the respondents is farming, the length of time in farming can be linked with the age of the farmers. As the age increases among the farmers, their years of experience also increase. This variable is measured in number of years the respondent has being into guava production.

(vi) Co-operative membership: Co-operative groups are organized for the promotion of special interest or meet certain needs that cannot be achieved by the individual efforts. They contribute to the dissemination of new ideas, practices and products as well as in sourcing for loan and farm input (Chikezie*et al*., 2012). Farmers that belong to a co-operative society are likely to adopt new technology more easily than those not in any co-operative. Thus, it influences the attitude of members towards community developmental projects. This variable was used to characterize farmers based on particular involvement in guava production at the time of data collection. This was measure in years of participation. The estimated coefficient of cooperative membership was expected to have negative sign on the technical inefficiency.

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

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

(ix) Quantity of Labour: This consist of family and hired labour, it was included in the model to examine how variability in labour used affect output. Labour was measured in man-days. The a priori expectation for quantity of labour was expected to be positive; this implies that, a unit increase in quantity of labour will bring about increase in output.

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

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Socio-Economic Characteristics of Guava Farmers

4.1.1 Age of guava farmer

The study shows that about 37% of the guava farmers were within the age range of 30-39 years with mean of 34 years. This implies that the farmers are strong, agile, and active and can participate adequately in farming activities. Age is expected to have negative influence on the respondents' participation in improved guava production that is why younger farmers are more active in the production of this improved variety. Age is very important in agricultural production activities because age has a significant influence on the decision making process of farmers with respect to adoption of improved farming technologies and other production-related decisions (Olaye*et al*. (2009) and Yaaishe*et al*., 2009).

Table 3: Age distribution of guava farmers

Variable	Frequency	Percentage	Mean
Age (years)			
20-29	42	33.3	34
30-39	46	36.5	
40-49	32	25.4	
50-59	6	4.8	
Total	126	100	

4.1.2 Educational Level of Guava Farmers

Education is an important socio-economic factor that influences farmers' decision making to awareness, perception and adoption of innovations that can bring about increase in productivity. The result in Table 4 shows that 15% of guava farmers had no formal education, about 44% of the respondent had only primary education, and 36% had secondary education about 6% had tertiary education. This indicates that the farmers' educational level is high. This finding is in line with Amaza (2000), education has a positive and significant impact on farmers' efficiency in production. Thus, literacy level will greatly influence the decision making and adoption of innovation by farmers, which may bring about increase in productivity.

Table 4: Distribution of guava farmers according to level education

Variable	**Frequency**	**Percentage**
No formal education	19	15.0
Primary education	55	43.7
Secondary education	45	35.7
Tertiary education	7	5.6
Total	126	100.0

4.1.3 Household Size of Guava Farmers

Table 5 shows the distribution of guava farmers by household size. Majority of the farmers (36%) had household size that ranged from 1-3 persons. The average household size was 5 persons. According to the report of Amaza, (2000), there is a positive and significant relationship between household size and farmers' efficiency in production. However, the absolute number of people in a certain family cannot be used to justify the potential for productive farm work because most household members do not participate in farm work nowadays.

Table 5: Distribution of guava farmers according to household size.

. Variable	Frequency	Percentage	Mean
1-3	45	35.7	5
4-6	42	33.3	
7-9	19	15.1	
>10	20	15.9	
Total	126	100.0	

4.1.4 Membership of guava Cooperative Society

Table 6 shows the numbers of years spent in cooperative. About (61%) of guava farmers do not participate in any cooperative association and the reasons for this include: being small scale and unaware of any association. Also 39% of the respondents belongs to cooperative with average of 2years spent in cooperative, the effect of this result is that most of the guava farmers in the study area do not enjoy the assumed benefits to co-operative societies through pooling of resources together for a better expansion, efficiency and effective management of resources and for profit maximization. Ajayi (2002) and Ekong (2003) Stated that membership of cooperative societies has advantages of accessibility to micro-credit, input subsidy and also as avenue in cross breeding ideas and information.

Table 6: Distribution of guava farmers according to years spent in the cooperative association

Variable	Frequency	Percentage	Mean
Non members	77	61.1	2
1-2 years	39	31.0	
3-4 years	7	5.6	
>5 years	3	2.4	
Total	126	100.0	

4.1.5 Numbers of Extension Visit

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

The result revealed that 87% of guava farmers in the study area had no visit to extension service about 13% had contact to extension service with average of 1 visit, this could be attributed to low extension agent-farmers' ratio in the study area.

