ANALYSIS OF PROFITABILITY AND PRODUCTION EFFICIENCY OF SMALL SCALE BAMBARANUT FARMING IN KAJURU LOCAL GOVERNMENT AREA OF KADUNA STATE

BY

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

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DECLARATION

I hereby declare that this dissertation titled "**Analysis of profitability and production efficiency of small scale bambaranut farming in Kajuru local government area of Kaduna State,"** 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 in this or any other institution. All borrowed information has been duly acknowledged in the text and a list of reference provided.

_____ _____

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CERTIFICATION

This dissertation titled "**Analysis of profitability and production efficiency of small scale bambaranut farming in Kajuru local government area of Kaduna State,"** by **Hamza MOHAMMED** meets the regulation governing the award of the degree of Master of Science in Agricultural Economics of the Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This work is dedicated to God Almighty who is the source of all knowledge, my mother, Mallama Hauwa Mohammed Bawo and my beloved wife Mrs Hajaratu Hamza.

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ABSTRACT

The Study focused on the Profitability and Production Efficiency of Bambaranut in Kajuru Local Government area of Kaduna State, Nigeria. A multi-stage sampling technique was used to select 180 farmers across the local Government. Structured questionnaire was used to collect the data. The data collected was based on 2014 cropping season. The data was analyzed using descriptive statistics, stochastic frontier model, and the gross margin analysis. It was found that the mean age of bambaranut farmers was 39 years. The mean for householdsize was 6 persons. The mean for the level of education was found to be 1. The mean for farming experience was found to be 12. The mean for extension contact was 2. The mean for funds obtained by bambaranut farmers was ₦7100. The mean farm size was found to be 3 and that of the cooperative society was 2. It was also found that the mean technical efficiency was 0.70. The mean allocative efficiency was 0.613 while that of the economic efficiency was 0.475. The mean technical efficiency of 0.70 means that majority of the Bambaranut farmers operated closer to their production frontier. Also, this implies that on the average, bambaranut farmers are able to obtain 70% potential output from a given mix of productive resources. The result revealed that 21% of the farmers had allocative efficiency (AE) of between 0.61 and 0.8 while about 79% of the farmers operate at less than 0.61 allocative efficiency levels. This implies that the greater majority of Bambaranut farmers were not allocative efficient because 21% of them attained efficiency level greater than 0.61. That is, the farmers are not efficient in producing Bambaranut at a given level of output using the cost minimizing input ratio since 21% of the bambaranut farmers have allocative efficiencies of 0.61 and above. The mean economic efficiency of the bambaranut farmers in the study areas was 0.47. This implies that on the average, there was a fall in the bambaranut output level by 53% from the maximum feasible level due to economic inefficiency. Therefore, the bambaranut farmer with the best and least practice had economic efficiencies of 0.72 and 0.13 respectively. The Bambaranut farmers in the study area got an average cost of ₦116148.89 and average return of ₦928669.44. The result of the analysis indicates that bambaranut production is profitable in the study area. Finally, it was found that 25% of the respondents' ranked inadequate capital as the major constraint to bambaranut production. It is recommended that agricultural loan facilities should be made accessible to Bambaranut producers to ensure timely and adequate utilization of agricultural inputs for improvement in farm production efficiency by the formal financial institutions.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Bambaranut (*Vigna subterranea*) is an indigenous African leguminous crop which has been cultivated in the tropical regions of Sub-Saharan Africa and Madagascar for many centuries. It originated in the Sahelian region of West Africa, from the Bambara tribe near Timbuktu who now live mainly in Central Mali, hence its name Bambaranut. The crop is essentially grown for human consumption (Atiku *et al.,* 2009). The nuts are also known as *jugo* beans (South Africa), *Ntoyo Cibemba* (Republic of Zambia), *Gurjiya* or *Kwaruru* (Hausa, Nigeria), *Okpa* (Ibo, Nigeria), *Epa-roro*(yoruba,Nigeria) and *Nyimo* beans (Zimbabwe). The seed contains 63% carbohydrate, 19% protein and 6.5% oil. At present, there are no improved varieties of Bambaranut, as such the crop is still cultivated in the form of landraces in semi-arid regions where rainfall is limiting and environmental conditions for sustainable growth are harsh and unsuitable. (Vijaykumar *et al., 2011)*

Bambaranut is cultivated by smallholders over much of semi-arid Africa and principally by farmers as a "famine culture" crop because it has several natural agronomic advantages including high nutritional value, drought tolerance and the ability to produce in soils considered insufficiently fertile for cultivation of other more favoured species such as common beans and groundnuts. Bambara nut is a particularly hardy crop, being extremely drought resistant, and can be grown wherever climate conditions are suitable for sorghum. It can be grown on soils too poor for groundnut (*Arachis hypogea*) sand thrives on Savannah. Despites its economic importance, no commercial production and industrial use of the crop take place in Nigeria. Its production is usually undertaken by the small scale farmers (Atiku *et al.,* 2009). At present, there are no

proved varieties of Bambaranut, as such the crop is still cultivated in the form of landraces in semi-arid regions where rainfall is limiting and environmental conditions for sustainable growth are unsuitable. A landrace is a combination of different genotypes with the ability to withstand biotic and abiotic stress and still produce good yields under low-input farming system (Atiku *et al.*, 2009). Bambaranut has an indirect beneficial use in agriculture because it is a legume, which has a symbiotic relationship with the bacteria that form root nodules. The bacteria can make use of the free nitrogen from the air and assimilate it in the plant root tissue. By so doing, they directly increase the level of the soil nitrogen, and in turn the yields of the cereal that may follow legumes in plant rotation, is increased.

Chemical fertilizers are not usually applied on the land. This has made the crop ideal for the resource poor farmers. For best growth, bambaranut needs bright sunshine, high temperatures, and frequent rain to grow best. It grows well in an average temperature of 20-28 °C and the optimum temperature for germination of the seed is 30^0-35^0C (Bamishaiye and Adegbola, 2011). It requires a frost-free period of at least 3 to 5 months. The plant is highly adaptable and tolerates harsh conditions better than most crops.

Efficiency is the ability to produce a given set of output with a minimum quantity of inputs (Asogwa *et..al.,* 2007). This occurs when a firm is combining resources in such a way as to produce a given output at the lowest possible average total cost. According to Ajibefun and Daramola 2003, efficient use of resources eliminates wastages and increases productivity and farm income. Production efficiency has two components: Technical efficiency and Allocative efficiency.

1.2 Problem Statement

Global consumption of bambaranut is consistently rising over the years without a corresponding increase in supply. Its production is low and usually undertaken by the small scale farmers (Atiku *et al.,* 2009). The inability of the producers of the crop to produce in order to meet its rising demand could be attributed to inefficient use of bambaranut resources, lack of improved seed varieties, scant research attention and information on profitability and production efficiency (Hampson *et al*., 2001). This study is intended to analyze the profitability and production efficiency of the crop in order to enable farmers to produce profitably and efficiently. It is against this background that the study seeks to answer the following questions research:

(i) What are the socio-economic characteristics of bambaranut farmers in the study area?

(ii) What are the costs and returns to Bambaranut production in the study area?

(iii) What is Economic efficiency of Bambaranut in the study area?

(iv) What are the constraints to the production of bambaranut in the study area?

1.3 Objectives of the Study

The main objective of the study was to determine the profitability and efficiencies of bambaranut production in Kajuru local government area. The specific objectives of the study were:

(i) describe the socio-economic characteristics of bambaranut farmers

(ii) estimate costs and returns in bambaranut production

(iii) determine the economic efficiency of bambaranut production

(iv) describe the constraints to bambaranut production in the study area.

1.4 Justification of the Study

The rising consumption for Bambaranut has led to a tremendous increase in its demand in many parts of the world but the supply is not rising to meet such demand. The supply problem could be attributed to low level of production which is caused by the inefficient use of productive resources, lack of improved seeds varieties, low marketing and low profit generation. Efficient use of resources is an important part of Agricultural sustainability. One way peasant farmers can achieve sustainability is to raise the productivity of their farms by improving efficiency within the limit of existing resource base. Inefficient use of resources brings economic wastages and loses and consequently low output and supply. It is in the light of the above that the research becomes necessary and imperative in order to bridge the information gap on profitability and production efficiency couple with contributing to the body of knowledge which will help farmers to improve on their production efficiency and profitability in order to produce to meet the rising demand of the crop. The research will also identify the constraints to Bambaranut production to serve as a guide to farmers and policy-makers.

1.5 Hypotheses:

The following hypotheses were tested for the study:

(1) Bambara nut production is not profitable in Kajuru Local Government Area

(2) There is no significant relationship between socio-economic characteristic of Bambaranut farmers and technical efficiency of Bambaranut production

CHAPTER TWO

LITERATURE REVIEW

2.1 Bambaranut Production

The annual world production is 330,000 metric tons, 45 – 50% of which are produced in West Africa (Nigeria, Niger, Burkina Faso, Chad, Cote d'Ivoire, Ghana and Mali (PROTA, 2006). In 2008, it was estimated that Nigeria produced between 100,000 and 168,700 metric tons from an area 15350 hectares (NFRA, 2008). It is locally given the names *Okpaotuanya* (Ibo), *Eparoro* (Yoruba), *Gurjiya*(Hausa) (NFRA, 2008). In the proposed study area it is called Ettali in Adara language. It is ranked next only to cowpea in both production and as a human food (Linnemann, 1992). While the production of the crop was declining in the Sahel and Sudan Savannah Zones due mainly to drought, its production was increasing in the Southern Guinea Savanna due to the fact that the crop fetches higher income now than it did previously (NFRA, 2008).

