ECONOMIC ANALYSIS OF SUGARCANE PRODUCTION AND ITS CONTRIBUTION TO FARM INCOME OF FARMERS IN MAIGANA AGRICULTURAL ZONE OF KADUNA STATE, NIGERIA

BY

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

JUNE, 2015

DECLARATION

I hereby declare that this dissertation titled **"Economic Analysis of Sugarcane Production and its Contribution to Farm Income of Farmers in Maigana Agricultural Zone 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 citation and sources of information are duly acknowledged by means of references.

....

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CERTIFICATION

This dissertation titled **'Economic Analysis of Sugarcane Production and its Contribution to Farm Income of Farmers in Maigana Agricultural Zone of Kaduna State, Nigeria'** by Muhammad Sulaiman meets the regulations governing the award of the Degree of Master of Science of Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

I dedicated this dissertation to the Almighty Allah (SWT) for facilitating the successful completion of this work.

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Abstract

The study examined the costs and return as well as resource use efficiency of sugarcane production and its contribution to farm income in Kaduna state, Nigeria. Primary data were collected from 330 sugarcane farmers selected using multi-stage sampling technique. The data of 2013 cropping season were collected with the aid of structured questionnaire. Data collected were analyzed using stochastic frontier production function. The maximum likelihood estimate (MLE) of the stochastic frontier model production function revealed that the resource inputs were under-utilized. The technical efficiency score of each respondent revealed that the most efficient farmer operated at 97% efficiency, the least was found to operate at 48% efficiency level, while the average was 89%, indicating that sugarcane farmers still have the potential to increase the efficiency in their farming activities by 11% in the study area. The inefficiency model revealed that farming experience, educational levels and extension contact increase technical efficiency of the farmers. The variance parameters of the frontier production model were Sigma-squared (δ^2) and Gamma (γ) and their estimated coefficients in the study area were 0.11 and 0.93, respectively. The return to scale was estimated to be 1.04. Sugarcane Production was profitable with an average return of 83 Kobo for every ₦1 invested in the study area. Sugarcane production in the study area contributed averagely to about 19.55% of the farmers' annual farm income. The maximum contribution made was 81.87% while minimum was 0.12%. The major constraints were low demand for the crop, inadequate capital and credit inaccessibility, fertilizer at unaffordable price, and theft. The study recommended the need for training sugarcane farmers on farm inputs optimum utilization by the extension agents, an enabling environment should be created for sugar industries, the farmers should form a formal and strong sugarcane farmers association that would represent their interests as steps towards boosting its production and utilization.

CHAPTER ONE

INTRODUCTION

1.1. Background to the Study

Sugarcane belongs to the grass family *Poaceae*, an economically important seed plant family that includes maize, wheat, rice, and sorghum and many forage crops. The main product of sugarcane is sucrose, which accumulates in the stalk internodes. Sucrose, extracted and purified in specialized mill factories, is used as raw material in human food industries or is fermented to produce ethanol. Ethanol is produced on a large scale by the Brazilian sugarcane industry. It is native to the warm temperate to tropical regions of South Asia, and used for sugar production. In 2012, FAO estimates it was cultivated on about 26.0 million hectares, in more than 90 countries, with a worldwide harvest of 1.83 billion tons. Brazil was the largest producer of sugar cane in the world. The next five major producers, in decreasing amounts of production, were India, China, Thailand, Pakistan and Mexico. The world demand for sugar is the primary driver of sugarcane agriculture. Cane accounts for 80% of sugar produced; most of the rest is made from sugar beets. Sugarcane predominantly grows in the tropical and subtropical regions, and sugar beet predominantly grows in colder temperate regions of the world. Other than sugar, products derived from sugarcane include *falernum, molasses, rum, cachaça* (a traditional spirit from Brazil), *bagasse* and ethanol (Godheja, Shekhar and Modi 2014).

The important sugar-producing countries in the tropical Africa are Mauritius, Kenya, Sudan, Zimbabwe, Madagascar, Cote dIvoire, Ethiopia, Malawi, Zambia, Tanzania, Nigeria, Cameroon and Zaire. Nigeria is one of the most important producers of the crop with a land potential of over 500,000 hectares of suitable cane field capable of producing

over 3.0 million metric tons of sugarcane. If processed, it will yield about 3.0 million metric tons of sugar. Nigeria has vast human and natural resources, in terms of land and water, to produce enough sugarcane, not only to satisfy the country's requirement for sugar and bio-fuel, but also for export (NSDC, 2003).

Nigeria is noted to be abundantly blessed with human, water and environmental potentials for the production of sugarcane. Areas with high potentials for commercial sugarcane /sugar production have been identified through studies sponsored by the Federal Ministry of Industry and conducted by Dutch consultants HVA in the early eighties. It should be pointed out that most of the areas in the Northern States where water for irrigation is available; sugarcane cultivation in large quantities is feasible. The crop can be rotated or even inter-planted with other crops where land with adequate sources of water abounds like in the various River Basin Development Authority Areas (Girei and Giroh 2012).

According to KADP (2013), sugarcane is produced and sold in many local government areas of the state, including Makarfi, Giwa and Kudan. About 20 thousand households in the state, grew sugarcane in 2013.

1.2. Problem Statement

The demand-supply gap of major industrial crops in Nigeria and most countries in Sub-Saharan Africa is largely met by importation (GAIN, 2008). This is because most of the vital inputs in production such as planting material, fertilizer, herbicides and irrigation facilities are not always within the reach of the farmers. Thus, crippling the return on investment and discouraging the farmers from continued production of these crops. This has contributed significantly to the poverty state of the nation judging from the fact that Nigeria is an agrarian economy and agricultural development is a *sine qua non* to economic growth. One of such industrial crops is sugarcane (Wayagari, Ayoola, Imolehin and Misari 2003).

Considering the shortfall in sugarcane production in Nigeria, the government has set up and mandated research institutes and agencies such as the National Sugar Development Council (NSDC) and National Cereal Research Institute (NCRI) to facilitate increase in sugarcane production and utilization. The Millennium Village Commission Programme (MVCP) on sugarcane production, in Jigawa State is a fall out from this initiative. However, many if not all the established institutes have not met the set out objectives (Babalola, Ajani, Omonona, Oni and Awoyinka, 2009)

Furthermore, over the years the government has carried out policies aimed at boosting sugarcane production in the country. Some of the policies are: 50% tariff on importation of white sugar, 5% levy on imported raw sugar, 5–year tax waving to sugar refineries and privatization of the major sugar firms in the country, still domestic production of sugar is slightly less than 5% of the country's annual requirement (CBN, 2008 and 2010).

Despite the laudable government policies and the increase in sugarcane area harvested in Nigeria, the annual sugarcane production and yield from 2008 to 2013 kept on declining with the exception of 2011, 2012 and 2013 where it remained constant. Contrary to this, from 2003 to 2007 the annual sugarcane production and yield were increasing as the area harvested increased as shown in FAOSTAT (2013), annual crops production data.

In addition, the reports of Agricultural Production Survey, conducted by KADP in the years 2010, 2011, 2012 and 2013, showed that the annual quantity of sugarcane production in the state is declining. The average yield falls from 18.90tonne per hectare in 2010 to 3.31tonne per hectare in 2013. Also, the sugarcane annual average price increased from 2010 to 2013 by 95%, while number of sugarcane retailers and wholesalers/dealers dropped by 18% and 28% respectively, within this period.

In view of the foregoing, the following research questions have been put forward:

i. Are resources efficiently utilized in sugarcane production in the study area?
ii. What are the effects of socio-economic factors on efficiency in sugarcane production in the study area?
iii. What are the costs and returns (profitability) of sugarcane production in the study area?
iv. What is the contribution of sugarcane farming to farm income of the farmers?
v. What are the major constraints associated with sugarcane production in the study area?

1.3 Objectives of the Study

The broad objective of the study is to examine the economics of sugarcane production and its contribution to farm income of farmers in Makarfi, Giwa and Kudan, LGAs of Kaduna state.

The specific objectives are to:

i. determine the resource use efficiency in sugarcane production in the study area;
ii. determine the effects of socio-economic factors on efficiency in sugarcane production in the study area.
iii. estimate the costs and returns and hence profitability of sugarcane production;
iv. estimate the contribution of sugarcane production to farm income of the farmers in the study area, and:
v. describe the constraints associated with sugarcane production in the study area.

1.4 Hypotheses

The hypothesis tested within the study is that:

i. resources are not efficiently utilized in sugarcane production in the study area.

1.5 Justification for the Study

Sugarcane is the raw material used for manufacturing sugar in Nigeria which accounts for about 61% of the total world sugar production. Two types of sugarcane are grown in Nigeria – industrial and soft (chewing) cane but only the later one would be interested in this study. This is because soft cane accounts for about 60% of total sugarcane production in many years in Nigeria. Globally the major use of the crop is in the manufacture of sugar. Major industrial users of the product include the pharmaceutical industries, the food and beverages industries, bakeries, soft drinks bottling plants as well as biscuit and other confectionery manufacturers. Domestically, it is used in large amounts as a table sweetener.