Table 7: Distribution of guava farmers according to extension visit

Variable	Frequency	Percentage	Mean
No contact	110	87.3	1
1-2	12	9.5	
3-4	4	3.2	
Total	126	100.0	

4.1.6 Farming Experience

The process of gaining knowledge and skills is termed experience. It is a measure of the period an individual farmer was involved in guavaproduction. The more the number of years of production by guava farmer, the more knowledge and skills gained. Experience influences individual’s perception and understanding of the management requirements and it is also an important factor determining both the productivity and the production level in guava farming.

The cultivation of this crop by many farmers is not long enough as presented in Table 8. The experience of the majority of the surveyed farmers in guava production shows that 100% of guava farmers had 1-3 years of experience with an average of 2 year. This is an indication that more farmers are embracing production of the crop due to high yield of the crop.

Table 8: Distribution of guava farmers according to farming experience (years)

Variable	Frequency	Percentage	Mean
Farming Experience(years)			
1-2	126	100.0	1
3-4	0	0.0	
Total	126	100.0	

4.2 Summary of Inputs and Output

Summary statistics of inputs and output

The summary statistics of level of inputs used and output realized in the study area are reported in Table 9. The inputs that were used in guava production include; land, seed, fertilizer, labour and agrochemical. Table 9 revealed the mean farm size was 0.54 hectares. The minimum and maximum land areas were 0.1 ha and 3 ha, respectively. The recommended yield kg/ha of guava rates harvest and potential yield kg/ha in year under consideration (second year) was 6673.19 and 7634.2kg/ha respectively.The average quantity of seed used by guava farmers was 1.473 kg/ha. The minimum and maximum seed used were 0.043 kg/ha and 2.09 kg/ha, respectively. Average fertilizer used by guava farmers was 567.90 kg/ha while the minimum and maximum were found to be 227.78 and 833.33 kg/ha, respectively. The mean labour recorded was 61.596 man-days while the minimum and maximum were observed to be 16.00 mandays/ha and 48.00 mandays/ha, respectively. This shows that agricultural production in the study area is of small scale and labour intensive.

Table 9: Summary of input and output

Variables	*Mean	Std. Dev.	Min	Max
Seed(kg)	1.473	13.04	0.043	2.09
Fertilizer (kg)	567.90	126.19	227.78	833.33
Labour (mandays)	61.596	12.92	16.00	48.00
Insecticide (litre)	8.583	2.99	3.70	14.81
Yield (kg/ha)	6673.19	6705.17	1851.52	18333.33

4.3 Profitability of Guava Production

The profitability was determined on the average of 2 years production of the farmers in the areas.

4.3.1 Average Cost of Guava Production in the Study Area.

4.3.1.1 Seed Cost

Seed Cost: Guava seed used by the farmers in the study area were mainly improved seeds taken from the horticultural unit, Institute for Agricultural Research, (IAR) Samaru, Zaria. The quantity of guava seed was 0.073kg/ha with an average market price of ₦5000 per kg, Cost of seed constitutes 5.14% of the total cost of production.

4.3.1.2 Fertilizer Cost

Fertilizer Cost: the quantity of fertilizer was 567.90kg/ha with an average market price of ₦100 per kg was used and this constitutes 58.42% of the total cost of production.

4.3.1.3 Agrochemical Cost

Quantity of agrochemical was 8.583litres/ha with an average market price of ₦400 per litre was used and this constitutes 3.53% of the total cost of production.

4.3.1.4 Labour Cost

Labour costs consist of cost of land preparation, planting, fertilizer application, spraying of agrochemical, weeding, replacement and harvesting. The family labour was computed on the basis of opportunity cost in man-day. The wage rate varied according to farm operation to be performed. An average wage rate of ₦400 per man-day was used, giving the average labour cost per hectare to be ₦24,638.4.

4.3.1.5 Fixed Cost

The total cost of fixed inputs (cost of renting land and depreciation of tools) incurred on guava production was ₦7350 and this constitute 2.41% of the total fixed cost.

4.4.0 Average Cost and return per hectare of Guava Production

The result presented in Table 10 shows that there was no production of guava throughout up to the period of eight months since the bearing of fruits usually starts after attaining eight months of age. Though only 2 years of production was considered in this study because they are new entrant into guava business having only 3 years of experience in guava production.The per hectare production of fruits starts increasing gradually from nearly three years to about sixth year orchard age. However, after attaining the age of six year it remain almost static with advance in age of the plants. Hence, the gross returns per hectare from guava orchard increased up to six year of the plant age. The gross returns per hectare worked out to be ₦266,926.8 in the third year that was full bearing stage. Thus, the negative returns during early years of guava cultivation reduced substantially from ₦24,170.51 per hectare for the first years age orchards.