Bambaranut is probably the most drought– resistant of the grain legumes and may be found surviving successfully where annual rainfall is below 500 mm and optimum between 900–1000 mm per year. The plant can be grown under dry climatic conditions where the rainfall during the rainy season would be adequate to enable them to accomplish their vegetative cycle. In Nigeria, like in many parts of Africa, Bambaranut is grown by subsistence farmers mostly women, in small patches of land, and is frequently intercropped with cowpea, maize and sorghum, (Mkandawire and Sibuga, 2002). Food legumes including Bambaranut enriches the soil by fixing atmospheric nitrogen, and thus resulted in reduced fertilizer requirement for subsequent crops (NFRA, 2008)

2.2 Utilization of Bambaranut in different parts of Africa

In Botswana, Bambaranut is predominantly grown for human consumption. Consumers often prefer the immature seeds, which are boiled in the pod, salted, and consumed, either on their own or mixed with maize seeds. When the seeds are ripe and dried, they are pounded into flour and used to make a variety of cakes, or are mixed with cereals and used to prepare several types of porridge. Livestock, especially goats, are very fond of the stem or stalk, which they are allowed to graze on at the end of the season, after the pods have been harvested. The seeds of the mature black landrace are used in traditional medicine (Bamishaiyi *et al., 2011).*

In Burkina Faso, bambaranut is primarily consumed by its producers, during the period before the cereals are harvested. Along with the cowpea (*Vigna unguiculata* (L.) Walp). It constitutes the main source of vegetable protein for the rural populace. Its leaves, which are rich in protein and phosphorus, are used as fodder for livestock (Bamishaiye *et al.*, 2011).

In Northern Ghana**,** the fresh immature beans are boiled and consumed after adding a little salt. The dry beans are also boiled, crushed and made into cakes or balls, which are then fried and used to prepare stews. In southern Ghana, the beans are usually soaked overnight, after which they are boiled until soft, to produce a kind of porridge/blancmange. Capsicum pepper and salt may be added during the boiling process. This preparation, called 'aboboi', is served with 'gari' (roasted, grated cassava) or with mashed, fried, ripe plantain. In the early 1960s, Bambara nut was canned in Ghana, in tomato sauce with pieces of meat, in brine, or as 'abobo (Bamishaiye *et al.*, 2011). In the Coast Province, the Kambe and Giriama peoples normally cooked Bambaranut or used when vegetables are in short supply. When the seeds are dried,

they are pounded in a ‘kinu’ (mortar) to remove the seed coat (they do not break), winnowed and boiled until they are cooked. They are then pounded using a ‘kipawa’ (serving spoon made from the coconut shell) or ‘mwiko’ (wooden spoon), and ‘tui’ (coconut juice) is added. The mixture is boiled until cooked and stirred with a wooden stirrer (‘lufidzo’) until smooth. It is then served with rice or ‘ugali’ stiff maize meal porridge). When the seeds are still green, the seed coat is peeled off by hand and the seeds are then prepared in the same way as the dry ones described above (Bamishaiyi *et al., 2011).*

In Kenya**,** the Lubya people cooked fresh in its pods (green pods are washed and boiled in salted water, which is said to penetrate the pods). This is reported to be the tastiest snack among the many that are made from bambaranut, and is rated even more highly than the peanut. The dry seeds are salted while roasting (the seeds may be washed before roasting). Owing to the hardness of the seeds, this dish is not a favourite, especially with children. Sometimes, a small number of seeds are reportedly roasted with a greater proportion of peanuts, to reduce the hardness effect. Dry seeds can either be pounded or ground and the resultant meal made into some stew (or sauce). The stew/sauce is then added to the traditionally prepared leafy vegetables, particularly ikhubi’/‘elikhubi’ (cowpea) and cooked. This may be served with ‘ugali’ or potatoes. Boiled with maize and beans and served as a snack, especially with tea. Fried (like peanuts), usually with sesame seeds. Boiled, then mixed with boiled sweet potatoes and mashed (a popular children’s dish). It is also consumed plain, after being boiled and mashed. Unshelled pods are boiled, fried and served with potatoes, bananas or ‘ugali. The Luo people of Kenya of Kenya prepared bambaranut in a number of ways. They used in the same way as kidney beans, to make ‘nyoyo’ (a mixture of beans and maize

boiled together), or plain boiled. This is served with tea, ‘nyuka’ (porridge), or on its own. Dried, ground using a ‘pong’ (grinding stone), or pounded in a ‘pany’ (mortar), then cooked in thesame way as greengrams, in a sauce traditionally known as ‘ogira’, this is served with other foods, such as potatoes. Traditionally it was eaten using a ‘sare’ (bivalve shell from lake Victoria). Roasted like the peanut; this is not common, because the seeds remain hard after roasting. Peanuts are normally added, probably to reduce the effect of hardness. Water from the boiled maize and pulse mixture is drunk to treat diarrhea.

The leaves are pounded with those of *Lantana trifolia* L. (‘nyabend inyo’,‘nyamrithi’), then water is added to make a solution used to wash livestock as a preventative against ticks. This solution is used as a pesticide on vegetables too. The leaves can be combined with those of ‘nyajagra’ (mexican marigold) and *L. trifolia*, pounded, and water added. This mixture can also be used as an insecticide. When applying the solution to vegetables, care needs to be taken to apply it to the ground, and not to pour it on the leaves, as it is reported to burn them. When dry, the leaves are pounded with traditional salt (‘mbala’, harvested at Sindo and Homalime), and fed to cattle infected with ‘tuoolao’ (a type of mouth disease). The leaves cauterize and heal the animals’wounds (Bamishaiye *et al.*, 2011). Also in Kenya**,** it has medicinal uses as follows**:** Water from boiled maize and Bambara nut is drunk to treat diarrhoea. The leaves are pounded with those of *Lantana trifolia* L. (‘nyabend winyo’, ‘nyamrithi’), then water is added to make a solution used to wash livestock as a preventative against ticks. This solution is used as a pesticide on vegetables too. The leaves can be combined with those of ‘nyajagra’ (mexican marigold) and L. trifolia, pounded, and water added. This mixture can also be used as an insecticide. When applying the solution to egetables, care needs to be taken to apply it to the ground, and not to pour it

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In south Africa**,** the following culinary uses of the crop were reported by Swanevelder (2011): Sekome’ (Sesutho), ‘tihove’ (Shangaan) or ‘tshidzimba’ (Venda) is prepared by adding ‘njugo’ beans and peanuts, or just one of the two, to maize or millet-meal and boiling the mixture until it forms a stiff dough. This is salted and pounded into a ball, and will often keep fresh for several days. Bambaranut is boiled and then stirred, to make a thin porridge, which is known as ‘tshipupu’ (Venda). Like maize, they may also be added to ‘lupida’, a porridge made from peanuts. ‘Njugo’ beans are often eaten when still immature, simply boiled until soft, and shelled. When quite dry and hard, they are generally shelled, and then boiled to make a stiff porridge. Bambaranut can be cooked with maize and pounded into thick, sticky dough known as ‘dithaku’ (in Sesutho). The only use of bambaranut observed among the local white population was of the dried beans, to make soup (Swanevelder, 2011).

In Nigeria, the freshly harvested pods are cooked, shelled and eaten as a vegetable snack, while dry seeds are either roasted and eaten as a snack in a manner similar to boiled peanuts or milled into flour and used in preparation of moin-moin or ‘*okpa*’ among the Igbo tribe of Nigeria or *allele* in the northern part of Nigeria. The stem or stalk is used for livestock feed, while in the Northern part of Nigeria, the seeds are often crushed into flour, to prepare the following dishes: ‘alele’, ‘alelen ganye’, ‘danwake’, ‘gauda’, ‘kosai’, ‘kunu’,‘tuwo’ and ‘waina. Bambaranut milk was a modified method for the extraction of cowpea milk. The dried mature seeds can be

converted into paste, steamed and eaten with vegetable soup or sauce. Bambaranut can also be fermented. A known dadawa type product is made from Bambaranut using a solid substrate fermentation method. Also the flour could also be used as composite flour used for cereal based confectionaries e.g. Biscuit, Cakes and bread.

It has been reported that in Zambia, Bambaranut is used for bread and milk making. Bambaranut in countries such as Angola and Mozambique, boiled salted seeds are often served as appetizers. Recently, a trial of bambaranut milk was carried out which compared its flavour and composition with those milk prepared from cowpea, pigeon pea and Soyabean (Bamishaiyi *et al.,* 2011*).*

2.3 Marketing of Bambaranut

It was only in recent years that people started selling it in local markets as boiled nuts. Bambaranut is grown mainly by local people, mostly for home consumption while the surplus may be sold to individuals in streets and at local markets. Seed size, variety and colour are important factors in determining the marketing of Bambara nut. The marketing continuum was described for Zimbabwe and Swaziland. The demand for the fresh crop in Swaziland was also estimated to be high, but production is lower, and more localized. The country is not yet self-sufficient in Bambaranut production. In addition, the entire dried crop sold as seed or food within Swaziland is imported from South Africa. Farmers in both countries consume the majority of their harvested crop, and sell any excess. The seed commands a high price, with demand far outweighing supply in many areas. Zimbabwe exports about 3,000 tones of bambaranut seeds a year to South Africa and Botswana, bambaranut is consumed fresh after harvest, and is also stored for consumption later in the year. The seed stores very well and is not prone to attack by

pests or disease. However, the dried seed becomes very hard to cook, requiring large amounts of time and fuel which, it is believed, is one of the main constraints to its increased utilization (Sessay, 2000).