The high economic potentials of sugarcane crop as an income earner to the producers, makes is imperative for concerned effort to be made by researchers on its agronomy practices in order to boost its production. However, from available records no adequate socio-economic data on the production of sugarcane in Kaduna state. Thus, this study is expected to provide the valuable bench mark information to the partially existing knowledge about the production of sugarcane in the study area.

According to KADP, (2012) Makarfi, Giwa and Kudan were selected as sugarcane basket of the state. Thus, detailed information on sugarcane production and identifying the problems associated with the production will help governmental and non-governmental organizations to design appropriate intervention measures in order to boost and improve production and the efficiency of sugarcane crop.

CHAPTER TWO

LITERATURE REVIEW

2.1. Sugarcane and the Nigerian Economy

Sugarcane (*Saccharum officinarum*) is a tropical crop that usually takes between 8 and 12 months to reach its maturity. Matured cane may be green, yellow, purplish or reddish considered ripe when sugar content is at its maximum (Onwueme and Sinha, 1991).

Although there are vast potentials for the commercial production of this crop, its processing industry did not come into existence in Nigeria until the early 1960's (Abdullahi, 2000). Commercial cultivation of sugarcane did not start until 1950 while industrial production of refined sugar stated in the early 1960's with the establishment of the Nigeria Sugar Company (NISUCO), at Bacita, Kwara State in 1964, Savannah Sugar Company (SSCL) Numan, Adamawa State in 1980 and Lafiagi in 1983. Similarly National Sugar Development Council, Abuja, is installing a medium-sized 250 ton-cane-day mini sugar plant at Sunti, Niger State. The combined installed capacities of these mills are about 120,000 metric tons of processed granulated white sugar per annum. However, total domestic production has fluctuated between 16,000 and 50,000 tonnes annually, which are able to satisfy only about 5 percent of the total national demand for sugar (Misari, 1997).The sugar industry is the major user of the sugarcane as its raw material source their requirement from local producers through the concept of out growers scheme of cane delivery. This is the major practice in Nigeria. Under this concept, sugarcane farmers are organized to grow and supply sugarcane for processing by the existing sugar plants. The purpose here is to encourage the production of sugarcane to feed sugar mills through the activities of smallholder and corporate out-growers. This approach tends to minimize the

overhead cost of sugarcane processors and enable them to concentrate on processing rather than growing of sugarcane (NSDC, 1996).

Most of Nigeria's sugar production only goes through the refining stage due to the lack of capacity to process sugarcane to raw sugar. Commercial sugarcane cultivation in Nigeria is almost negligible, due to poor infrastructure and incentives to encourage cultivation. Nigeria imports about 80% of her raw sugar requirement in spite of the prevalent favorable agricultural climate for sugarcane cultivation. Nonetheless, the prospects for sugarcane production and milling remains bright, given the already growing capacity. In 2007, Savannah Sugar (which was acquired by Dangote Industries Limited) commenced production and is currently expanding its operations. The NSDC is currently partnering with government (such as Agricultural Development Projects in states) in organizing and supporting sugarcane farmers to expand and improve output. Furthermore, the Federal Government has put in place incentives for investment in agriculture and agro-processing. Such incentives include: 1) Full capital allowance for agro-allied companies; 2) Processing of agricultural produce is a pioneer industry, consequently there is 100% tax-free period for 5 years; 3) All agricultural and agro-industrial machines and equipment are charged low import duty (1-3%); 4) The NSDC in collaboration with the Central Bank of Nigeria and local banks, introduced a scheme to deliver inputs and credit to sugarcane growers at sub 10% interest rates (Vetiva, 2011).

Based on the consumption patterns and projections, Nigeria may need to spend more than N12 billion each year on sugar importation if local production of sugar is not encouraged and improved (NSDC 2003). This situation can lead to crisis for sugar users. Furthermore, the stated policy of the government is to move Nigeria quickly from dependence on imports

to at least 70 percent self sufficiency in domestic sugar production in the near term (GAIN 2008). If the challenges are ameliorated, government initiative through programme intervention has been proposed as a sure way of making the farming business more rewarding and to encourage increased local production of industrial crops such as sugarcane (Babalola, Okoruwa, Omonona and Oni 2013).

2.2. The Concept of Production

In economics, production is the act of creating output, a good or service which has value and contributes to the utility of individuals (Kotler, Rackham and Krishnaswamy, 2006). According to Ekanem and Iyoha, (1999), production does not refer simply to the process of fabricating commodities, but also covers any activity concerned with the packaging, storage, transportation or marketing of these products as well as the rendering of personal and commercial services of all kinds. In short, any activity, which creates economic value, represents production.

2.2.1. Production Process

The whole system of activities leading to the fabrication of material goods and services is known as the production process. In other words, it is the combined system of activities by which various inputs are transformed into material goods and services per unit of time (Ekanem and Iyoha 1999)

2.1.2. Production Function

Koutsoyiannnis, (1979) defined production function as a purely technical relation which connects factor inputs and outputs. It describes the law of proportion and includes all the technical efficient methods of production. According to John, (2002), production function

is a function showing the maximum output possible with any given set of inputs, assuming these are used efficiently.

In economics, a production function relates physical output of a production process to physical inputs or factors of production. The production function is one of the key concepts of mainstream neoclassical theories, used to define marginal product and to distinguish allocative efficiency, the defining focus of economics. The primary purpose of the production function is to address allocative efficiency in the use of factor inputs in production and the resulting distribution of income to those factors, while abstracting away from the technological problems of achieving technical efficiency, as an engineer or professional manager might understand it (Heathfield, 1971).

2.3. Sugarcane Ecosystem and Production Trend in Nigeria

Sugarcane ecosystem: According to Ramanujam and Venkataramana (1999), sugarcane is grown in the world from altitude 36.7° N and 31.0° S, from sea level to 1000m of altitude or little more. It is considered as essentially a tropical plant. It is a long duration crop and thus it encounters all the seasons, viz: rainy, winter and summer during its life cycle. Principal climatic components that control cane growth, yield and quality are temperature, light and moisture availability. The plant thrives best in tropical hot sunny areas. The "ideal" climate for production of maximum sugar from sugarcane is characterized as:

- A long, warm growing season with a high incidence of solar radiation and adequate moisture (rainfall) – the plant uses from 148g to 300g of water to produce 1.0g of dry substance.

- A fairly dry, sunny and cool, but frost free season for ripening and harvesting – moisture percentage drops steadily throughout the life of the sugarcane plant, from 83% in very young cane to 71% in mature cane, meanwhile sucrose grows from less than 10 to more than 45% of the dry weight.

- Freedom from typhoons and hurricanes

Sugarcane is produced in Africa in the following five ecosystems: (1) Dry land (rain-fed upland), (2) hydromorphic (rain-fed lowland), (3) Mangrove swamp, (4) Inland swamp, and (5) Irrigated ecology. The various ecosystems face many constraints. Some of these constraints are specific to particular ecosystems while others are general and cut across ecosystems and regions.

Production trend: Based on the FAOSTAT (2013) data, the trend of sugarcane production in Nigeria can be deduced to have being increasing, especially in the last decade (i.e. between 2002 and 2011). The production trend between 1992 and 2001 increased between 1% and 9.7% but decreased more for up to 30% in 1994. In the last decade, the production increased more than ever, that is between 3.4% and 52.5%, especially in 2007 where the significant expansion has occurred. This was as a result of double and more increase in the area of harvest. The trend in the first half of this period is an upward one before it then fluctuated. This could be despite the increases in the area harvested, as a result of inefficiency in the production and climatic changes in the area. The trend is presented in Table 1.

Table 1: Sugarcane Production Trend of Two Decades in Nigeria

Year	Area Harvested (Ha)	Yield (Tonne/ha)	Production (Tonnes)
1992	22400	40	896000
1993	23800	38.03	905000
1994	18750	33.76	633000
1995	19270	30.57	589000
1996	21053	29.21	615000
1997	21900	30.82	675000
1998	23000	29.35	675000
1999	24000	28.42	682000
2000	24000	28.96	695000
2001	23000	30.65	705000
2002	40000	18.75	750000
2003	42000	19	798000
2004	43000	19.86	854000
2005	44000	20.77	914000
2006	47000	21	987000
2007	63000	23.9	1506000
2008	71890	19.64	1412070
2009	73060	19.19	1401680
2010	73060	19.16	1400000
2011	74000	19.59	1450000
2012	74000	19.59	1450000
2013	74000	19.59	1450000

Source: FAOSTAT 2013

2.4. Review of Empirical Studies on Sugarcane Production

In a study of analysis of the factors affecting sugarcane production under the Out-growers Scheme in Adamawa state, Girei and Giroh, (2012) reported that majority of the respondents (60%) were males who engaged in sugarcane production in the study area while 40% were found to be females. This could be attributed to the fact that sugarcane production is strenuous, labour intensive and hence the more males are found in production than females. The age distribution of respondents showed the mean age was 42.1 years with

majority (69%) falling into the age group of 31 – 40 years. This could be considered as productive age bracket (Haruna and Kushwaha, 2003). This is followed by those in the age group of 41-50 years which constituted 26% of the total respondents, while the remaining 5% of the respondents fall within the age bracket of between 21-30 years. The analysis further revealed that the minimum age of the respondents was 25years while the maximum was 50 years. It was concluded that the out-grower farmers of Savannah Sugar Company Limited, Numan are mostly medium age and hence in productive age. This age group of the sugarcane farmers may have much energy to work for a longer period of time. The younger farmers are more active in the adoption of new farming techniques and always willing to change for better than the older ones who are somehow conservative, adamant to change and vu1nerable to change involving the adoption and application of modern farming implements and other technologies.