The average total revenue was ₦266,926.8 while the total cost was ₦97213.07. The average net farm income under year of consideration was therefore ₦169, 749.73. the average rate of return on investment (return per naira invested) was ₦2.75, indicating that for every ₦1 invested in guava production in Kaduna state, a profit of ₦1,75 kobo was made. Thus, it could be concluded that guava production in the study area though on a small scale, was economically viable. This results got the support from the findings reported by Dahiya (2002), Mishra et al. (2000) and Naphade and Tingre (2008).

Table 10: Average Cost and return per hectare of Guava Production

Particular	Year 1	Year 2	Year 3	Average

Labour	12,319.21	7391.52	4927.68	24,638.4
Manure and fertilizer	39,753	17037	-	56790
Insecticide and fungicides	-	1716.6	1716.6	3433.2
Seed/seedling	4501.3	500.15	-	5001.47
Fixed asset (renting of land, hoeing & cutlass)	7350	-	-	7350
Total cost	24,170.51	26645.27	6644.28	97213.07
Total revenue	-	80,078.04	186,848.76	266,926.8
Benefit	-24170.51	53432.77	180,204.48	169,713.73
Return per naira invested				2.75

4.5.0 Efficiency of Guava Production

4.5.1 Estimation of the Technical Efficiency of Guava Farmers

The model specified was estimated using maximum likelihood (ML) method using FRONTIER 4.1 software developed by Coelli (1995). The ML estimates and inefficiency determinants of the specified frontier are presented in Table 11. However, the estimated coefficients of fertilizer and labour were positive and significant at 5% level of probability and hence play a major role in guava production in the study area while the estimated coefficients of seed and agrochemical were negative. Seed was significant at 1% while agrochemical was not significant. The average technical efficiency for the farmers was 0.82 implying that, on the average the respondents were able to obtain 82% of output from a given mixture of production inputs. Thus, in a short run, there is minimal scope (18%) of increasing the efficiency, by adopting the best practice in guava production.

The estimated coefficient for seed was -3.514 which is negative and statistically significant at 1% level. The estimated -3.501 of seed implies that increasing seed by 1% will decrease guava output by more than 1% which means, all things being equal the output is inelastic to changes in the quantity of seed used. The negative coefficient of seed may suggest that the farmers applies the right seed rate and spacing, so, further increase in quantity of seed may result in high competition among crops, resulting in lower yield. However, this finding is at variance with the findings of Shehu*et al.,* (2010) who observed that the estimated coefficient of seed and labour inputs were positive as expected and significant at 1% level implies that the more seed is applied and the more labour employed the better the output of guava.

The production elasticity of output with respect to quantity of fertilizer was positive and statistically significant at 5% level. This implies that a 1% increase in fertilizer will increase guava output by 0.7%. Fertilizer is a major soil augmenting input because it improves the quality of soil by raising yields per hectare. This study is in agreement with the findings of Maurice (2004) and Oladiebo and Fajuyigbe (2007).

The coefficient of labour was 0.529 which is positive and statistically significant at 5% level. This shows the important of labour in guava farming in the study area. This is in line with several studies by Okike (2000) and Umoh (2006) which show the importance of labour in farming, particularly in developing countries where mechanization is rare on small scale farms. In the study area, human power plays a crucial role in virtually all farming activities. This situation has variously been attributed to the practice of split-plot cropping on small scattered land holdings and lack of affordable equipment (Umoh, 2006).

The estimated coefficient of agrochemical was negatively related with the output and not statistically significant.

Tables 11: Estimates Results of Frontier Production Function (Technical Efficiency) of Guava production

Variables	Parameters	Coefficients	Std. error	T-Value
Production Function				
Constant	β_0	17.651	1.296	13.62***
Seed	β_1	-3.514	0.373	-9.429***
Fertilizer	β_2	0.661	0.299	2.203**
Labour	β_3	0.529	0.244	2.168**
Agrochemical	β_4	-0.126	0.161	-0.783

Diagnostic Statistic				
Sigma-square	(**σ^2**)	0.375	0.0424	8.832***
Gamma	**(γ)**	0.026	0.0042	0.558
Log likelihood function	*L/f*	-115.687		
LR test	9.096			
Total number of observation	126			
Mean efficiency	0.82			

****=1% *=5% and *=10%.*

4.5.2 Estimated Stochastic Frontier Cost Functions

The Maximum Likelihood (ML) estimate of the stochastic frontier cost function for guava production is presented in Table 12. For the cost function, the sigma (σ^2 = 0.37) and the gamma (γ=0.06) are quite high and highly significant at 1% and 5% level of probability respectively.