2.4 Concept of Efficiency

Efficiency is the ability to produce a given set of output with a minimum quantity of inputs (Asogwa *et..al.,* 2007). This occurs when a firm is combining resources in such a way as to produce a given output at the lowest possible average total cost. According to Ajibefun and Daramola 2003, efficient use of resources eliminates wastages and increases productivity and farm income. Production efficiency has two components: Technical efficiency and Allocative efficiency.

2.4.1 Technical efficiency

This 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 maximal output from a given set of inputs. It is also referred to as the ability of a farmer to obtain maximum possible output from a given set of resources. A firm is said to technically efficient if it is producing the maximum output from the minimum quantity of inputs such as labour, capital and technology. Economic efficiency is the product of technical and allocative efficiencies. The simplest way to differentiate productive and technical efficiency is to think of productive efficiency in terms of cost minimization by adjusting the mix of inputs, whereas technical efficiency is output maximization from a given mix of inputs Markovits (2008).

2.4.2 Technical inefficiency

This occurs when the level of production for the firm is less than the frontier output and it arises when timing and methods of application of production inputs are mismanaged (Asogwa *et al.,* 2007). This is also referred to the factors that are not directly used in production but affect productive efficiency negatively. These include age, level of education, gender, house hold size, cooperative membership, farming Experience etc. These variables can have a great influence on the technical efficient variables of the farmers.

2.4.3 Allocative efficiency

This is the ability of a firm to use inputs optimally given their respective prices. It is referred to the ability of a farmer to use the inputs in optimal proportion given their respective prices (Asogwa *et al.,* 2007). A more precise definition of allocative efficiency is at an output level where the price equals the marginal cost (MC) of production. This is because the price that consumers are willing to pay is equivalent to the marginal utility that they get. Therefore the optimal distribution is achieved when the marginal utility of the goods equals the marginal cost. Allocative efficiency occurs when consumers pay a market price that reflects the private marginal cost of production. The condition for a firm is to produce output where marginal cost equates price (P=MC). Allocative efficiency is the main tool of welfare analysis to measure the impact of markets and public policy upon society and subgroups being made better or worse-off. Markovits (2008). If the marginal cost of a good is ₦5 and the price is ₦10, the price (MU) is greater than marginal cost. This suggests under consumption that, if output is increased and price fell, society will benefit from enjoying more of the goods Markovits (2008).

2.4.4 Economic efficiency

This is the product of technical efficiency (TE) and allocative efficiency (AE). It reflects the ability of a firm to use the inputs optimally given their respective prices and technologies (Helfarnd, 2003).

2.5 Cost and Return Analyses:

2.5.1 Cost analysis

Cost is defined as the value of a factor of production (input) employed in the production of final outputs. A direct cost is a cost that can easily and conveniently be traced to the particular farm activity (e.g. commodity). For example, in most cases the use of fertilizer is a direct cost of a particular crop as far as the flow of utility it produces benefits to that crop. Vice versa an indirect cost is a cost that cannot be easily and conveniently traced to the particular farm activity. For example, if a farm produces several crop commodities, the cost item such as machinery maintenance is an indirect cost of all crops for which the machinery was utilized. Costs are generally of two types- fixed costs and variable costs. Fixed costs are on fixed inputs which do not change as production changes. The fixity of cost is just in a short run because in the long run all costs become variable since condition may warrant changing all the factors of production. Even plant and equipment can be changed in the long run though in the short run they are considered fixed. Variable costs are those costs that change with the level of output (Isermeyer, 2011).

2.5.2 Return analysis

Revenue is the income accruing to the producer and can be measured on per unit output basis. It is also measureable in total, average or marginal quantities. These are

obtained by multiplying the physical quantities of output by the unit price of output (Isermeyer, 2011)

2.6 Theoretical Framework

Efficiency: It is generally associated with the possibility of farms producing a certain optimal level of output from a given bundle of resources or certain level of output at least cost (Helfarnd, 2003). According to him, productive efficiency is the attainment of production goal without waste. The crucial role of efficiency in increasing Agricultural output has been widely recognized by researchers and policy makers. It has remained an area of important research both in developed and developing countries. The reason behind measure of efficiency is that farmers are not making efficient use of existing technology as a means of increasing output (Helfarnd, 2003).

Profitability Analysis enables you to evaluate market segments, which can be classified according to products, customers, orders or any combination of these, or strategic business units, such as sales organizations or business areas, with respect to your company's profit or contribution margin (Helfarnd, 2003).

Participatory Rapid Appraisal (PRA) study of bambaranut (*Vigna subterranea* (L.)Verdc.) Production was conducted in six villages sampled from three Local Government Areas (LGA). The LGAs were Ogbadibo, Kwande (Benue State) and Olamaboro (Kogi State), all located in Southern Guinea Savanna of Nigeria. The study involved 6 group discussions and 240 individual key informants who were interviewed using a check list with a view to provide information on existing bambaranut-based cropping systems. Results indicated that most bambaranut farmers were literate (99.58%). 52.91% of the farmers were males and 47.08% were females. Bambaranut

production was mainly in small holdings (≤1ha). About 30 % of bambaranut farmers plant the crop as sole while 65.83% intercropped it with other crops. Intercropping with cassava dominated the intercrop systems. Planting was mainly on ridges (83.33%). About 77% of the farmers do not apply fertilizer to bambaranut with the belief that it could grow well on poor soils. Weeding was done manually by 87.08% of the farmers, while 21.25% of them used herbicides for weed control mainly in Kwande LGA. Yields of bambaranut were generally low (100-600 kg/ha). Labour and lack of finance ranked the highest consideration by farmers as constraints to the production of bambaranut in Southern Guinea Savanna. Pests/diseases were considered next with a score of 2.16. Poor germination of seeds and unreliable rainfall were considered unimportant among the list of constraints in the production of Bambaranut.

CHAPTER THREE

METHODOLOGY

3.1 The Study Area

The study was conducted in Kajuru local government area of Kaduna state. Its headquarters are in the town of Kajuru. Kajuru local government Area is located on longitude 9^0 59'N and 10^0 55'N and Latitude 7^0 34'E and 8^0 13'E with an Area of 2,464km^2. It was carved out of Chikun local government in March, 1997 (Stag Survey and Toro, 2001). It has an estimated Population of 110,868 people (National Population Commission Census, 2006). The projected population in 2015 is 160,920(Research and statistics section of Kajuru local government area 2015). It has an annual rainfall of 1300mm. Kajuru local government has fourteen (16) Districts and Ten(10) political Wards. The political Wards are Kufana, Kasuwan Magani, Buda, Rimau, Kallah, Idon, Maro, Afogo, Kajuru and Tantatu (Reconnaissance Survey, 2014). Kajuru local government shares boundaries with Igabi local government Area to the North, Chikun Local Government to the West, Kauru local government to the east, Zangon Kataf Local Government Area and Kachia local government to the South-West and South respectively (Toro, 2001). The major ethnic group is Adara others include Hausa, Fulani, Gbagi, Yoruba and Igbo and Jaba among others. The main religions in the Country are practiced in the Area that is, Christianity, Islam and Traditional Worship. The main economic activity in the area is Farming. The people produce food crops such as maize, rice, bambaranut, ground nut, sorghum, yam, cocoa yam, potatoes, millet soya beans, black beans(Achishuru). They also produce Cash Crops such as onion, pepper and tomatoes. However, most of the food crops are also sold for cash. few livestock are reared. These include goats, pigs poultry and cattle, (Toro, 2001).