In a study on the Economic Evaluation of Chewing Sugarcane in the Central Zone of Nigeria carried out by Wayagari *et al.*, (2003), showed that the gross revenue on chewing (soft) sugarcane production in Benue state is N103,578/ha at a market price of N3000/tonne. The average output is 35.5 tonnes per hectare. The total cost of production is N46, 667/ha. The resultant net return is N56, 909/ha. The net return per each Naira invested in chewing sugarcane production is N1.22. Labour cost had the highest operating expenses and that constituted 68% of the total production cost.

Babalola *et al.*, (2013) in a study carried out under Assessment of the Influence of Government Intervention Programme on Sugarcane Production in Nigeria: Evidence from Jigawa State, reported that Farmers' year of experience in farming is expected to increase quality and quantity of output by reducing pre-harvest and post-harvest losses and increase

efficiency of the farmers. It is even more important among illiterate farmers. The Millennium Village Commission (MVC) farmers had an average of ten years farming experience while the Non-Millennium Village Commission (NMVC) farmers had an average of fifteen years of experience in farming. Based on this result, the production potential of the NMVC farmers is expected to be higher than the MVC farmers if adequately supported and motivated. They also observed that, for the MVC farmers, the mean age was 4 years while, for the NMVC farmers, the mean age was 58 years. This result implies that on the average, MVC farmers were younger than NMVC farmers and are, relatively, still in their active working age. They could therefore still contribute significantly to farm production for many more years. In addition to this, the majority of the farmers in the study had one form of education or the other. However, 83 percent (133) of the NMVC farmers had only Qur'anic education; as such, they could only read in Arabic language and might not effectively use materials and equipments whose instructions were written in English. Also, they are likely not going to benefit adequately from programmes and events conducted in English Language.

2.5. Review of Expected Analytical Tools

2.5.1 Stochastic Production Frontier Analysis

Stochastic production frontier analysis has been widely used to study technical efficiency in various settings since its introduction by Aigner, Lovell and Schmidt, (1977) and Meeusen and van den Broeck (1977). The approach has two components: a stochastic production frontier serving as a benchmark against which firm efficiency is measured, and a one-sided error term which has an independent and identical distribution across observations and captures technical inefficiency across production units, (Yanyan, 2006).

Gabriel, (2006) used stochastic frontier production function to analyze the resource use efficiency of urban farmers in Uyo, Southeastern Nigeria. The result of his study shows that about 5% of the respondents were found to be less than 50%. The most efficient farmer operated at 91% efficiency while the least efficient farmer was found to operate at 43% efficiency level. Urban farmers performed at an average technical efficiency of 72% while the most frequently occurring efficiency score was 71%. From the results obtained, although farmers were generally relatively efficient, they still have room to increase the efficiency in their farming activities as about 30% efficiency gap from the optimum (100%) remains yet to be attained by all farmers.

Girei, Dire, Iliya and Salihu (2013) assess the resource use efficiency of Fadama II beneficiary crop farmers in Adamawa state, Nigeria. The maximum likelihood estimates (MLE) for the stochastic production function of their results shows that the coefficients of farm size, inorganic fertilizer, hired labour and expenses on ploughing, significantly affect food crop output of the respondents. The mean technical efficiency was 0.71 (or 71%), the mean allocative efficiency was 0.76 (or 76%) and the mean economic efficiency was 0.54

(or 54%). The study concludes that, the maximum likelihood estimates (MLE) for the stochastic production function of the coefficients of farm size(X1), inorganic fertilizer (X3), hired labour (X5) and expenses on ploughing (X6) were found to be positive and significantly affect food crop output of the respondents with the mean technical efficiency is 0.71 (or 71%).

Amodu, Owolabi and Adeola (2011) studied Resource Use Efficiency in Part-time Food Crop Production. In their study, the farm level technical efficiency scores shows that about 72% of part-time farmers had technical efficiency scores of over 50 % with a mean score of 65%. The maximum technical efficiency was 98.80% and the minimum was 36.58%. The 65% level of technical efficiency shows that there is room to improve production to reach the optimum efficiency level of 100 %.

Awudu and Richard (2001) used a trans– log stochastic frontier model to examine technical efficiency in maize and beans in Nicaragua. The average efficiency levels were 69.8 and 74.2 percent respectively. In a study by Wilson *et al. (2001)*, a trans– log stochastic frontier and joint estimate technical efficiency approach was used to assess efficiency. The technical efficiency among wheat producers in eastern England was between 2 and 98 percent.

Pius and Odjuwederihe (2006) investigated the determinants of yam production and economic efficiency among small holders in South-eastern Nigeria. The result showed the mean technical efficiency of 0.41, implying inefficiency in resource use of yam farmers in the study area. However, the result also showed a wide gap between the efficiency of the best economically– efficient farmer (0.85) and that of the average farmer (0.41).

Usman (2009) studied farm planning and resource use efficiency of sesame farmers in Jigawa State of Nigeria. The mean technical efficiency was found to be 57 percent. This implies that there is a scope of increasing production by 43 percent by adopting the technology and techniques of the best sesame farmer.

2.5.2. Net Farm Income Analysis

Barnard and Nix (1976), described budgeting as the detailed quantitative statement of a farm plan and a forecast of its financial result. Olukosi and Erhabor (1988) defined a farm budget as a detailed physical and financial plan for the operation of the farm for a certain period of time. Farm budgeting was used in this study to determine the levels of costs, returns and net revenue that accrue to sugarcane production based on the inputs used. The budgeting tool that was used in the study is the Net Farm Income (NFI). It is measured as the difference between the Total Revenue (TR) and Total Costs (TC). The Gross Margin by definition is the difference between the Gross Farm Income (GFI) and the Total Variable Cost (TVC); while the Gross Farm Income (GFI) also known as Total Value of Production (TVP); it is the Total Physical Product (TPP) multiplied by unit market price of the product, (Olukosi and Erhabor 1988).

Net farm income is the difference between gross income (revenue) and total cost of production (Olukosi and Erhabor, 2005). It is used to show the levels of costs, return 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 Erhabor, (1988) have examined two major categories of costs involved in crop production. These are fixed and variable cost. Fixed cost (FC) refers to those costs that do not vary with the level

of production or output while variable costs (VC) refer to those costs that vary with output. The total cost (TC) is the sum of total fixed cost (TFC) and total variable cost (TVC).

Several researchers have used net farm income as a tool for determining the profitability of crop production. Ayinde, Akerele, and Ojeniyi, (2011), examined resource-use efficiency and profitability of fluted pumpkin and found that the net farm income to be ₦116, 891.39 per hectare. Yusuf, Sanni, Ojuekaiye, and Ugbabe, (2008), assessed the profitability of Egusi Melon under sole and intercropping system in Okeni Local Government area of Kogi State of Nigeria and found out that the average net farm income per hectare for sole melon and two, three and four crop mixtures were ₦1,328.68, ₦915.77, ₦887.27 and ₦414.57 respectively; the total gross return per hectare for melon (pooled data) averaged ₦12,638.61 while the total cost of production was ₦8,838.74 on average and the total net farm income per hectare for both sole and mixed (pooled data) melon was ₦3,799.00 on the average, implying that Egusi melon production was profitability in the study area.

Abdulrahman, Yusuf and Suleiman, (2015) examined profit efficiency of cocoyam production in Kaduna State. The result of their finding revealed that the total revenue (TR) was ₦290,076.7 while the total cost (TVC + TFC) was ₦171,760. The net farm income was therefore ₦118,316.7; the average rate of return on investment (return per naira invested) was 1.69, indicating that for every ₦1 invested in cocoyam production in Kaduna state, a profit of 69 kobo was made. Thus, it could be concluded that cocoyam production in the study area though on a small scale, was economically viable. This finding is similar to that of Okoye and Asumugha, (2009) who observed that cocoyam production is profitable by returning ₦1.80 to every ₦1.00 spent.