The high and significant value of the sigma square (σ^2) indicate the goodness of fit and correctness of the specified assumption of the composite error terms distribution (Idiong, 2005). The gamma (γ = 0.06) shows that 6% of the variability in the output of guava farmers that are unexplained by the function is due to allocative inefficiency.

The result of Cobb Douglas stochastic frontier cost function for guava in Kaduna State is presented in Table 12. The estimated coefficients of the cost function are positive. The cost variable of seed is significant at 5% level while fertilizer, labour and agrochemical are not significant.

The coefficient of the cost of seed was positive and statistically significant at 5% level of probability. This implies that an increase in the cost of seed will result in an increase in the total cost of production.

The factors influencing allocative efficiency of guava farmers in Kaduna State are age, level of education, farming experience, extension contact, cooperative association and household size. The coefficients for age, level of education, farming experience, extension contact, cooperative association and household size, only extension contact was significant at 1% level of probability and negatively related to allocative efficiency. It implies that the number of extension contact, the less the allocative inefficiency.

Table 12: Maximum Likelihood Estimates Results of Frontier Cost Function (Allocative Efficiency) of Guava production

Variables	Parameters	Coefficients	Standard error	T-Value
Production Function				
Constant	β_0	15.254	1.344	11.35***
Seed	β_2	1.032	0.482	2.14**
Fertilizer	β_3	0.138	0.339	0.41

Labour	β_4	0.081	0.244	0.33
Agrochemical	β_5	0.010	0.151	0.06
Inefficiency Variable				
Constant	Z_0	0.589	0.371	1.59
Age	Z_1	-0.011	0.017	-1.10
Education	Z_2	-0.089	0.079	-1.13
Farming experience	Z_3	-0.044	0.038	-1.14
Extension contact	Z_4	-0.128	0.041	-3.11***
Cooperative association	Z_5	-0.193	0.195	-0.10
Household size	Z_6	0.306	0.206	1.48
Diagnostic Statistic				
Sigma-square	(σ^2)	0.3678	0.0502	7.33***
Gamma	(γ)	0.0570	0.0334	1.71*
Log likelihood function	*L/f*	-115.015		
LR test	8.7896			
Total Number Of Observation	126			
Mean efficiency	0.61			

****1%, **5%, *10%.*

4.5.3 Frequency Distribution of TE, AE and EE Estimates of Guava Farmers

4.5.3.1 Frequency Distribution of Technical Efficiency Estimates of Guava Farmers

The frequency distribution of the technical efficiency estimates for guava farmers in the study area was obtained from the stochastic frontier model presented in Table 13. It was observed from the study that 52% of the farmers had technical efficiency (TE) of 0.81 and above while 48% of the farmers operate at less than 0.8 efficiency level. The farmer with the best and least practice had a technical efficiency of 1.00 and 0.50 respectively. This implies that on the average, output fall by 18% from the maximum possible level due to inefficiency. Also 52% of the farmers were estimated to have technical efficiency exceeding 0.8, indicating there are some 48% technical inefficient farmers in the study area.

The study also suggest that for the average farmer in the study area to achieve technical efficiency of his most efficient counterpart, he could realize about 18 percent (1-0.82/1.00*100) cost savings while on the other hand, the least technically efficient farmers will have about 50 percent (1-0.50/1.00*100) cost savings to become the most efficient farmer.

4.5.3.2 Frequency Distribution of Allocative Efficiency Estimates of Guava Farmers

The Maximum Likelihood (ML) estimates of the stochastic frontier cost function for guava are presented in Table 8. The sigma (σ^2 = 0.37) and the gamma (γ=0.06) are quite high and highly significant at 1% and 10% level of probability respectively. The high and significant value of the sigma square (σ^2) indicate the goodness of fit and correctness of the specified assumption of the composite error terms distribution (Idiong, 2005). The gamma (γ = 0.06) shows that 6% of the variability in the output of guava farmers that are unexplained by the function is due to allocative inefficiency.

The allocative efficiency estimates presented in Table 14, indicate that it ranged from 0.20 to 1.00; the mean allocative efficiency was 0.61. The result indicates that average guava farmer in the study area would enjoy cost saving of about 41 (1-0.61/0.96*100) percent if he or she attains the level of the most efficient farmer among the respondents. The most allocatively inefficient farmer will have an efficiency gain of 82 (1-0.21/0.96*100) percent in guava production if he or she is to attain the efficiency level of most allocatively efficient farmer in the state.