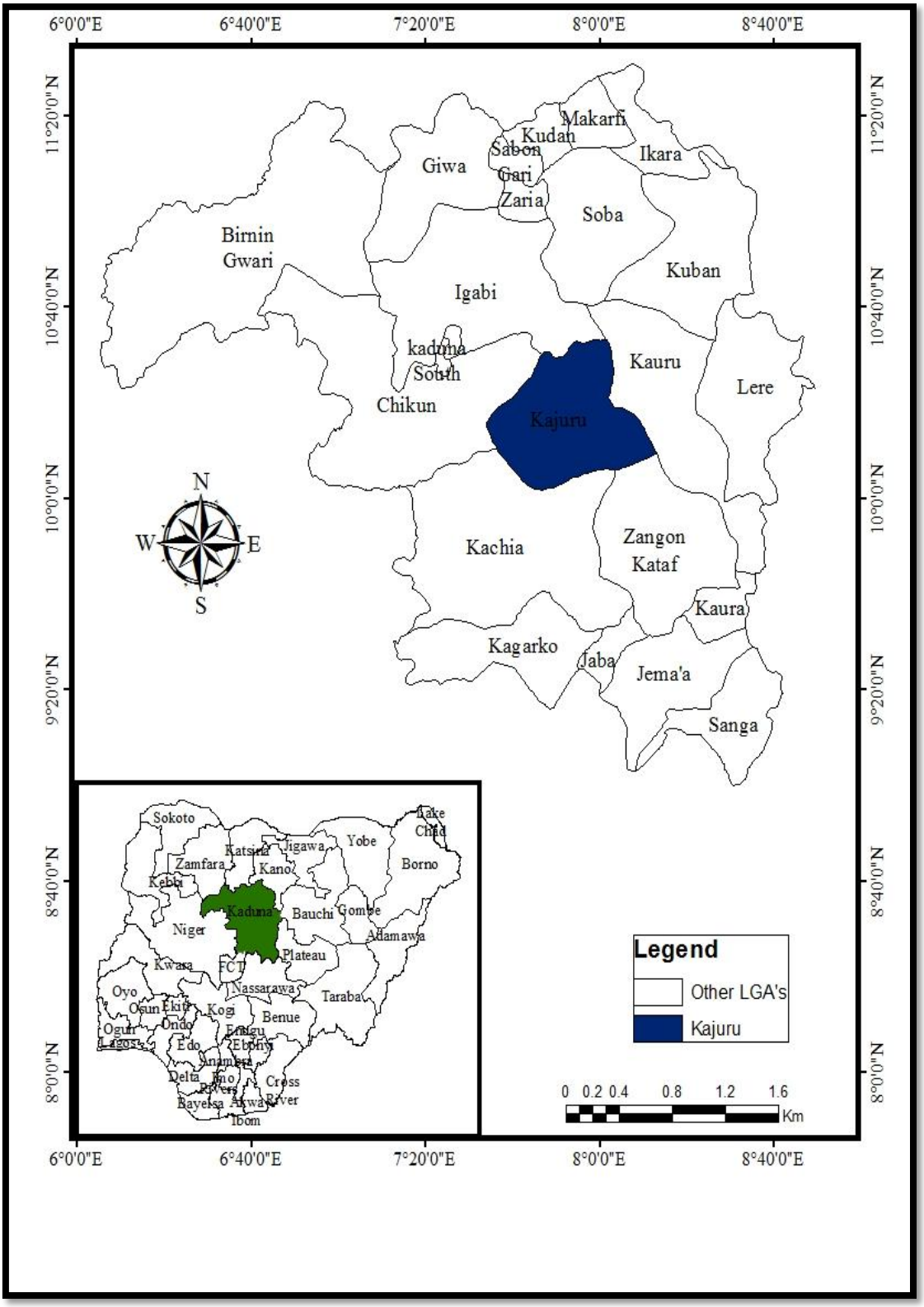


Figure 1: The Map of Kaduna State Showing Kajuru Local Government Area

3.2 Sample Size and Sampling Techniques

A multi-stage sampling was used for the study. A reconnaissance survey was conducted in the study area. There are 1198 farmers producing Bambaranut in the Ten (10) political Wards of the local government area. These are: Kufana(173), Kasuwan Magani(164), Buda(136), Rimau(122), Kallah(121), Idon(115), Maro(107), Afogo(99), Tantatu(82), Kajuru (79). This information was obtained from Agric Extension unit of Agricultural Department of Kajuru Local Government Area during the reconnaissance survey (2014). Kajuru Local Government was purposively selected out of the twenty-three (23) local government areas in Kaduna state because of its intensity in bambaranut production compared to other local government areas in the State. The Sample Size for the Study was 15% of each of the ten political wards.

Table 1: Distribution of selected Bambaranut Producers

Wards	Sample Frame	Sample Size 15%
Kufana	173	26
Kasuwan Magani	164	25
Buda	136	20
Rimau	122	18
Kallah	121	18
Idon	115	17
Maro	107	16
Afogo	99	15
Tantatu	82	12
Kajuru	79	12
Total	1198	180

3.3 Data Collection

Primary data was collected for this study. The data were collected by administering structured questionnaires to the farmers. The questionnaires were administered by the researcher and trained enumerators of the research and statistics unit of the Budget, Planning, Research and Statistics Department of Kajuru Local Government as well as some Staff of Agric Department of the local Government. The data collected include input- output of the farmers for both the production and cost function analyses, socio-economic characteristics of the farmers such as age, sex, marital status, household size, farm size, educational status, farming experience. The output data includes the total value of Bambara nut produced plus those consumed at home and given out as gifts while the input data include labour (man-day), quantity of seeds (kg), and quantity of Agro-chemical (litters). And for the cost function analyses, the output data includes the total input cost of production while input data includes cost of labour, average cost of seeds, and average cost of agro-chemicals. Data for the year 2012/2013 cropping season was used for the study.

3.4 Analytical Techniques

Analytical Techniques used were: Descriptive statistic, Gross Margin Analysis and Stochastic frontier production function

3.4.1 Descriptive statistics: This was used to achieve objectives i and iv of the study. It involves the use of percentages, means and frequency distribution.

3.4.2 Gross margin analysis: This is the difference between the gross farm income (GI) and the total variable costs (TVC). It was used to achieve objective ii.

GM=GI-TVC…….. (1)

Where:

GM is the Gross Margin per hectare in naira

GI is the Gross farm income in naira per hectare

TVC is total variable costs(cost of seeds, cost of pesticides, cost of herbicides and cost of labour) for production in naira per hectare (Isermeyer, 2011)

3.4.3 The stochastic frontier production function: This was used to achieve objectives iii. The stochastic frontier model for Bambaranut farm is specified by the Cobb-Douglass frontier production function as follows:

$$LnYi=\beta_0+ \beta_1 lnX_1 + \beta_2 lnX_2 + \beta_3 lnX_3 + \beta 4 lnX4 + Vi-Ui \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where: Y_i = output of Bambaranut (kg)

X_1=Quantity of seeds (kg)

X_2 = quantity of pesticides (litres)

X_3=quantity of herbicides (litters)

X_4=labour (man-day)

βo = Constant or intercept

β_1-β4=unknown scalar parameters to be estimated

ln= natural logarithm to base e

V□= random errors

U□=technical inefficiency effects predicted by the mode

3.5 Technical Inefficiency Model

This was also used to determine technical inefficiency. The inefficiency model assumes that the inefficiency effects are independently distributed having N (O, δ2u) and mean Ui will be used (Coelli and Battese, 2009)

$$Ui = z_0 + z_1 w_1 + z_2 w_2 + z_3 w_3 + z_4 w_4 + z_5 w_5 + z_6 w_6 + z_7 w_7 + z_8 w_8 e \ldots \ldots\ldots\ldots\ldots\ldots (3)$$

Ui = Technical inefficiency of the Bambaranut

W_1=Age (years)

W_2= Household size (no. of children and relatives)

W_3=level of education (years of schooling)

W_4=Farming Experience (years of farming Bambaranut)

W_5=Extension contact

W_6=Amount of credit

W_7=Farm size (ha)

W_8=Cooperative Association.

ei= error term

z_1-z_5 are parameters to be estimated.

3.6 Allocative Efficiency:

The stochastic frontier Cost function which is the basis for estimating the allocative efficiency of the farm was used to achieve part of objective iii. The Cobb- Douglass cost frontier for the Bambaranut farms is specified as follows:

$$LnC = \alpha_o + \alpha_1 lnp_1 + \alpha_2 lnp_2 + \alpha_3 lnp_3 + \alpha_4 lnp_4 + V_i + Ui \ldots\ldots\ldots\ldots\ldots\ldots 4$$

Where: C= total input cost of the Bambaranut farm (kg)

P_1=Cost of seeds (₦)

P_2= Cost of pesticides (litres)

P_3= Cost of herbicides (litres)

P_4=Cost of labour (man-day)

α =intercept or constant

α_1-α_4= parameters to be estimated

Vi= A random error term which accounts for the random variation in output by factors beyond the control of the farmer.

Ui =A random variable called technical inefficiency effects.

ln= natural logarithm to base e

3.7 Economic Efficiency:

The allocative and technical efficiencies combined provide an overall economic efficiency measure. The product of TE and AE provides the index of economic efficiency. This was used to achieve objective 5 of the study. All the efficiency measures are bounded by zero and one. A farm is said to be efficient if it is operating at the frontier.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1.0 Socio-Economic Characteristics of Bambaranut Farmers

4.1.1 Age Distribution of Bambaranut Farmers

The result in Table 4.1 revealed that about 16% of the bambaranut farmers were within the age range of 20-29 years, about 41% are within the age range of 30-39 and about 22% are within the age range of 40-49 with a mean age of 39 years. The average age of bambaranut farmers was found to be approximately 39 years with minimum of 20 years and maximum of 80 years. 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. This implies that, the farmers are strong, agile, and active and can participate adequately in farming activities. The age distribution is expected to have positive influence on the respondent's participation in bambaranut production, which invariably means better efficiency in production. This finding is similar to that of Adegboye (2011) who observed that youth constitute the majority of the sorghum farmers in the study area. This result is also in line with the findings of Obeta and Nwagbo (1999) who observed that youth constitute the majority of the sorghum farmers, and younger farmers are more flexible to new ideas and risk; hence they are expected to adopt innovations more readily than older farmers.