CHAPTER THREE

METHODOLOGY

3.1. The Study Area

The study was conducted in Kaduna state of Nigeria which lies between latitudes $9^{o}10'$ East and $11^{o}30'$ North and longitudes 6^{o} East and $9^{o}10'$ North, respectively. It shares borders with Kastina and Kano states to the north, Plateau state to the north-east, Nasarawa state to the south and Niger and Zanfara states to the west. To the south-west, the state shares border with the Federal Capital Territory (FCT). The state has a total land area of about 4.5 million hectares, with an estimated total arable land of about 2.02 million hectares comprising 1.94 million hectares upland and 0.8 million hectares lowland. The state's population is approximately 6,113,503 with an annual growth rate of 3.2% making it the third most populous state in Nigeria. The state's population is projected to be 8,376,973 by 2016. (NPC, 2015).

There are two distinct seasons in the state namely: wet and dry. Wet season generally spans April – October, while dry season falls between October and March. The average rainfall is about 1,482 mm, while temperature ranges from $35^{o}c$ to $36^{o}c$ during the humid period to as low as $10^{o}c$ – $23^{o}c$ during the winter periods of November – February. The state falls within the Southern and Northern Savannah Ecological Zones characterized by woodlands with grasses of different species. The soil is developed from undifferentiated complex igneous and metamorphic rocks. The fine top soil coupled with reasonable organic matter in it, enhances the fertility status of especially the Southern part of the state. The physical properties of the soil are moderately good and allow for continuous cropping for a wide variety of crops, (KADP 2013).

About 80 percent of the State's population is engaged in peasant farming producing both food and cash crops. The crops produced in the state include cotton, groundnut, tobacco, maize, beans, guinea corn, millet, rice, ginger, cassava, sugarcane, yam and potatoes. During the dry season, a considerable number of people in the state are engaged in irrigation farming along some major rivers and dams. Low lying fertile land with a lot of alluvial deposit known as the "Fadama" is particularly important for irrigation farming in Kaduna State. The total "Fadama" area in Kaduna state is estimated to be 80,000 ha out of this only 11,000 ha have been put under cultivation. The crops cultivated are mainly vegetables and among the cash crops, there is sugarcane, (KADP 2013).

The state produces over 40,000 MT of sugarcane every year. Makarfi LGA accounts for about 39% (15,500MT), Giwa LGA produces 15% (6,200MT) while Kudan LGA 13% (5,200MT) of the total annual state production. Another important aspect of agriculture engaged by the people is the rearing of cattle, sheep, goatsl, pigs and poultry farming. Kaduna State occupies a very strategic position in terms of its historical role, contemporary political development and economic activities. Kaduna state has 23 local government councils, (KADP 2013).

3.2. Sampling Procedure and Sampling Size

For this study, a multi-stage sampling technique was employed. In the first stage, Makarfi, Giwa and Kudan local government areas were purposively selected because they are prevalent in sugarcane production in the state (KADP, 2013). In the second stage, nine villages were purposively selected out of villages that were prevalent in sugarcane production (three from each of the selected LGA).

In the third stage, only 25% of the total number of sugarcane farmers in each of the nine villages was randomly selected for this study. This represented a sample size of 330 respondents, as shown in Table 2 and using Yamane (1967) sample size Simplified Formula. The formula is expressed as:

$$n = \frac{N}{1+N\,(e)^2} \quad \text{----------} \quad (1)$$

Table 2: Sugarcane Farmers' Sample Frame and Sample Size

LGA	Village	Total No of Farmers	Sample Size
MAKARFI:			
	Dandamisa	200	50
	Danguzuri	170	43
	Gimi	190	47
GIWA:			
	Shika	100	25
	Giwa	160	40
	Gangara	130	32
KUDAN:			
	Hunkuyi	140	35
	Taban-Sani	110	28
	Garu	120	30
TOTAL	**9**	**1320**	**330**

3.3. Methods of Data Collection

The data for this study was collected from primary source only. The data was obtained using the interview method with well structured questionnaires administered among the respondents. The information collected from the respondents of sugarcane producers included: age, sex, number of years in farming, educational qualification, household size, number of extension contacts, farm size, inputs availability and prices, farming technique, output and its price(s). Other information collected were: volume of sales, how it is sold, to whom it is sold and storage costs. Finally, credit accessibility and interest charged (if any), membership of associations and constraints faced in sugarcane production were also obtained from the respondents.

3.4. Analytical Techniques

In order to achieve the objectives of this study, the following tools of analysis were employed:

(1) Descriptive Statistics (2) Stochastic Production Frontier Analysis and (3) Farm Budgeting Analysis

3.4.1. Descriptive Statistics

Descriptive statistics analysis was employed to achieve objectives (iv) and (v). This tool was employed to have summary description of the data collected. It involved the use of percentages, figures, means and frequency distribution to group the farmers into a number of classes with respect to socio economic characteristics.

3.4.2. Stochastic Production Frontier Analysis

The stochastic production frontier analysis was used to satisfy objectives (i) and (ii) of the study. According to Sunday *et al.,* (2013), Stochastic Production Frontier Analysis indicates the maximum expected output for a given set of inputs. It is derived from the production theory and based on the assumption that output is a function of inputs and the efficiency of the producer in using these inputs. The stochastic production frontier assumes that the boundary of the production function is defined by "best practice" firms. It therefore indicates the maximum potential output for a given set of inputs. The difference between observed output and the potential output is generally attributed to a combination of inefficiency and random error.

Following the Battese and Coelli, (1995) and Fari *et al.,* (2001) Stochastic Production Frontier (SPF) is defined as:

$$Y_j = f(X_{ij}\,;\,\beta) + (V_j - U_j)\ (_i = 1, 2, n) \quad \text{---------- (2)}$$

Where:

Y_j is the output of j firm; X_{ij} is the vector of actual j^{th} inputs used by the i^{th} firm; V_j is the stochastic error term which is associated with random factors outside the farmers control such as topography, weather and it is independent of U_j. The U_j is a one sided error representing the technical inefficiency of firm j. Both V_j and U_j are assumed to be independently and identically distributed with constant variance and zero mean.

The technical efficiency (TE) of a firm using Stochastic Production Frontier is given as:

$$TE = \frac{Yj}{Yj*} = \frac{\text{Observed Output}}{\text{Frontier Output}} = \frac{\exp(Vj - Uj)}{\exp(Vj)} \quad \text{---------- (3)}$$

$$TE = \exp(-U_j) \quad \text{---------- (4)}$$

The empirical stochastic frontier – Cobb-Douglas production model is specified as follows:

$$InY_j = \beta_0 + \beta_1 InX_1 + \beta_2 InX_2 + \beta_3 InX_3 + \beta_4 InX_4 + \beta_5 InX_5 + V_j - U_j \quad \text{---------- (5)}$$

Where:

In = Logarithm to base e (natural log)

β_0 = Constant or intercept

$\beta_1 - \beta_5$ = Unknow scalar parameters to be estimated

Y = Quantity of sugarcane output (Kg)

X_1 = Farm size (Ha)

X_2 = Quantity of sugarcane cutting (*sett*) used (Kg)

X_3 = Fertilizer (Kg)

X_4 = Agrochemicals (Liter)

X_5 = Labour (Man days)

V_j = Stochastic error term

U_j = Technical inefficiency effect predicted by the model

Subscript j indicates jth farmer in the sample.

The *a priori* expectation is that the coefficients of the whole inputs X_1 to X_5 which are β_1, β_2, β_3, β_4 and β_5 should be positive, respectively (i.e. greater than zero).

The inefficiency model is of the form:

$$U_i = \delta_0 + \delta_j Z_{ji} \quad \text{---------- (6)}$$

$$U = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 \quad \text{---------- (7)}$$

Where:

U_i = Technical inefficiency effect

Z_{ji} = Values of explanatory variables for the technical inefficiency effects for the i^{th} farmer

δ_0 = Intercept

δ_j = 1, 2, …, 5 are unknown scalar parameters

Z_1 = Age of the i^{th} farmer

Z_2 = Household size

Z_3 = Years of sugarcane farming experience

Z_4 = Level of education

Z_5 = Extension visit (number of meetings)

The specification of the model for the inefficiency effects in equation (3d) implies that, if the independent variables of the inefficiency model have a negative sign on an estimated parameter, then the associated variable has a positive impact on efficiency while a positive sign indicates that the reverse is true.

Thus, the *a priori* expectation is that the coefficients of the whole independent variables of the inefficiency model (i.e. δ_1, δ_2, δ_3, δ_4 and δ_5) should be negative, respectively (i.e. less than zero).

3.4.3. Farm Budgeting Techniques

This is one of the most common analytical tools used in farm management investigations to derive performance standard of the farm enterprise. It was used to achieve objective (iii) of the study.