4.5.3.3 Frequency Distribution of Economic Efficiency Estimates of Guava Farmers

The frequency distribution of the economic efficiency estimates for guava farmers in the study area as obtained from the stochastic frontier model is presented in Table 13. It was observed from the study that 2% of the farmers had economic efficiency (EE) of 0.81 and above while 98% of the farmers operate at less than 0.8 efficiency level. The mean economic efficiency of the 126 sampled farmers in the study area was 0.50. The farmer with the best and least practice had economic efficiencies of 0.89 and 0.12 respectively. This implies that on the average, output fall by 50% from the maximum possible level due to inefficiency. Also 2% of the farmers were estimated to have economic efficiency exceeding 0.8, indicating there are some 20% economic inefficient farmers in the study area.

The study also suggest that for the average farmer in the study area to achieve economic efficiency of his most efficient counterpart, he could realize about 56 percent (1-0.50/0.89*100) cost savings while on the other hand, the least technically efficient farmers will have about 99 percent (1-0.12/0.89*100) cost savings to become the most efficient farmer. However, the average economic efficiency of the guava farmers was 50 percent. This indicates that guava farms were economically inefficient.

Table 13: Frequency Distribution of Technical, Allocative and Economic Estimates from the Stochastic Frontier Model

Efficiency Level	TE	%	AE	%	EE	%
< 0.2	0	0	0	0	3	2.38

0.21-0.40	0	0	14	11.11	27	21.44
0.41-0.60	7	5.56	38	30.16	67	53.17
0.61-0.80	54	42.86	61	48.41	26	20.63
0.81-1.00	65	51.58	13	10.32	3	2.38
Total	126	100	126	100	126	100
Minimum	0.50		0.21		0.12	
Maximum	1.00		0.96		0.89	
Mean	0.82		0.61		0.50	

4.6Estimates Results of Determinants of Technical Efficiency of Guava production

The estimated result of the inefficiency model is contained in Table 14. Generally, a negative sign on a parameter means that the variable reduces technical inefficiency, while a positive sign increases technical inefficiency. The results shows that age of the farmers, extension contact, cooperative association and household size have a negative sign, and therefore reduce technical inefficiency (or increase technical efficiency) while level of education and farming experience have positive signs, implying that they increase technical inefficiency (or reducing technical efficiency).

The coefficient of farmer's age had negative sign and not statistically significant. This had a positive influence on technical efficiency in guava farming in the study area. This finding is at variance with Kolawole and Ojo (2007) who in their study of small scale farmers in Nigeria found age to be positively related to inefficiency.

The estimated coefficient of education has a positive sign and not statistically significant. This indicates that level of education attained increase technical inefficiency. This could probably be explained by the fact farmers do not probably employ their educational advantages as opportunity to develop their production capability and inferably would not be ready to adopt innovations and technologies for improved productivity.

The coefficient of farming experience in the inefficiency model is negative but not significantly different from zero. This indicates that an increase in the number of years in guava production decreases technical inefficiency. This is line with findings of Ojo and Ajibefun (2000) and Usman (2009).

The coefficient of Extension visit has a negative sign related to inefficiency and significantly not different from zero. This implies that they increase technical efficiency. Extension visit was due to the fact that there is a very low extension agent-farmers' ratio in the study area.

The estimated coefficient of cooperative association has a negative sign related to inefficiency and significant at 5% level of probability. The effect of this result is that most of the guava farmers in the study area do not enjoy the assumed benefits accrued to co-operative societies through pooling of resources together for a better expansion, efficiency and effective management of resources and for profit maximization. Ajayi (2002) and Ekong (2003) opined that membership of cooperative societies has advantages of accessibility to micro-credit, input subsidy and also as avenue in cross breeding ideas and information.

The coefficient of household size in the inefficiency model is negative and statistically significant at 10% level of probability. The implication of the negative coefficient of household size is that it contributes positively to technical efficiency in guava farming in the study area. The effect of household size on farm level technical efficiency is traceable to its contribution to the supply of family labour for work on the farm. This is line with findings of Bayacag (2001), who revealed that there is a positive and significant relationship between household size and farmers' efficiency in production.

Table 14: Estimates Results of Determinants of Technical Efficiency of Guava production

Variables	Parameters	Coefficients	Std. error	T-Value
Constant	Z_0	0.349	0.329	1.057
Age	Z_1	-0.0087	-0.0087	-0.906
Education	Z_2	0.143	0.096	1.491
Farming experience	Z_3	-0.043	0.030	-1.429
Extension contact	Z_4	-0.081	0.0328	-0.247
Cooperative association	Z_5	-0.111	0.0469	-2.367**
Household size	Z_6	-0.221	0.119	-1.89*
Diagnostic Statistic				
Sigma-square	(σ^2)	0.375	0.0424	8.832***
Gamma	(γ)	0.026	0.0042	0.558
Log likelihood function	*L/f*	-115.687		
LR test	9.096			
Total number of observation	126			
Mean efficiency	0.82			

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

4.6 Contribution of Guava to Household Farm Income in the Study Area.

The main economic activities in the study areas were crop production, the summary of the contribution of guava to household farm income is presented in Table 15. The net household farm income is derived from the total net revenues from guava and other crops produced by guava farmers for the year under consideration. The relative contributions of the various farm income sources are shown in Table 15.