Table 2: Age distribution of bambaranut farmers

Age (years)	Frequency	Percentage
20-29	30	16.7
30-39	73	40.6
40-49	40	22.2
50-59	24	13.3
60-69	10	5.6
>70	3	1.7
Total	180	100
Mean	39	
S. E	0.870	
Min	20	
Max	80	

4.1.2 Household Size of Bambaranut Farmers

The result in Table 3 shows the distribution of bambaranut farmers by household size. Majority of the farmers (86%) had household size that ranged from 1-10 persons with minimum of 1 person and maximum of 32 persons. The significance of household size in agriculture hinges on the fact that the availability of labour for farm production, the total area cultivated to different crop enterprises, the amount of farm produce retained for domestic consumption, and the marketable surplus are all determined by the size of the farm household (Amaza, Joseph and Yakubu 2009). However, Ahmed (2011) argued that large household size is associated with increased household consumption expenditure which reduces the money that could be used for production purposes. According to the report of Oluwatayo *et al.,* (2008), there is a positive and significant relationship between household size and farmers' efficiency in production. However, the absolute number of people in a certain family cannot be used to justify the potential for productive farm work. This is because it can be affected by some important factors

namely; age, sex and health status. Essentially, it is the composition of the household that determine labour supply for the accomplishment of farm operations.

Table 3: Distribution of bambaranut farmers according to household size

Household Size	Frequency	Percentage
1-10	154	85.6
11-20	22	12.2
21-30	2	1.1
>30	2	1.1
Total	180	100
Mean	6	
S. E	0.388	
Min	1	
Max	32	

4.1.3 Educational level of bambaranut farmers

Education is an important socio-economic factor that influences farmers' decision making because of its influence on farmers' awareness, perception and adoption of innovations that can bring about increase in productivity. The result in Table 4 shows that 61% of bambaranut farmers had no formal education, 16% of the respondents had only primary education, and about 8% had secondary education while about 16% had tertiary education. This indicates that the farmers' educational level was low. This finding varied with the finding of Amaza (2000) who found that education has a positive and significant impact on farmers' efficiency in production.

Table 4: Distribution of bambaranut farmers according to level education

Education Status	Frequency	Percentage
No formal education	110	61.1
Primary education	28	15.6
Secondary education	14	7.7
Tertiary	28	15.6
Total	180	100
Mean	1	
S. E	0.083	

4.1.4 Farming experience among bambaranut farmers

Farmers' distribution by their farming experience as presented in Table 5 shows that about 31% of sorghum farmers had between 1-10 years of farming experience, majority (57%) had farming experience of 11-20 years while about 4% had farming experience of over 31 years in bambaranut production. The average farming experience for bambaranut production is about 12 years. Farming experience of a farmer determines his ability to make effective farm management decisions, not only adhering to agronomic practices but also with respect to input combination or resource allocation. Farming experience is expected to influence farm production efficiencies because of accumulation of skills. Adebayo (2006) noted that the longer a person stays on a particular job, the better his job performance. The result suggests that job performance in bambaranut production would be better under long years of experience.

Table 5: Distribution of bambaranut farmers according to farming experience

Farming Experience (years)	Frequency	Percentage
1-10	56	31.1
11-20	102	56.7
21-30	15	8.3
≥31	7	3.9
Total	**180**	**100**
Mean	12	
S. E	0.699	
Min	1	
Max	40	

4.1.5 Numbers of extension contact by bambaranut farmer

The ultimate aim of extension contact is to enhance farmers' ability to efficiently utilize resources through the adoption of new and improved methods used in bambaranut 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 6. The result in Table 6 revealed that about 72% of the bambaranut farmers in the study area had no contact to extension service while about 28% had one form of extension contact or the other ranging from 1-6 contacts. The maximum extension contact observed was 5 times with a minimum of zero time and with average of 1 extension contact. The low rate of extension services could be attributed to low extension agent-farmers' ratio in the study area.

Table 6 : Distribution of bambaranut farmers according to extension visit

Extension contact	Frequency	Percentage
No contact	130	72.2
1-3	46	52.6
4-6	04	2.2
Total	180	100
Mean	2	
S. E	0.702	
Min	0	
Max	5	

4.1.6 Funds obtained by bambaranut farmers

Credit availability is a very strong factor that is needed to acquire or develop any enterprise which could determine the extent of production capacity. The result in Table 7, Shows that 79% of bambaranut farmers financed their production from personal savings while about 21% obtained credit to finance their production activities through formal source, with mean of ₦7100. The low access to credit could be attributed to the fact that Government or formal financial institutions seldom grants credit to farmers

Table 7: Distribution of bambaranut farmers according to funds obtained

Sources (₦)	**Frequency**	**Percentage**
Personal saving	142	78.9
Credit Obtained:		
1-20000	5	2.8
20001-40000	10	5.6
40001-60000	6	3.3
60001-80000	8	4.4
80001-100000	4	2.2
≥ 100001	2	2.8
Total	180	100
Mean	7100.00	
S. E	1523.40	
Min	0	
Max	100000	

4.1.7 Farm size of bambaranut farmers

The result in Table 8 revealed the distribution of bambaranut farmers according to their farm size. Majority about 62% of bambaranut farmers had farm sizes between 0.1-2.0 hectares while about 36% had farm sizes that ranges between 2.1-4.0 and just 2% had had farm size than 4.1 with an average farm size of 3 hectares. Small farm sizes might be as a result of the fact that most of the farmers got their land through inheritance and majority financed their production through personal savings. The implication of this finding is that bambaranut farmers are predominantly small-scale farmers. This result also agrees with Ojuekaiye's (2001) classification of farms between 0.1 hectares and 5.9 hectares as small-scale.

Table 8: Farm Size Distribution of Bambaranut Farmers

Farm Size	Frequency	Percentage
0.1-1.0	47	26.1
1.1-2.0	64	35.6
2.1-3.0	38	21.1
3.1-4.0	26	14.4
≥ 4.1	5	2.8
Total	180	100
Mean	3	
S.E	0.127	
Min	0.4	
Max	8	

4.1.8 Membership of cooperative society

Table 9 shows the numbers of years spent in cooperatives. About (75%) of bambaranut farmers do not participate in any cooperative association because of unawareness of any association while about 25% participated with average of 2 years spent in co-operative. The effect of the result is that most of the farmers in the study area do not enjoy the assumed benefits accrued to co-operative societies through pooling resource together for a better expansion, efficiency, effective management of resources and for profit maximization. Gona *et al.* (2011) and Oluwatayo *et al*. (2008), stated that membership of co-operative societies has advantage of accessibility to micro-credit, input, subsidy and also an avenue through which innovation can occur.

Table 9: Distribution of bambaranut farmers according to years spent in cooperative association

Membership of Cooperative Society	Frequency	Percentage (%)
Non members	135	75.0
1-5 years	20	11.1
6-10 years	14	7.8
11-15 years	6	3.3
>16 years	5	2.8
Total	180	100
Mean	2	
S. E	0.3555	
Min	0	
Max	30	

4.2. Costs and Returns of Bambaranut Production in the Study Area

4.2.1 The level of inputs used and output realized.

The level of inputs used and output realized in the study area are reported in Table 10. The inputs that were used in bambaranut production include; land, seed, pesticides, herbicides and labour. It was revealed that the mean farm size was 2.85 hectares. The minimum and maximum land areas were 0.4 ha and 8 ha, respectively. The average quantity of seed used by bambaranut farmers was 66.14 kg/ha. The minimum and maximum seed used were 25 kg/ha and 500 kg/ha, respectively. Average pesticides used by bambaranut farmers was 2.42 L/ha while the minimum and maximum were found to be 0.00 L/ha and 8 L/ha, respectively. Average herbicides used by farmers is 1.32 L/ha while the minimum and maximum were found to be zero and 15L/ha, respectively.The mean labour recorded is 25.92man-day/ha while the minimum and maximum were observed to be 43.33 man/days/ha and 189 man/days/ha, respectively. This shows that agricultural production in the study area is of small scale and labour

intensive. The wide variation in input used by the farmers could be attributed to the fact that they differ in purchasing power and size of production.

Table 10: Level of input utilized and output realized in bambaranut production

Variable	Mean	Std dev	Min	Max
Seed (kg/ha)	66.14	98.59	25.00	500.00
Pesticides (kg/ha)	2.42	3.31	0.00	8.00
Herbicides (L/ha)	1.32	2.30	0.00	15.00
Labour (man/day/ha)	25.92	43.33	10.00	189.00
Yield (kg/ha)	651.71	1108.25	260.00	5200.00

4.2.2 Profitability of bambaranut production in the study area

Bambaranut seed used by the farmers in the study area were mainly local seeds taken from the last harvest. The quantity of bambaranut seed is 66.14kg/ha with an average market price of ₦500 per kg constitutes 66.4% of the total cost of production as reveled in Table 11. The quantity of pesticides is 2.42kg/ha with an average market price of ₦1000 per liters constitutes 4.9% of the total cost of production. The quantity of herbicides is 1.32L/ha with an average market price of ₦1000 per L was used and this constitutes 2.7% of the total cost of production.

Labour costs consisted of cost of land preparation, planting, pesticides and herbicides application, weeding and harvesting. The family labour was computed on the basis of opportunity cost in man-days. The wage rate varied according to farm operation performed. An average wage rate of ₦500 per man-day was used, giving the average labour cost per hectare to be ₦12,960.00 and this constitutes about 26% of the total cost of production, and this shows how labour intensive bambaranut production is constituting about 26% of the total cost of production.