The Model is expressed as follows:

$NFI = TR - TC$ ---------- (8)

$TR = GFI = TVP = TPP.P_x$ ---------- (9)

$TC = TVC + TFC$ ---------- (10)

$GM = GFI - TVC$ ---------- (11)

$GFI = TVP = TPP.P_x$ ---------- (12)

Where:

NFI = Net Farm Income (Naira/ha)

TR = Total Revenue (Naira/ha)

GFI = Gross Farm Income (Naira/ha)

TVP = Total Value of Production (Naira/ha)

TPP = Total Physical Product (Kg/ha) and

P_x = Unit market price of the product (Naira/kg)

TC = Total Costs

TFC = Total Fixed Cost (Naira/ha)

TVC = Total Variable Cost (Naira/ha)

GM = Gross Margin (Naira/ha)

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1. Resource Use Efficiency in Sugarcane Production

The estimates of the stochastic frontier model presented on Table 3 revealed that the coefficients of the resource inputs had positive sign, thus conformed to the *a priori* expectation. Farm size, cutting (*sett*) and fertilizer were statistically significant at 1% level each, labour was at 5% level while agrochemical was not statistically significant. These resource inputs were found to be inelastic and not intensively being utilized. Hence, an increase in any of these production resource inputs will also lead to an increase, though less than proportionate in output of sugarcane production in the study area.

Farm size (β_1): the estimated coefficient was found to be 0.120. This implies that, sugarcane production in relation to the cultivated farm size in the study area was inelastic; meaning that 10% increase in farm size other things being equal will lead the sugarcane output to increase by less than proportionate margin of 1.2% and vice-versa. This goes in line with the findings of Girei *et. al,* (2013) on the resource use efficiency of Fadama II Crop Farmers in Adamawa state. The estimated coefficient of farm size in their study was found to be positive and statistically significant at 1% level. This also agrees with the findings of Bifarin, *et. al,* (2010).

Table 3: Result of Maximum Likelihood Estimates of the Stochastic Frontier Production Function for Sugarcane Production

Variables	Parameters	Coefficient	Standard-Error	T-ratio
Constant	β_0	4.076	0.245	16.67***
Farm Size	β_1	0.120	0.022	5.42***
Cutting	β_2	0.535	0.053	10.03***
Fertilizer	β_3	0.273	0.043	6.33***
Labour	β_4	0.110	0.049	2.21**
Agrochemical	β_5	0.003	0.022	0.13
In-efficiency model				
Constant	δ_0	0.010	0.176	0.06
Age	δ_1	0.008	0.005	1.69
Household size	δ_2	0.003	0.017	0.17
Farming Experience	δ_3	-0.054	0.005	-10.37***
Educational Level	δ_4	-0.001	0.036	-0.03
Extension Visit	δ_5	-0.069	0.038	-1.83
Variance parameters				
Sigma-squared	σ^2	0.109	0.022	5.01***
Gamma	Γ	0.931	0.017	55.95***
Returns to Scale		1.04		
Number of Observations		330		

Note: ** = Significant at 5% *** = Significant at 1%

Cutting (*sett*) (β_2): the estimated coefficient was 0.535, implying that sugarcane production in relation to the *sett* in the study area was inelastic. As such, 10% increase in cutting (*sett*) *ceteris paribus,* will augment sugarcane output by less than proportionate margin of 5.35% and vice-versa. This indicates that it was not efficiently being utilized in the study area. This accords Ojo *et. al,* (2009) findings which indicated positive relationship between seed rate used and output and was statistically significant at 5%. Thus, 10% increase in seed rate will correspond to an increase in output by 3.65%.

Fertilizer (β_3): its estimated coefficient was found to be positive 0.273. Implying that 10% increase in fertilizer, *ceteris paribus*, increases (though less than proportionate) sugarcane output by 2.73%. Hence, fertilizer application in the study area was inelastic and not intensively been utilized. This goes in line with Umoh, (2006). In his study of urban farming, he found the coefficient of fertilizer to be positive, inelastic (0.4183) and highly significant at 1% level (2.7212).

Labour (β_4): the estimated coefficient was 0.110 and inelastic. This implies that 10% increase in labour, other things being equal, increases sugarcane output by less than proportionate margin of 1.1%. This reveals that labour in the study area was inelastic too. This agrees with the findings of Amodu, (2011) who revealed labour in the study area to have positive coefficient and statistically significant. This shows how important labour input is in farming, especially in our developing countries where mechanized way of farming becomes unaffordable to majority number of the farmers.

Agrochemical (β_5): the coefficient was estimated to be positive 0.003 and conformed to the *a priori* expectation but statistically not significant. Hence, application of agrochemicals in the study area was relevant too. As such, 10% increase in agrochemical, other things being equal, increases sugarcane output by 0.03%. This goes in line to the findings of Taru, Lawal, and Tizhe, (2011) where coefficient of agrochemical was found to be positive (0.65) but statistically significant at 1%. This shows that the output of cowpea will increase though less than proportionate as agrochemical used increases in the study area.

In view of the forgoing estimated coefficients of resource inputs used in sugarcane production, it can be deduced that there is a great potential for increasing the sugarcane output through increase and efficient utilization of the resource inputs.

4.2. Effects of Socio-Economic Factors on Technical Efficiency of Sugarcane Production

The inefficiency model as presented in Table 3 on the other hand reveals that all the estimated coefficients of the socio-economic factors with the exception of age and household size had negative sign, thus conformed to the *a priori* expectation. A negative coefficient in the inefficiency model means positive effect on productivity (i.e. it increases technical efficiency and production), while a positive one means negative effect on productivity (i.e. it decreases technical efficiency and production).

Age (δ_1): the estimated coefficient of age was found to be 0.008, thus failed to conformed to the *a priori* expectation but statistically significant at 10% level (1.69). This implies that there was a positive relationship between technical inefficiency in sugarcane production and the farmers' age in the study area. Hence, the older the farmers of sugarcane, the more technically inefficient they become. Sugarcane farming consumes time more and demands a lot of activities from planting to harvesting which are tougher in nature than other crops farming; it requires at least 4 number of weeding; it takes between 10 and 12 months from planting to harvesting, thus needs someone who is energetic, hardworking and endurable like the younger farmers. Therefore, the older sugarcane farmers were unable to give what was expected from them due to their natural inability (i.e. old age) and thereby led to technical inefficiency in the sugarcane production as shows by the estimated coefficient of the farmers' age. A 10% increase in age of sugarcane farmers in the study area will lead to

an increase in technical inefficiency (i.e. decrease in production) by 0.08%. This accords the finding of Kolawole and Ojo (2007) who in their study of small scale farmers in Nigeria found age to be positively related to inefficiency.

Household Size (δ_2): the coefficient was estimated to be positive (0.003) not as expected too and statistically not significant. This implies that there was a positive relationship between technical inefficiency in sugarcane production and the farmers' household size. Farmers with more household size tend to have more free hands in the farm. They use it as their farm main source of labour supply. These free hands usually do no good work (poor workmanship), because they feel that they were discharging free services to their family, as such no money is going to be paid to them after finishing, unlike if they were on hired basis or working in their own personal farms. Thus, they quickly worked in the family's farm within short period, reserved energy and further moved to either their personal farms or where they can labour for money and thereby led to technical inefficiency in their family's (sugarcane) farm. Hence, 10% increase in household size, other things being equal, will positively influence technical inefficiency by 0.03% in the study area. This agrees with the findings of Amodu *et. al.*, (2011) who revealed household size in their study area to have positive coefficient (0.24) and statistically significant at 5% level (2.29).

Farming Experience (δ_3): the estimated coefficient of farming experience was negative (-0.054) as expected, thus conformed to the *a priori* expectation and statistically significant at 1% level. This implies that farmers with past sugarcane production experience were more technically efficient in sugarcane production in the study area. In other words, the farmers who have been in sugarcane production for quite long period knew better the suitable land area where the crop can be planted, how to plant it, time of planting, weed control, fertilizer

application and other resource inputs efficient utilization than those who had just recently started. Therefore, as farmers' production experience increases by 10% the technical inefficiency in sugarcane production decreases by 0.54% and thereby increasing the output. This goes in line with the findings of Dengle, Joyce and Yustus, (2011) where farming experience was found to have negative coefficient (-0.009).

Educational Level on Sugarcane Production (δ_4): the estimated coefficient was negatively related to technical inefficiency (-0.001) as expected but statistically not significant (0.03). Meaning that farmers who had more knowledge and up to date information on sugarcane production have technically increased efficiency in the crop production than those with less, as it has been found in the study area. Most of the farmers who had greater yield of 50tonne and above per hectare were those who have no formal education but experience and technical know-how in the sugarcane production. Hence, an increase of 10% in educational level on sugarcane production will increase technical efficiency of the farmers by less than proportionate margin of 0.3%. This agrees with Isa, (2012) who found educational level of medium scale rice farmers in Benue state to have negative coefficient (-0.7011).