The study revealed that about 32% of the sample farmers' income was generated from other crops (Maize, rice and sorghum) apart from guava. The contribution from guava amounted to about 68% of total household farm income. This in line with findings of Christopher and Yusoff (2011) who asserted that the importance of guava production to food security especially in Nigeria is of significant importance for continued sustenance of improved agricultural productivity. This followed by maize with about 26%, sorghum 5% and rice 2% contribution to total household farm income in the study area. This finding provides enough evidence for the guava farmers to reallocate some resources from other crops production to guava production if only they view profitability and efficient utilization of resources as their main goals.

Table 15: Contribution of Guava to household Farm Income in the Study Area

Income source		Amount (₦)	% contribution
A. Net guava revenue		368,126.9	67.99776
B. Net income from other crops			
B_1	Maize	142,068.26	26.24183
B_2	Sorghum	25277.75	4.669125
B_3	Rice	8524.10	1.574511
C. Net farm income for other crops (B_1+B_2+B_3)		173,253.97	
D. Total net household income (CD)		**541,380.9**	**100**

4.7 Estimated Potential Impact of Guava Production on Farmers Income

The potential impact of guava production on farmers' income was carried out by comparing the profit of guava producing farmers and non-guava producing farmers (mango and citrus) in the study area. The summary of guava farmers' income and non-guava farmers' income in the study area is presented in Table 16.

The average costs incurred and revenue obtained per hectare for guava were estimated to determine the profitability or otherwise of guava production in the study area (table 16). The total revenue (TR) was ₦266,926.8 while the total cost was ₦97,213.07. The net farm income was therefore ₦169,749.73. The average rate of return on investment (return per naira invested) is ₦2.75, indicating that for every ₦1 invested in guava production in study area; a profit of ₦1.75 kobo was made while the total revenue for Mango and Citrus producer in the study area under consideration were ₦191110.4 and ₦77552.00 with an average cost incurred as ₦179186 and 75454.58 respectively. Therefore, The average rate of return on investment (return per naira invested) was ₦1.07 and ₦1.03 respectively, indicating that for every ₦1 invested in mango production in study area; a profit of 7 kobo was made and also for every ₦1 invested in citrus production in study area; a profit of 3 kobo was made. Thus, it could be concluded that guava production in the study area has a potential impact on the income of the farmers.

Table 16: Potential Impact of Guava production on farmers' income

Variable	Guava	Mango	Citrus
Total Revenue(₦)	266,926.8	191110.4	77552.00
Total Cost(₦)	97213.07	179186	75454.58
Net Farm Income(₦)	169,749.73	11924.4	2097.42
Return per Naira Invested	2.75	1.07	1.03

4.8 Constraints of Guava Production in the Study Area.

The problems faced by guava farmers in the study area were ranked according to their severity as stated by the farmers (Table 17). Pest and disease was the most severe constraint of guava producers with about 90% of guava farmers attesting to this fact. Guava as a crop is susceptible to attack by numerous insects and diseases throughout the life cycle and the effective control of these is inevitable if reasonable yield is expected. This causes discoloration of the leaf, leaf patches, shrinking of the seed and seed dormancy were responsible for pre-harvest and post-harvest losses which automatically represent a serious decline in quality and substantial reduction in priceUgbajah and Uzuegbuna (2012). About 42% of the respondent was also more severe with lack of capital to expand their production. This affects guava production in the study area, because the meager savings the farmers might have made or the funds generated from relatives is not sufficient to satisfy various activities in guava production. High cost of inputs like seed, fertilizer and labour were severe constraint of guavaproducers with about 32%, 3% and 7% respectively. According to the respondents, due to high cost of improved seed they make use of seeds from their previous harvest which is not reliable and can jeopardize improved and sustainable productivity. This finding is in line with Ekong (2003)), opined that most farmers have little or no access to improved seeds and continues to recycle seeds that have become exhausted after generations of cultivation. Also, Farmers perceived that high cost of fertilizer constraints, according to the respondent fertilizer is made available when farmers are far into the production period, sometimes at the middle of the raining season and family labour was predominant in the study area and that is why there was acute shortage of labour. According to the farmers, during active period of production-every household would have been engaged in his family farm work. The demand for labour is normally very high and expensive during the peak period of land clearing, ridging, harvesting, processing and weeding. Ugbajah and

Uzuegbuna (2012) while 16% of the respondents said high cost of transportation and lack of access to market was the major constraint faced in the study area.