Table 11: Cost and return to bambaranut production in (₦) per hectare

Variables		Values/ha (₦)	% of TVC
A. Variable costs			
a. seeds (kg)		33,070.00	66.40
b. pesticides (L)		2,420.00	4.90
c. herbicides (L)		1,320.00	2.70
d. labour (man-days)	(i) Land preparation	1850.00	
	(ii) Planting	2600.00	
	(iii) Weeding	5400.00	
	(iv) Harvesting	3110.00	
Total labour (man-days)		12,960.00	26.00
Total Variable Cost (TVC)		49,770.00	
B. Gross Income (GI)		162,925.00	
C. Gross Margin (GM) = (GI - TVC)		113,155.00	
Return per Naira Invested (RNI) TVC		2.27	

Results presented in Table 11 indicated that the Gross Income (GI) was ₦162,925.00 while the total variable cost (TVC) is ₦49,770.00. The Gross Margin (GM) is therefore ₦113,155.00. The average rate of returns on investment (Return per Naira Invested) is 2.27, indicating that for every ₦1 invested in bambaranut production in the study area; a profit of ₦1.27 kobo was made. Thus, it could be concluded that bambaranut production in the study area though on a small scale, was economically viable. This

finding is similar to that of Ani *et al.,* (2013) studied the Profitability and economic efficiency of bambaranut production in Benue state, Nigeria where it was observed that bambaranut production is profitable by returning ₦1.40 to every ₦1.00 spent.

4.2.3 Test of hypothesis I

The null hypothesis (H_o) which stated that bambaranut production is not profitable in the study area was tested using the result of a t-test presented in Table 12. From the result in the table 12, an average cost was ₦116148.89 and average return was ₦928669.44. The calculated t-value was 19.53 and exceeds the critical value (t-critical two tail) of 1.97, therefore H_o is rejected at 1% level of significance. Therefore, the result of the analysis indicates that bambaranut production is profitable in the study area.

Table 12: t-test result of profitability of bambaranut production.

Variable	Average cost (₦)	Average return(₦)
Mean	116148.8944	928669.444
Standard deviation	4367459254	3.0706E+11
Observations	180	180
Pooled Variance	1.55712E+11	
Hypothesized Mean Difference	0	
Df	179	
t Stat	19.53	
P(T<=t) one-tail	1.15528E-58	
t Critical one-tail	1.65	
P(T<=t) two-tail	2.31056E-58	
t Critical two-tail	1.97*	

*P<0.05

4.3. Efficiency of Bambaranut Production

4.3.1 Estimated technical efficiency of bambaranut farmers

The model specified was estimated by the maximum likelihood (ML) method using FRONTIER 4.1 software developed by Coelli (1995). The ML estimates and

inefficiency determinants of the specified frontier are presented in Table 13. The study revealed that the generalized log likelihood function was -147.0797. The log likelihood function implies that inefficiency exist in the data set. The log likelihood ratio value represents the value that maximizes the joint densities in the estimated model. Thus, the functional form that is, Cobb-Douglas used in this estimation is an adequate representation of the data. The value of gamma (γ) is estimated to be -2.1436 and it was significant at 15 level of probability. This is inconsistent with the theory that true γ-value should be greater than zero. This implies that 21% of random variation in the yield of the farmers was due to the farmers' inefficiency in their respective sites and not as a result of random variability. Since these factors are under the control of the farmer, reducing the influence of the effect of γ will greatly enhance the technical efficiency of the farmers and improve their yield. The value of sigma squared ($\boldsymbol{\sigma^2}$) was significantly at 1% level of probability. This indicates a good fit and correctness of the specified distributional assumptions of the composite error terms while the gamma γ indicates the systematic influences that are unexplained by the production function and the dominant sources of random error. This means that the inefficiency effects make significant contribution to the technical inefficiencies of bambaranut farmers.

The estimated coefficients of all the parameters of production function (seed, herbicides and labour) were positive and significant at 1% level of probability which play a major role in bambaranut production in the study area. The average technical efficiency for the farmers was 0.75 implying that, on the average, the respondents are able to obtain 75% of potential output from a given mixture of production inputs. Thus, in a short run, there is minimal scope (25%) of increasing the efficiency, by adopting the technology and techniques used by the best bambaranut farmer.

The estimated coefficient for seed is 0.7939 which is positive and statistically significant at 1% level. The estimated 0.7939 elasticity of seed implies that increasing seed by 1% will increase bambaranut output by less than 1% which means, all things being equal the output is inelastic to changes in the quantity of seed used. The significance of seed quantity is however, due to the fact that seed determines to a large extent the output obtained. If correct seed rates and quality seeds are not used, output will be low even if other inputs are in abundance. This is in consistent with the findings of Shehu *et al* (2010) who observed that the estimated coefficient of seed and labour inputs were positive as expected and significant at 1% level which implies that the more seed is applied and the more labour employed the better the output of bambaranut in the study area.

The production elasticity of output with respect to quantity of herbicides is 0.0979 which is positive and statistically significant at 1% level. This implies that a 1% increase in quantity of pesticides used will increase bambaranut output by 0.09%.

The coefficient of labour was 0.0695 which is positive and statistically significant at 1% level of probability. This shows that labour is an important variable in bambaranut production in the study area. This is in line with several studies by Umoh (2006) and Okike (2000) which show the importance of labour in farming, particularly in developing countries where mechanization is rare on small scale farms. In the study area, human power plays a crucial role in virtually all farming activities. This situation has variously been attributed to the practice on small scattered land holdings and lack of affordable equipment (Umoh, 2006).

The result of the inefficiency model in Table 10 was also shown. The estimated coefficients with negative signs attached indicate that they reduce technical inefficiency

among the farmers, while positive signs indicate that the coefficients increase technical inefficiency or reduce technical efficiency. The results showed that age, household size, education, farming experience, extension, amount of credit and cooperative association were the determinants of technical inefficiency among the bambaranut farmers. Extension contacts, farm size and cooperative association were negatively related with technical inefficiency.

The coefficient of extension was found to be -0.0098 and is negative and significant at 1% probability level. This implies that holding other factors constant, a unit increase in the extension contacts of bambaranut farmer will reduce their technical inefficiency by magnitude of 0.0098. This finding corroborates with Kolawole *et al.*, (2007) who in their study of small scale out growers in Nigeria found that extension visits have negative relationship with inefficiency.

The coefficient of Farm size was -0.1280 which is negative and significant at 1% probability level. This implies that as farm size increases, the technical inefficiency reduces thereby increasing technical efficiency of farmers. This is because increasing farm size is significantly and positively associated with increased smallholder agricultural sales and total household income sufficient to reduce inefficiency easily by enlarging the small farm holdings to medium scale farm whereby they will employ or hire some machinery to ease production and consequently increase output and technical efficiency. This is in line with the findings of Sridhar (2007), who assessed the impacts in terms of changes in farm size and recorded a significant and positive impact on farm income due to increase in farm size and consequently reducing rural poverty and increasing technical efficiency.

Cooperative association was also found to be negative and significant at 10% probability level with the coefficients of -0.0290. This implies that cooperative association contributes towards increase in the technical efficiency of the bambaranut farmers by reducing their inefficiency level. This is because cooperative association have more access to agricultural information, credit and other production inputs as well as more enhanced ability to adopt information. This finding is consistent with that of Onyenweaku and Nwaru (2005) that membership of cooperative society enhances technical efficiency of farmers

Table 13: Results of Maximum Likelihood Estimates of Stochastic Frontier Production Function of Bambaranut production

Variables	**Parameters**	**Coefficient**	**Standard- error**	**T-value**
Production function				
Constant	β_0	3.8921	0.4548	8.56***
Seed	β_1	0.7939	0.392	20.22***
Pesticides	β_2	-0.2046	0.3195	-0.64
Herbicides	β 3	0.0979	0.0230	4.26***
Labour	β_4	0.0695	0.0261	2.66***
Inefficiency model				
Constant	Z_0	0.8974	0.4721	1.90
Age	Z_1	0.001	0.0023	0.48
Household size	Z_2	-0.0024	0.0043	0.54
Education	Z_3	-0.0031	0.0017	-0.18
Farming experience	Z_4	-0.0003	0.0026	-0.13
Extension contact	Z_5	-0.0098	0.0042	-2.33***
Amount of credit	Z_6	0.1470	0.5910	0.25
Farm size	Z_7	-0.1280	0.0720	-1.78***
Cooperative association	Z_8	-0.0290	0.0173	-1.68*
Diagnostic statistics				
Sigma-squared	(σ^2)	-0.5408	0.0711	7.60***
Gamma	(γ)	-2.1436	0.3158	6.78***
Log likelihood function	*L/f*	-147.079		
LR test		21.5786		
Total number of observation		180		
Mean efficiency		0.754		

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

4.3.2 Test of hypothesis II

The null hypothesis (H_o) which stated that there is no significant difference between socio economic characteristics and technical efficiency of bambaranut production in the study area was tested using the result of in Table 11. The estimated sigma and gamma value was 7.60 and 6.78 respectively and significant at 1% which is greater than zero. This implies that the random variation in the yield of the farmers was due to the farmers' inefficiency in their respective sites and not as a result of random variability. This implies that there is significant relationship between the socio-economic characteristics and technical efficiency in bambaranut production. The H_o hypothesis is therefore rejected and accepts the alternative.