Extension Visit (δ_5): the estimated coefficient also conformed to the *a priori* expectation (-0.069) and statistically significant at 10% level. This implies that extension services had a positive effect on sugarcane production technical efficiency. Therefore, farmers who received more and regular contacts were better technically efficient in sugarcane production than those who received less in the study area. Extension contact could be received directly from an extension agent, experienced (sugarcane) farmer or indirectly through the media, such as radio, television, and publications as in agricultural journals and write ups. As such,

a 10% increase in extension visit, increases production by less than proportionate margin of 0.69%. This accords Ambali, Adegbite, Ayinde and Idowu, (2011). In their research work titled 'Analysis of Production Efficiency of Food Crop Farmers of Bank of Agriculture Loan Scheme in Ogun State' extension contact coefficient was found to be negative as expected (-0.0464) and statistically significant at 1% level (-7.310).

The variance parameters of the frontier production model were represented by Sigma-squared (δ^2) and Gamma (γ). The Sigma-squared indicates the total amount of variance found in the model. Its estimated coefficient in the study area was 0.11 and statistically significant at 1% level. Gamma shows the ratio of variance of the inefficiency terms over the total amount of variance. In another words, Gamma indicates the systematic influences that are unexplained by the production function and the dominant sources of random errors. Its estimated coefficient in the study area was 0.93 and statistically significant at 1% level. This shows that, 93% of the variation in sugarcane output was as a result of the differences in technical inefficiencies of the farmers. Thus, the result reveals that inefficiency effects were present and significant in the study area.

4.3. Analysis of Inputs Used and Output of Sugarcane Production in the Study Area

Tables 4 shows the summary statistics of the inputs utilized, output and yield of sugarcane cultivated in the study area. The average yield of sugarcane in the study area was found to be 37,603.13kg per hectare. This was obtained by using averagely, 3,014.90kg/ha (i.e. 3.01tonne/ha) of cutting (sett), 161.04kg/ha of fertilizer, 1.51liter/ha of agrochemical and about 25 man-days/ha of labour, respectively. According to FAO STAT (2013), the world average yields of sugarcane in the years 2012 and 2013 were 69.56tonne (i.e. 69,560kg) and 82.09 (82,09kg) per hectare, respectively. Nearly 10 – 12 tonnes of cutting (setts),

550kg of fertilizer and 3.5 liters of herbicide are required to plant sugarcane on one hectare of field (NETAFIM, 2012). Indian Institute of Sugarcane Research (IISR), (2011) stated that it requires about 50 – 65 man-days on an average per hectare for a normal sugarcane farming, excluding harvesting. The average farm size and output cultivated were found to be 0.49ha and 20,589.55kg/ha, respectively. These clearly show that the farmers in the study area were producing far below the potential (frontier) quantity and the resource inputs were not efficiently utilized. This was due to the fact that most of the farmers lacked modern and up-to-date knowledge of sugarcane production; they used unimproved *sett*, applied insufficient quantity of fertilizer and agrochemical and maintained the traditional method of farming, thereby producing below the potential quantity.

Table 4: Input and Output Levels for Sugarcane Production in Maigana Agricultural Zone, Kaduna State

Variable	No of Observation	Maximum	Minimum	Mean	Standard Deviation
Output (Kg)	330	165,000	900	20,589.55	24,766.52
Yield (Kg/ha)	330	79,254	11,453.47	37,603.13	20,109.28
Cutting (Kg/ha)	330	25,000	200	3,014.90	3,574.34
Fertilizer (kg/ha)	330	1300	12	161.04	187.36
Labour (Man-day)	330	200	3	25	27.69
Agrochemicals (Litre/ha)	330	6	1	1.51	0.96

4.4 Technical Efficiency Indices among Sugarcane Farmers

The respective estimated levels of technical efficiency of an individual sugarcane farmer were summarized and presented in Table 5 as obtained from the stochastic frontier production model. It was observed from the study that 0.30% of the farmers had the lowest efficiency levels which ranged from 0.40 to 0.49; whereas the largest percentage (71.52%) of them had efficiency levels from 0.90 and above. The maximum, minimum and mean

technical efficiencies for sugarcane farmers in the study area were found to be 0.97, 0.48 and 0.89, respectively. This implies that, the farmer with the best practice had a technical efficiency of 0.97; farmer with the worst practice had a technical efficiency of 0.48 while in general, farmers in the study area had an average practice technical efficiency of 0.89. Judging from this, it is then possible to increase the yield by 11% in the short run using the presently available techniques.

Table 5: Technical Efficiency Indices among Sugarcane Farmers

Class-Interval of Efficiency Indices		Frequency	Percentage (%)
0.20 – 0.29		0	0.00
0.30 – 0.39		0	0.00
0.40 – 0.49		1	0.30
0.50 – 0.59		6	1.82
0.60 – 0.69		6	1.82
0.70 – 0.79		12	3.64
0.80 – 0.89		69	20.91
≥ 0.90		236	71.52
Maximum	**0.97**		
Minimum	**0.48**		
Mean	**0.89**		
Total		**330**	**100**

4.5 Profitability Analysis in Sugarcane Production

This is simply the difference between the total revenue and total costs of production. Thus, on average basis, the estimated total revenue in the study area was ₦171,510.95k per hectare. This was obtained by multiplying the average sugarcane output by the unit price. The average sugarcane output (20,589.55kg) was determined as total quantity of sugarcane output (6,794,550kg) divided by total number of sugarcane farmers (330) in the study area. The unit price was the price at which a kilogram of sugarcane output was sold. This was estimated as follows: on average basis a tie (***dami***) of sugarcane was sold at ₦250 and it

contains 15 stalks; a stalk of sugarcane then cost ₦16.67k; a stalk weighs 2kg averagely, thus a kilogram of sugarcane was sold at ₦8.33. Total variable cost per hectare was ₦65,254.90k; this was the sum of cutting, fertilizer, labour and agrochemical costs. Averagely the cost of 100kg bag of cutting (*sett*) was ₦1000, fertilizer was ₦5000 per 50kg bag, labour was ₦700 per man-day (i.e. ₦500 payment for the 5 hours farm work carried out in the morning and ₦200 for 2 hours of the evening time) and agrochemical was ₦1000 per liter. The average quantity of sugarcane cutting, fertilizer, labour and agrochemical used per hectare in the study area were 3014.09kg, 161.04kg, 25 man-day and 1.51liter respectively. Hence, these variable inputs costs were estimated to be ₦30,140.90 for cutting, ₦16,104 for fertilizer, ₦17,500 and ₦1,510, respectively. The total fixed cost was ₦28,220 per hectare; it comprises the land renting and depreciation cost of the farming tools. Averagely, a hectare of land for sugarcane production was rented at ₦25,720; a hoe costs ₦500 and spends 5 years averagely functional, thus its annual depreciation value is ₦100. About 25 number of hoes were used per hectare in the sugarcane production. Hence, the total depreciation cost of the farming tools was estimated to be ₦2500. By subtracting total variable cost and total fixed cost (i.e. total costs) from the total revenue respectively, the net farm income of sugarcane farmers in the study area per hectare was realized to be ₦78,036.05k as presented in Table 6.

The results also revealed that the average return on investment was ₦1.83k; meaning that for every ₦1 invested in sugarcane production in the study area, a profit of 83 *kobo* was realized by the farmers. Hence, it is vivid to say that sugarcane production in the study area was profitable. Therefore, the null hypothesis of the study stating that, sugarcane production in the study area is not profitable was rejected while the alternative accepted.

Table 6: Average Cost and Return Per Hectare of Sugarcane Production

A. Return:	**Value (₦/ha)**
i- Average Output (kg/ha)	20,589.55
ii- Average Price (₦/kg)	8.33
Total Revenue (TR) = (i*ii)	**171,510.95**
B. Cost:	
1. Variables Costs	
a- Cutting (kg)	30,140.90
b- Fertilizer (kg)	16,104.00
c- Labour (Man-day)	17,500.00
d- Agrochemicals (Litre)	1510.00
Total Variable Cost (TVC) = (a + b + c + d**)**	**65,254.90**
2. Fixed Costs	
e- Land Renting	25,720.00
f- Depreciation	2,500.00
Total Fixed Cost (TFC) = (e + f**)**	**28,220.00**
Total Costs (TC) = (TVC + TFC)	**93,474.90**
Gross Margin (GM) = (TR - TVC)	**106,256.05**
Net Farm Income (NFI) = (TR - TC)	**78,036.05**
Net Farm Income on ₦1 Invested = (TR/TC)	**1.83**

4.6. Contribution of Sugarcane Farming to the Farmers' Annual Income

The farmers in the study area were found to have had other sources of farm income other than sugarcane farming, such as other crop(s) farming, animal rearing, poultry, etc. The average annual farm income of the sugarcane farmers was estimated to be ₦299,556.36k; the average income (profit) earned from sugarcane production by the farmers was estimated to be ₦58,556.36k. Hence, sugarcane production in the study area contributed averagely to about 19.55% of the farmers' annual farm income as presented in Table 7.