Table 17: Production Constraints of Guava Farmers

Constraining factors	Frequency	Percentage	Ranking
Pest and diseases	114	90.48	1st
Inadequate capital	53	42.06	2nd
High cost of seed	40	31.75	3rd
High cost of labour	4	3.17	4th
High cost of fertilizer	9	7.14	5th
High cost of transportation	5	3.97	6th
Access to market	17	13.49	7th

 Multiple responses 242

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

This study analyzed the economic efficiency of guava production among smallholder farmers in selected local government areas in Kaduna State. To achieve this, the study came up with seven main objectives. These were to: describe the socio-economic characteristics of guava farmers, determine the cost and return associated with guava production, determine the technical, allocative and economic efficiency of guava production, estimate the determinants of efficiency in guava production, contribution of Guava to household farm income in the study area, estimated Potential Impact of Guava production on farmers income and to describe the constraints to guava production in the study area.

Three villages were randomly selected each from two Local Government Areas and 126 farmers were selected in this area. The purpose of the study was to examine the economic analysis guava production among smallholder farmers in Kaduna state, Nigeria, primary data were collected from 126 respondents using structured questionnaire. The statistical tools used to analyze the data were descriptive statistics, net farm income and stochastic production frontier function model. A descriptive statistics attributes of guava producers, contribution of other crops to farmers income, potential impact of guava production and constraints to guava production.

The result of the analysis shows that 37% of the respondents fall within the age range of 30-39 years with an average of 34 years, the majority of the farmers 85% were literate while 15% had no formal education. 36% of the household size ranged from 1-3 persons with an average of 5 persons. Majority of the farmers, 61% were not members of a cooperative society. About 87% of the respondents do not have contact to extension agent while 100% of guava farmers have farming experience range from 1-3 years with an average of 2 years.

The average costs incurred and revenue obtained per hectare for guava were estimated to determine the profitability or otherwise of guava production in the study area (table 15). The total revenue (TR) was₦266,926.8 while the total cost (TC) was ₦97,213.07. The net farm income was therefore ₦169,749.73. The average rate of return on investment (return per naira invested) is ₦2.75, indicating that for every ₦1 invested in guava production in study area; a profit of ₦1.75 kobo was made. Thus, it could be concluded that guava production in the study area is highly profitable.

The stochastic frontier production function was estimated for technical, allocative and economic efficiency. About 52% of the farmers had technical efficiency (TE) of 0.81 and above while 48% of the farmers operate at less than 0.8 efficiency level. The mean technical efficiency for the 126 sampled farmers in the study area was 0.82. The farmers with the best practice have a technical efficiency of 1.00 while 0.50 was for the least efficient farmers. This implies that on the average, output fall by 18% from the maximum possible level due to inefficiency. The mean allocative efficiency was 0.61. The result indicates that average guava farmer in the state would enjoy cost saving of about 41% while allocatively inefficient farmer will have an efficiency gain of 82% to attain the level of most efficient farmer among the respondents. The mean economic efficiency was 0.50. The farmer with the best practice has an economic efficiency of 0.96 while 0.21 was for the least efficient farmers. This implies that on the average, output fall by 50% from the maximum possible level due to inefficiency.

The relative contributions of the various farm income sources obtained shown that about 32% of the sample farmers' income generated from other crops (maize, rice and sorghum) apart from guava. The contribution from guava amounted to 68% of total household farm income.

The potential impact of guava production on farmers' income was carried out by comparing the profit of guava producing farmers and non-guava producing farmers(Mango and citrus)in the study area. Thus, it could be concluded that guava production in the study area is highly profitable when compared with maize and sorghum production in the study area.

Study revealed that constraints to guava production in the study area were; pest and disease (90%), inadequate capital (42%), high cost of inputs such as seed, fertilizer, and labour were (31%, 3% and 7%),high cost transportation (4%) and lack of access to market (31%).

5.2 Conclusions

Based on the findings of this study, it could be concluded that guava production in the study area is profitable by returning ₦1.75 kobo to every ₦1.00 spent.

The farm specific technical efficiency distribution reveals that none of the farmers achieved the maximum efficiency level. Thus, within the context of efficient agricultural production, output can still be increased by 18% using available inputs and technology. These results call for policies aimed at encouraging new entrants especially the youths who are agile and stronger to grow guava and the experienced ones to remain in guava farming.