Table 14: Result from stochastic frontier production estimates

Variables	Values	(H_o)	(H_1)
Sigma-squared	7.60***	Rejected	Accepted
Gamma	6.78***		
Log likelihood function	-147.079		
LR test	21.5786		
Total number of observation	180		

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

4.4. Estimated Stochastic Frontier Cost Functions

The Maximum Likelihood (ML) estimates of the stochastic frontier cost parameters for bambaranut production are presented in Table 12. For the cost function, the mean allocative efficiency is 61%, the sigma ($\sigma^2 = 3.026$) and the gamma (γ=0.087) are quite high and highly significant at 1.0% level of probability. The high and significant value of the sigma square (σ^2) indicate the goodness of fit and correctness of the specified

assumption of the composite error terms distribution (Idiong, 2005). The gamma (γ = 0.087) shows that 8.7% of the variability in the output of bambaranut farmers that are unexplained by the function is due to allocative inefficiency. The results of stochastic frontier cost function for bambaranut farmers in the study area are shown in Table 12. The estimated coefficients of the parameters of the cost function that are significant are positive and they are seed and labour. The cost variables seed and output are significant at 1% level of probability. The coefficient of the cost of seed (0.425) is positive and significant at 1.0% level of probability. This implies that seed are important in crop production in bambaranut farms. The implication of this is that 1% increase in the cost of seed will give rise to 0.41% increase in the cost of bambaranut production. This is in agreement with the findings of Okoh (2009), who pointed out that seed and labour cost as determinant of allocative efficiency in the Fadama production of tomato in Benue State.

The coefficient of output output (0.364) is positive and significant at 1 % level of probability. This implies that as the quantity of bambaranut produced increases, the cost of production increases accordingly. This shows that the cost of production is influenced by the quantity of bambaranut output realized. This finding concurs with the one of Ogundari *et al.,* (2006) that reported direct effect of output on cost of production in the study on economies of scale and cost efficiency in small scale maize production in Nigeria.

Table 15: Results of Maximum Likelihood Estimates of Frontier Cost Function for bambaranut production.

Variable	Parameters	Coefficient	Standard-error	T-value
Production function				
Constant	β_0	8.0745	0.6867	11.7584***
Seed	β_1	0.425	0.0586	7.2525***
Pesticides	β_2	-0.0658	0.1722	0.381
Herbicides	β_3	0.1534	0.1906	0.8048
Labour	β_4	-0.0641	0.0465	-1.3784
Output	β_5	0.364	0.0816	4.4617***
Diagnostic statistics				
Sigma-squared		3.0245	0.9892	3.0575***
Gamma		0.0879	0.0106	8.2941***
Log likelihood function		-84.6898		
LR test		11.1253		
Total number of observation		180		
Mean efficiency		0.61		

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

4.5 Technical, Allocative and Economic Efficiencies of Bambaranut Farmers in the Study Area.

4.5.1 Technical efficiency of bambaranut farmers in the study area.

The frequency distribution of the technical efficiency estimates for bambaranut farmers in the study area as obtained from the stochastic frontier model is presented in Table 13. The study revealed that 34% of the bambaranut farmers had technical efficiency (TE) of 0.61 and above while 66% of the farmers operate at less than 0.61 efficiency level. Therefore, the bambaranut farmers with the best and least practices had technical efficiencies of 0.89 and 0.23 respectively. This implies that on the average, bambaranut output fall by 11% from the maximum possible level of 1.00 due to technical inefficiencies. The result also showed a mean technical efficiency of 0.70. This means that majority of the bambaranut farmers operated closer to their production frontier. Also, this implies that on the average, bambaranut farmers are able to obtain 70%

potential output from a given mix of productive resources. In a short-run, there is scope for increasing bambaranut output by 30% through adopting the techniques and technologies employed by the best bambaranut farmers. Furthermore, the study also revealed that for the average bambaranut farmer in the study areas to become the most efficient bambaranut farmer, he will need to realize about 21%[1-(0.70/0.89)*100] cost savings, while on the other hand, the least technically efficient bambaranut farmer will need about 73% [1-(0.26/0.89)*100] cost savings to become the most technically efficient bambaranut farmer in the study area respectively.

4.5.2 Allocative efficiency estimates of bambaranut farmers

Table 13 below depicts the frequency distribution of the allocative efficiency estimates of bambaranut farmers in the study areas. The result revealed in Table 12 that 21% of the farmers had allocative efficiency (AE) of between 0.61 and 0.8 while about 79% of the farmers operate at less than 0.61 allocative efficiency levels. This implies that the greater majority of bambaranut farmers were not allocative efficient because only 21% of them attained efficiency level greater than 0.61. That is, the farmers are not efficient in producing bambaranut at a given level of output using the cost minimizing input ratio as about 21% of the bambaranut farmers have allocative efficiencies of 0.61 and above. High values of allocative efficiencies represent less efficiency or more inefficiency among the bambaranut farmers during the course of production in the study areas. The estimated allocative efficiencies differ substantially among the bambaranut farmers ranging between the minimum value of 0.30 and maximum value of 0.98. This means that the most allocative inefficient bambaranut farmers operated closer to their cost frontier or minimum cost of 1.00. The mean allocative efficiency was 0.61. The study also revealed that for the average bambaranut farmer in the study areas to become the most allocative efficient farmer, he will need to realize about 38% cost saving i.e. [1-

(0.61/0.98)*100] while on the other hand, the least technically efficient bambaranut farmer will need about 69% [1-(0.30/0.98) x100] cost savings to become the most allocative efficient bambaranut farmer.

4.5.3 Economic efficiency estimates of bambaranut farmers

The frequency distribution of the economic efficiency estimates of bambaranut farmers in the study areas is contained in Table 13. The result in Table 12 revealed that 10% of the bambaranut farmers had economic efficiency (EE) of between 0.61 and 0.8 while the remaining 90% of the bambaranut farmers operated at less than 0.61 efficiency level. The mean economic efficiency of the bambaranut farmers in the study areas was 0.47. This implies that on the average, there was a fall in the bambaranut output level by 53% from the maximum feasible level due to economic inefficiency. Therefore, the bambaranut farmer with the best and least practice had economic efficiencies of 0.72 and 0.13 respectively.

In the same vein, the study also revealed that for the average bambaranut farmer in the study area to achieve economic efficiency of his most efficient counterpart, he will have to realise about 34% [1-(0.48/0.73)*100] cost savings while on the other hand, the least economic efficient bambaranut farmers will have to realize about 82% [1-(0.13/0.73)*100] cost savings to become the most economic efficient bambaranut farmer. However, the result indicates that the bambaranut farmers have economic efficiencies between 0.01-0.04, representing about 36% of the 180 bambaranut farmers. This is an indication that the farmers were not economic efficient in producing bambaranut at a minimum cost for a given level of technology.

Table 16: Frequency Distribution of Technical, Allocative and Economic Estimates from the Stochastic Frontier Model

Efficiency level	Technical efficiency		Allocative efficiency		Economic efficiency	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
0.01-0.20	5	2.7	36	20.0	64	35.6
0.21-0.40	54	30.0	22	12.2	56	31.1
0.41-0.60	62	34.5	84	46.7	42	23.3
0.61-0.80	48	27.7	38	21.1	18	10.0
0.81-1.00	11	6.1	0	0.0	0	0.0
Total	180	100.0	180	100.0	180	100.0
Minimum	0.236		0.3034		0.125	
Maximum	0.891		0.987		0.729	
Mean	0.704		0.613		0.475	

4.6. Constraints Faced by Bambaranut Farmers

Result revealed that bambaranut farmers in the study area faced some constraints to produce bambaranut and these problems were ranked according to their severity as stated by the farmers and as shown in Table 14. It was found that about 25% of the respondents' ranked inadequate capital 1st the major constraint. This is because purchasing farm inputs such as seeds and herbicides were being limited by lack of capital, or by the lack of access to credit facilities that would enable farmers to use more of these inputs. The second constraint was high cost of inputs as indicated by 23% of the respondents and ranked 2nd. Family labour was mainly used in the area and during the planting period, there is usually the short of labour. The demand for labour is normally high and expensive at this time of the season. It agrees with findings of Nasiru, (2010) who noted that access to micro-credit could have prospect in improving the productivity of farmers and contributing to uplifting the livelihoods of disadvantaged rural farming communities. Lack of improved seeds was ranked 3rd by about 18% of the respondents which makes the crop a little bit susceptible to pest and

disease infestation. This finding is in line with Ekong (2003) who opined that most farmers had little or no access to improved seeds and continues to recycle seeds that have become exhausted after cultivation.

About 15%, 12% and 6% of the respondents ranked lack of extension visits, pest and diseases and low demand as the 4th, 5th and 6th constraints respectively. This finding agrees with that of Hyun *et al.,* (2008), Tekana *et al.,* (2011) and Onuk *et al.,* (2010) who observed that high cost of farm inputs, inadequate capital, high cost of labour, inadequate storage/processing facilities and inadequate extension visits were among the constraints faced by farmers. This revealed that farmers in the study area are faced with constraints that can limit bambaranut production.