Table 7: Contribution of Sugarcane Farming to the Farmers' Annual Income

Contribution of Sugarcane (%)		Frequency	Percentage of Farmers (%)
0.01 – 10		159	48.18
10.01 – 20		61	18.48
20.01 – 30		45	13.64
30.01 – 40		23	6.97
40.01 – 50		24	7.27
> 50		18	5.45
Maximum	**81.87**		
Minimum	**0.12**		
Mean	**19.55**		
TOTAL		**330**	**100**

The maximum contribution made was 81.87% while minimum was 0.12%. These imply that none of the farmers solely depended on sugarcane farming as his only source of income; rather majority of them (i.e. about 80%) earned most of their income from other sources annually, as judged by the mean contribution. This was because sugarcane production takes longer period of between 10 and 12 months from planting to harvesting unlike other crops such as tomato, chili paper, cabbage, carrot, maize etc that take shorter period of between 3 and 6 months from planting to harvesting. Thus, they generate income annually more often than the sugarcane. About 13% (i.e.42) of the farmers incurred loss due to low demand for the crop in this production season while the remaining 87% realized profits at different levels.

It can be deduced from this finding that sugarcane production served as one of the sources of farm income of the farmers. In other words, the income of the sugarcane farmers has increased, thereby reducing poverty level among its producers.

4.7. Test of the Hypothesis

The hypothesis to be tested on the study is: (i) Resources are not efficiently utilized in sugarcane production in the study area.

Considering the estimated values of sugarcane mean technical efficiency presented earlier in Tables 4.5 which was found to be 0.89 (i.e. < 1). It is concluded that resource inputs were not efficiently being utilized in the study area. Thus, the null-hypothesis (H_0) is accepted.

4.8. Constraints Associated with Sugarcane Production in the Study Area

Like other crops farming, sugarcane in the study area was found to be associated with numerous constraints. The major constraints were identified and ranked in descending order as presented in Table 8 and they were: low demand for the crop was ranked the first constraint, having the highest percentage; inadequate capital and credit inaccessibility, fertilizer at unaffordable price, and theft were ranked second, third and fourth, respectively.

Low demand for the sugarcane crop was identified as the major constraint in sugarcane production in the study area. This was mainly because of the recent insurgency, especially in the northern part of the country where the crop was usually produced in larger quantity. Most of the sugarcane farmers complained that the dealers and or wholesalers who normally come from different parts of the country and even abroad like Niger (country) in order to buy the crop in bulk, this season failed to due to the insecurity nature of the region. Thus, led to excess supply over demand for the crop into the community's and its neighboring towns markets and thereby caused low price for the sugarcane crop. A sugarcane tie (*dami*) sold at ₦500 or ₦700 before was this season sold between ₦200 and ₦300 due to low demand for

the crop. Therefore, 108 farmers (32.73%) out of the 330 solely chose low demand for the crop as their only problem associated with sugarcane production in the study area whereas some added to it other constraint(s) as presented in Table 8.

Table 8: The Constraints Associated with Sugarcane Production

Problems	**Frequency**	**Percentage**	**Rank**
a) Low Demand for the Crop	108	32.73	1
b) Inadequate Capital & Credit Inaccessibility	21	6.36	2
c) Fertilizer at Unaffordable Price	16	4.85	3
d) Theft	0	0.00	4
e) All of the above (i.e. a + b + c + d)	43	13.03	------
f) Options **a** & **b**	50	15.15	------
g) Options **a** & **c**	40	12.12	------
h) Options **a** & **d**	9	2.73	------
i) Options **b** & **c**	9	2.73	------
j) Options **c** & **d**	3	0.91	------
k) Options **a, b** & **c**	22	6.67	------
l) Options **a, b** & **d**	3	0.91	------
m) Options **a, c** & **d**	6	1.82	------
Total	**330**	**100**	

Inadequate capital and credit inaccessibility was ranked the second major constraint associated with sugarcane production in the study area. The farmers complained that they have no sufficient fund to cater for the whole expenses incurred in the course of sugarcane production; larger portion of what they spent in the production came from their personal savings while the remaining were borrowings from family members, relatives, friends and local lenders which in most cases they give less than what has been demanded. As a result the farm activity that supposes to be carried out and finished within few days, such as weeding, buying and application of fertilizer would be delayed for weeks due to the fact that the farmer had no sufficient fund to hire labourers that will do it within the desired period. Thus, he instead did the work himself with few or without family labourers support. This

delay led to inefficient utilization of resource inputs in the sugarcane production and affected negatively its quality and quantity produced. Therefore, 21 farmers (6.36%) out of the 330 solely chose inadequate capital and credit inaccessibility as their only problem associated with sugarcane production in the study area whereas some added to it other constraint(s) as presented in Table 8.

Fertilizer at unaffordable price was ranked the third major constraint to the sugarcane farmers. It was stated annoyingly by sugarcane farmers that the prices of fertilizers were high. A 50kg bag of NPK fertilizer was sold at ₦5,500 while that of urea was ₦4,500. Hence, a piece of land that required say five bags of fertilizer for sugarcane production ended up applied in only two or three bags due to high price nature of the fertilizer coupled with inadequate capital. This insufficient application of fertilizer to the sugarcane crop in the farms crippled its growth and as a result, shortened the desired (frontier) quantity of sugarcane to be produced. Thus, 16 farmers (4.85%) out of the 330 solely chose fertilizer at unaffordable price as their only problem associated with sugarcane production in the study area whereas some added to it other constraint(s) as presented in Table 8.

Theft was ranked the fourth and the last major problem associated with sugarcane production in the study area. On several occasions according to some farmers many people were caught with theft sugarcane crop loaded on wheel barrows, donkeys, pick-ups and some on foot. This happened mostly at night and especially during the midst harvesting period when most of the sugarcane farmers started harvesting. In course of the thieving many stalks of the sugarcane, especially the immature ones were crushed and damaged, thus most be removed and sold at unwanted price, consumed or given unwillingly as a gift. This reduced the rate of profit earned by these sugarcane farmers suffered from the problem of

theft and or augmented their losses. Accordingly, there was no single farmer out of the 330 solely chose theft as their only problem associated with sugarcane production in the study area but added to it other constraint(s) as presented in Table 8.

CHAPTER FIVE

5.0. SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1. Summary

The specific objectives were: to determine the resource use efficiency in sugarcane production; to determine the socio-economic factors effects on efficiency in sugarcane production, estimate the costs and returns (profitability) of sugarcane production; estimate the contribution of sugarcane to farm income of farmers and identify the major constraints associated with sugarcane production in the study area.

The data for the study were collected from primary source only, using the interview method with well structured questionnaires administered among the respondents. A multi-stage sampling technique was employed. In the first stage, Makarfi, Giwa and Kudan local government areas were purposively selected being them the most prominent sugarcane producing areas out of 23 LGAs in the state. In the second stage, nine villages were purposively selected out of villages that are prominent in sugarcane production (three from each of the selected LGA). In the third stage, only 25% of the total number of sugarcane farmers in each of the nine villages was randomly selected for this study. This formed a sample size of 330 respondents by applying the Yamane, (1967:886) sample size 'Simplified Formula'. The analytical techniques used to analyze the data include descriptive statistics, stochastic frontier production analysis and net farm income.

The results from stochastic frontier production function of sugarcane production showed that most of the resource inputs used and the inefficiency variables in the study area conformed to a *priori* expectations and were statistically significant at 1% and 5% levels respectively. Thus, increase in these resource inputs used and inefficiency variables lead to

an increase in sugarcane output. The mean technical efficiency for the farmers in the study area was 0.89 meaning that there is potential for increasing the sugarcane yield by 11% using the presently available techniques.

On the average, sugarcane output was 20,589.55kg, yield 37,603.13kg, cutting (sett) 3,014.90kg, fertilizer 161.04kg, labour 25 man-days and agrochemical 1.51liter per hectare. Hence, it is clearly showed that, the farmers in the study area were producing far below the desired (frontier) quantity.

With regards to the costs and revenue analysis, on average basis the estimated total revenue in the study area was ₦171,510.95k per hectare, total variable cost was ₦65,254.90k per hectare and total fixed cost was ₦28,220 per hectare. By subtracting total variable cost and total fixed cost (i.e. total costs) from the total revenue respectively, the net farm income of sugarcane farmers in the study area per hectare was realized to be ₦78,036.05k. The results also revealed that, the average return per *Naira* invested was ₦1.83K; meaning that for every ₦1 invested in sugarcane farming in the study area, a profit of 83 *Kobo* was realized as revealed in Table 6.

The sugarcane farmers in the study area were found sold their output after harvesting either right in the farm or taken to the market place for sale. Most of the farmers stressed that selling the sugarcane crop in the farm is preferred and better than taken it to the market place. This was because it saves the cost of transportation and the risk of not having buyers in the market. Thus, 292 farmers (88%) sold their sugarcane harvest right in the farm while the remaining 38 (12%) took it to market place for sale.

The result of the hypothesis tested revealed that the resource inputs used in sugarcane production were not efficiently utilized. This can be deduced from the mean technical efficiency value which was estimated to be 0.89 (i.e. < 1). Thus the null hypothesis (H_0) is accepted.

The major constraints identified by the sugarcane farmers in the study area were: low demand for the crop, inadequate capital and credit inaccessibility, fertilizer at unaffordable price and theft.