5.3 Contribution of the study to knowledge

i. The study revealed that guava production in the study area is profitable with net farm income of ₦169,749.73 and for every naira spent in guava production; a gain of ₦1.75 kobo was made.

ii. It was discovered that guava farmers were economically inefficient in the study area having an economic efficiency of fifty (50) percent.

iii. The study revealed that guava farmers in the study area achieved technical efficiency of 82 percent.

5.4 Recommendations

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

i. The most severe problems encountered in guava production is pest and disease This constraint constitute serious impediments to guava production and need to be addressed adequately before guava production can be improved in the study area. It is recommended that the farmers involved in guava production can contact research institutes like I A R to seek for possible solution to such problems.

ii. Inadequate capital was one of the constraints to guava production, it is therefore recommended that guava farmers should form cooperative societies, to pull their resources together and help themselves in the purchase of inputs for guava production.

iii. Cooperative association is one of the technical efficiency determinants that significantly influence guava production in the study area. It is therefore recommended that farmers should form co-operative association through pooling of resources together for a better expansion, efficiency and effective management of resources and for profit maximization.

iv. The study revealed that for every naira spent in guava production, a gain of ₦1.75 kobo was made; it is therefore recommended that farmers should be encouraged to go into guava production in the study area in order to generate more income.

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APPENDIX

ECONOMIC ANALYSIS OF GUAVA(*Psidiunguajava*) PRODUCTION AMONG SMALLHOLDER FARMERS IN SELECTED LOCAL GOVERNMENT AREAS OF KADUNA STATE

Dear Respondent,

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

Village/Community…………………………………………………L.G.A
…………………………………………………….

A. SOCIO –ECONOMICS CHARATERISTICS

1. Name of farmer………………………………

2. Sex: Male ( ) Female ( )

3. Age (years)…………………………………………

4. Married ( ) Single ( )

5. Highest level of Education:

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

Education ( ) (d) Tertiary Education ( )

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

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

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

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

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

10. What benefit did you derive as a member?

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

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

d. Money Lenders (Borrow) ( )

12. If you borrow, what were the sources of the credit? a. commercial bank( ) b. Bank of Agriculture ( ) c. Cooperative Society ( ) d. Money Lenders( ) e. Friends and Family ( ) f. Others (specify)……………………………………………………………………………

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

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

Others (Specify)		

14. Have you been visited by an extension agent? Yes (   ) No (   )
15. If Yes, How many times in last one year?
16. What activities did the agent teach you? ....
17. Of what benefit were the techniques learnt to you to the success of your farm? ....

18. Have you been trained on guava farming? Yes (   ) No (   )
19. If yes, which organization conducted the training?
20. Was the training beneficial to you?

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

B. INFORMATION ON INPUTS

(1) Farm size (Ha)

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

Plot NO	Plot Size (Ha)
1	
2	
3	

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

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

2					
3					

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

(II) Variable inputs (Last production Cycle)

(ii)Seed (Kg)

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

(iii).Fertilizer.

Plot No	Fertilizer type (first application)	Quantity(Kg)	Cost(₦)
1			
2			
3			
	Fertilizer type (second application)		
1			
2			
3			
	Fertilizer type (third application)		

1			
2			
3			

(iv).Agrochemical.

Plot No	Agrochemical type (first application)	Quantity(Kg)	Cost(₦)
1			
2			
3			
	Agrochemical type (second application)		
1			
2			
3			

	Agrochemical type (third application)		
1			
2			
3			

(v) Labour input

(a) Land preparation (seedling)

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

(b) Land preparation (seed)

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

(c)Planting

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

(d) First Fertilizer Application

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

(e) Second Fertilizer Application

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

(f) Third Fertilizer Application

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

(g) First Weeding

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

(h) Second Weeding

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

(i) Third Weeding

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

(j).Replacement of dead guava seed planted

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

(k) First Harvesting

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

(l) Second Harvesting

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

(m) Third Harvesting

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

(n) Information on Gauva output

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

(i) Information on other crops

Plot No	Types of crop growned	No. of output produced(Kg)	Total Qty sold	Price/Unit	Total cost incurred (₦)	Profit
1						
2						
3						

21. Where do you sell your produce?

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

22. When do you sell your produce?

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

CONSTRAINTS OF GUAVA PRODUCTION

S/n	Constraints	Ranking according to severity 1=least severe, 2=moderately severe, 3= severe, 4=	Coping Strategy

		more severe, 5= most severe.	
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			