Table 17: Bambaranut production constraints among farmers

Constraints	**Frequency**	**Percentage**	**Ranking**
Inadequate capital	121	25.2	1st
High cost of inputs to input	110	22.9	2nd
Lack of improved seeds	88	18.3	3rd
Shortage of extension visits	74	15.4	4th
Pest and diseases	57	11.9	5th
Low demand	31	6.4	6th
Total	**481** □		

□ Multiple responses

CHAPTER FIVE

SUMMARY, CONCLUSION, CONTRBUTIONS TO KNOWLEDGE AND RECOMMENDATIONS

5.1 Summary

This study focused on the profitability and production efficiency of bambaranut production among farmers in Kajuru Local Government Area of Kaduna state, Nigeria. Five (5) wards were randomly selected from 10 wards in the Local Government Area and 180 farmers were selected in this area depicting the sample size of this study. The purpose of the study was to examine the profitability and efficiencies of bambaranut among farmers in Kajuru Local Government Area of Kaduna state, Nigeria, and to achieve this, the study came up with six main objectives. These were to: describe the socio-economic characteristics of bambaranut farmers, estimate the cost and return associated with bambaranut production, determine the technical efficiency of bambaranut production, determine the allocative efficiency, determine the economic efficiency in bambaranut production and to describe the constraint faced by bambaranut famers in the study Area. Primary data were collected from 180 respondents through the use of random sampling techniques with the aid of structured questionnaire. The statistical tools used to analyze the data were descriptive statistics, gross margin analysis and stochastic production frontier function model. A descriptive analysis of the sample farmers was done to understand and describe the socio-economic factors influencing bambaranut production and as well as income made from the production and constraints faced in the study area.

The results of the socio-economic analysis shows that majority 79% of the respondents fall at less than 50 years of age, the majority of the farmers (61%) had no formal education. The household size ranged from 1-10 persons with 86%. Majority of the

farmers, (75%) were not members of a cooperative society. 57% of the farmers had farm holding that ranges between 0.1-2.0 ha with the mean of 3 ha.

The average costs incurred and revenue obtained per hectare for bambaranut were estimated to determine the profitability in the study area as shown in table 11. The gross income (GI) was ₦162,925.00 while the total variable cost (TTFC) was ₦49,770.00. The gross margin (GM) was therefore, ₦113,155.00. The average rate of return on investment (return per naira invested) is 2.27, indicating that for every ₦1 invested in bambaranut production in study area; a profit of ₦1.27 kobo was made. Thus, it could be concluded that bambaranut production in the study area though on a small scale, was economically viable.

The stochastic frontier production function was estimated for technical, allocative and economic efficiency. It was observed from the study that 34% of the farmers had technical efficiency (TE) of 0.61 and above while 66% of the farmers operate at less than 0.61 efficiency level. The mean technical efficiency for the 180 sampled farmers in the study area was 0.70. The farmer with the best practice has a technical efficiency of 0.89 while 0.23 was for the least efficient farmers. This implies that on the average, output fall by 11% from the maximum possible level due to inefficiency. The mean allocative efficiency was 0.70. The result indicates that average bambaranut farmer in the state would enjoy cost saving of about 21% while allocatively inefficient farmer will have an efficiency gain of 73% to attain the level of most efficient farmer among the respondents. The mean allocative efficiency was 0.61. About 21% operate between 0.61 and 0.80 of allocative efficiency while 79% operate at less than 0.61. The farmer with the best and least allocative efficiency practices are 0.98 and 0.30 respectively.

The mean economic efficiency was 0.48. The farmer with the best practice has an economic efficiency of 0.72 while 0.13 was for the least efficient farmers. This implies that on the average, output fall by 28% from the maximum possible level due to inefficiency.

Finally, among the constraints identified in the study area were, inadequate capital (25%), high cost of farm inputs (23%) and lack of improved seeds (18%) as the major constraints and ranked 1st, 2nd and 3rd respectively.

5.2 Conclusion

Based on the findings of this study, it could be concluded that bambaranut production in the study area is profitable by returning ₦1.23 kobo to every ₦1.00 spent. Therefore, due to the importance of bambaranut as a food item in Nigeria, any attempt to increase its productivity would be a right step towards the increase of income among farmers in the study area.

5.3 Contribution of the Study to Knowledge

i. The study revealed that bambaranut production in the study area is profitable with gross margin of ₦113,155.00 despite the problems identified.
ii. It was revealed that bambaranut farmers were economically inefficient in the study area having an economic efficiency of forty-eight(48%) percent
iii. The study revealed that bambaranut farmers in the study area achieved technical efficiency of 70 percent and allocative efficiency of 61%.
iv. The study revealed inadequate capital (25%), high cost of inputs (23%) and lack of improved seeds (18%) were the major constraints affecting bambaranut production, thereby reducing the output of the crop.

5.4 Recommendations

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

i. Cooperative membership was a significantly determinant of technical efficiency, therefore, bambaranut farmers should join more cooperative societies, so as to be able to benefit from the government and non-governmental organization through increased credit access, input supply and farm advisory services because most projects wants to identify farmers through cooperative groups before giving them any assistance like grants.

ii. Inadequate capital was the major constraints identified and majority of the farmers financed their production through personal savings and relatives which are mostly not adequate for appreciable production. Therefore, agricultural loan facilities should be made accessible to bambaranut producers to ensure timely and adequate utilization of agricultural inputs for improvement in farm production efficiency by the formal financial institutions.

iii. Another severe problem encountered the cause of bambaranut production is high cost of inputs such as fertilizer and agrochemicals. This constraint constitute serious impediments to bambaranut production and need to be addressed adequately before bambaranut production can be improved in the study area. Therefore, timely and adequate supply of fertilizer should be made available to farmers at affordable price in order to enhance the production of this crop by the government and at a subsidize rate.

iv. Lack of improved seeds also makes their crop susceptible to pest and disease thereby getting low output. It is recommended that agro based industries and non-governmental organization should be encouraged by the local government to support research and production of bambaranut products for commercial purposes. They can also seek for support of professional advice and seeds from research institutions

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

Dear Respondent,

I am a post graduate student (M.sc) of the aforementioned department carrying out a research on the topic: **ANALYSIS OF PROFITABILITY AND PRODUCTION EFFICIENCY OF SMALL SCALE BAMBARANUT FARMING IN KAJURU LOCAL GOVERNMENT AREA OF KADUNA STATE, NIGERIA.**
Please kindly answer the following questions to the best of your knowledge. Information provided will be treated confidentially.

Best regards**.**

Instruction: Kindly tick (√) or fill in the blank spaces as appropriate

A SOCIO –ECONOMICS CHARATERISTICS

1. Name of farmer……

2. Sex: Male ( ) Female ( )

3. Age (years)……

4. Marital status: Married ( ) Not married ( )

5. Highest level of Education:

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

6. Household 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 Bambara nut farming?(Years of experience)…….

8. What is your major source of capital for Bambara nut farming?

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

   d. Money Lenders (Borrow) ( )

9 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)……..

10 Have you been trained on Bambara nut farming? Yes ( ) No ( )

11 If yes, which organization conducted the training?

12. Was the training beneficial to you?

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

13. How long have you been in this cooperative society in years……

14. What was the last annual savings for the cooperative society before obtaining credit in (naira) ……?

15 How much credits do you obtained last 2 years from your cooperatives…….?

16. How much interest (total interest) did you paid when you obtained the credit……..?

17. Do you save? (a) Yes [ ] (b) no [ ]

18. If yes, how do you save? (a) At Home [ ] (b) Friends /Relatives [ ] (c) Others (Specify)……..

19. If yes, how Much do you Save per month in naira ……?

20. If yes, what Amount do you keep for saving in the Following Way in naira?

(a)Cash At Home…… (b)Cash in the Bank……

(c)Cash with friends/relatives……. (d) Others……

21. If yes, what amount are you able to save from your farm income before obtaining credit……

22 If yes, what amount are you able to save from your non- farm income before obtaining credit ……

23. If no, why……

24. What are the opportunities in your membership of cooperative society?

……

25. How much is the monthly contributions as a member in (naira)……?

26 How long do you contribute every year since you join the cooperative society in (month).....?

27. How much have you contributed since you join the cooperative society in (Naira) …….?

28. What is your share in the cooperative society in (naira)……..?

29. What are the schedules of activities for this cooperative society? List them:

……

……

30. To what extent has this cooperative societies impacted on your household?

(a) Very high [ ] (b) High [ ] (c) Average [ ] (d) Low [ ] (e) Very low [

B. INFORMATION ON INPUTS

(1) Farm size (Ha)

(a) How many Bambara nut farm plots do you have? ..... Indicate and the size in the table below.

Plot NO	Plot Size (Ha)
1	
2	
3	

(b). 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					

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

(II) VARIABLE INPUTS (LAST PRODUCTION CYCLE)

(a) Seed (Kg)

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

(b) AGROCHEMICAL.

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

2			
3			

(c) LABOUR INPUT:

(a) Land preparation

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

(b)Planting

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

(e)Weeding

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

(f)Weeding

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

3						

(g)Harvesting

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

14 . Where do you sell your produce?

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

15. When do you sell your produce?

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

CONSTRAINTS TO BAMBARA NUT PRODUCTION

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

Thanks for your Attention