5.2. Conclusion

It was found in this study that technical efficiency in sugarcane production was positively affected by majority of the socio-economic characteristics of the sugarcane farmers. All the inputs were positively related to the output. The sugarcane farming contributed about 20% to the farmers' annual farm income. Hence, it is concluded that sugarcane production in the study area was profitable despite the fact that the resource inputs were not efficiently being utilized.

5.3 Contributions of the study to knowledge

i. The study revealed that sugarcane farmers in the study area achieved averagely, technical efficiency of 89%.

ii. It was found that sugarcane production in the study area, contributed to about 20% of the farmers' annual income.

iii. The study found that low demand for the crop; inadequate capital and credit inaccessibility, fertilizer at unaffordable price, and theft were the major constraints affecting sugarcane production in the study area.

iv. It was found also that sugarcane farming was carried out mostly by small scale farmers with an average farm size of 0.49 hectare in the study area.

5.4. Recommendations

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

i. The resource inputs used in the study area were not efficiently being utilized. Thus, there is need for training sugarcane farmers on farm inputs optimum utilization by the extension agents in the study area.

ii. An enabling environment should be created for sugar industries in the country by the government to boost demand for sugarcane crop.

iii. Both agricultural and micro-finance banks should financially support the small and medium scale sugarcane farmers.

iv. The farmers should form a formal and strong sugarcane farmers association that would represent their interest. This would help them to have better knowledge about sugarcane farming, access to financial and farming supports by the government.

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APPENDIX I

ANALYSIS OF SUGARCANE PRODUCTION AND ITS CONTRIBUTION TO HOUSEHOLD FARM INCOME OF FARMERS IN MAIGANA AGRICULTURAL ZONE OF KADUNA STATE

Dear Respondent,

This questionnaire is designed by a student from the Department of Agricultural Economics and Rural Sociology, Ahmadu Bello University, Zaria to collect relevant data for a research work titled as seen above and as part of the requirements for the award of Master's Degree (M.Sc.) in Agricultural Economics, ABU Zaria.

Please, fill as appropriate. All information collected will be kept confidential and strictly used for the purpose of this research only.

Thank you.

Sulaiman, Muhammad

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

1. **Sex:** (a) Male [ ] (b) Female [ ]
2. **Age:** (a) 18 – 25 Years [ ] (b) 26 – 30 Years [ ] (c) 31 – 40 Years [ ] (d) > 40 Years [ ]
3. **Marital status:** (a) Married [ ] (b) Single [ ]
4. **Level of education:** (a) No Formal Education [ ] (b) Primary School Education [ ] (c) Secondary School Education [ ] (d) Tertiary Education [ ]
5. **Family size:** (a) 1 – 5 [ ] (b) 6 – 10 [ ] (c) 11 – 15 [ ] (d) >15 [ ]
6. **Farming experience** (For how long have you been in sugarcane farming)?

   (a) > 1 year [ ] (b) 1 – 5 years [ ] (c) 6 – 10 years [ ] (d) > 10 years [ ]

7. **Did you belong to any sugarcane production cooperative association:**

   (a) Yes [ ] (b) No [ ]

8. **If yes, for how long? (**a) < 1 year [ ] (b) 1 – 5 years [ ] (c) 6 – 10 years [ ] (d) > 10 years [ ]

9. **As a member, what benefit did you derive from it? (**a) Financial [ ] (b) Orientation/enlightenment [ ] (c) Others [ ]

   Specify ……

10. **What was/were your major source(s) of capital for sugarcane farming?** (a) Personal savings [ ] (b) Friends and family [ ] (c) Borrowing [ ] (d) Others [ ] Specify……..……

11. **If '*Borrowing'*, from whom did you borrow?** (a) Commercial banks [ ] (b) Friends and family [ ] (c) Local money lenders [ ] (d) Others [ ] Specify ……..

12. **How much did you borrow and interest charged to finance last production?** (Fill for the source you indicated in Q. 11)

    Specify: (i) Amount **(₦)** …… (ii) Interest rate **(%)** ……..……

13. **Have you been visited by any extension agent/experienced sugarcane farmer during production period?** (a) Yes [ ] (b) No [ ]

14. **If *yes*, how many times?**

    Specify ……..…….

15. **Of what benefit were the techniques learnt from the agent to the success of your sugarcane farming?**

    Specify ……

B. INFORMATION ON SUGARCANE INPUTS (Last production cycle)

(i) Farm Size:

16. How many sugarcane farm plots do you have? Specify …… Indicate their respective size in table below:

Plot No	1	2	3	4	**Total**
Plot Size (Ha)					

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

Plot	**Mode of Acquisition**			
	Inheritance	Lease	Purchased	Gift
1				
2				
3				

18. Assuming you acquired the land through '*Lease*' for sugarcane production last season, how much do you think it will be paid as rent?

Specify (Ha/Naira) ……

19. What was the mode of land preparation did you employ on the sugarcane field?

(a) Animal traction [ ] (b) Tractor hiring [ ] (c) Manual implements [ ]

(d) Others [ ] Specify ……

20. If you employ any in Q19 above, how much do you pay per hectare? Specify ..……. Naira

(ii) Variable Inputs:

- **Sugarcane Cutting (Kg)**

21. What variety of sugarcane did you plant?

(a) Unimproved (Local) [ ] (b) Improved (Hybrid) [ ]

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

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

❖ **Fertilizer**

23. Did you apply fertilizer or manure on your sugarcane? (a) Fertilizer [ ] (b) Manure [ ] (c) Both [ ] (d) None [ ]

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

(Tick and specify where appropriate)

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

❖ **Agro-chemicals:**

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

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

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

(a) Land Preparation:

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

(b) Planting:

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

(c) Fertilizer Application:

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

(d) First Weeding:

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

(e) Second Weeding:

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

(f) Replacement:

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

(g) Harvesting:

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

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

26. What quantity of sugarcane was consumed at home and that gave as gift after harvest?

Plot No	1	2	3	4	Total
Home Quantity (Kg)					
Gift Quantity (Kg)					
Total					

27. Specify below the total quantity of sugarcane you have harvested (produced) and sold:
(i.e. after subtracting home and gift consumption)

Plot No	Quantity Harvested (Kg)		Price Per Unit Sold (₦)		Total Sales (₦)
	A Tie of 13 – 17	A Tie of 20 - 30	A Tie of 13 - 17	A Tie of 20 - 30	
1					
2					
3					
Total					

28. Did you sell it right in the farm or take it to the market for sale?

(a) Sold right in the farm [ ] (b) Took to the market for sale [ ]

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

30. Are there barriers to entry into the sugarcane market?

(a) Yes (i.e. barriers to entry are high) [ ] (b) No (i.e. there is free entry and exit) [ ]

31. Whom did you sell the sugarcane to? (a) Wholesalers/dealers only [ ] (b) Retailers only [ ] (c) Both wholesalers and retailers [ ] (d) Others [ ] Specify …….

32. Who did set the sugarcane price? (a) By the market [ ] (b) By negotiation between the farmer and middlemen (wholesale, retailer) [ ] (c) Others [ ] Specify ……..……

33. At what rate (in Naira) **did you sell?** (a) A tie of 13 – 17 stalks [ ] was sold at ……..…. (₦) (b) A tie of 20 – 30 stalks [ ] was sold at ……. (₦) (c) Others [ ] Specify……(₦)

34. Did you have commissioned agent(s) selling the sugarcane for you?

(a) Yes [ ] (b) No [ ]

35. If Yes, how much commission did you pay the agent(s) in Naira per tie? (Specify the tie) …… ₦

36. Did you have any source of income other than sugarcane farming? (a) Yes [ ] (b) No [ ]

37. If yes, choose among the following income earning sources: (a) Other crop(s) farming [ ] (b) Animals and/or birds Rearing [ ] (c) Business(es) [ ] (d) Others [ ] Specify ……..……..…..….

38. How much did you earn from each of the other sources in last production season? (to be filled based on Q37 options **a, b, c** and **d**) Specify the profit only as: for option (a) …...……..…₦ For option (b) ……..……..₦. For option (c) ……₦

For option (d) ……..……..…₦

39. **Was any or all of the following, the constraints (i.e. problems/challenges) that you have encountered in sugarcane production?** (a) Inadequate capital and credit inaccessibility [ ] (b) Shortage of land [ ] (c) Bad roads to and distance of market from the farm [ ] (d) Low demand for the crop [ ] (e) Unavailability of fertilizer at affordable price [ ] (f) Inadequate storage facilities [ ] (g) Unimproved varieties [ ] (h) Diseases and pests [ ] (i) Lack of standardized means of measurement (scaling or weighing) [ ] (j) All of the above [ ]
(k) None of the above [ ] Others [ ]
Specify…….…….....…….....
.....

40. **Suggest possible solutions to the problems/challenges encountered in sugarcane production**
Specify…….……
……
……
……
……
……

41. **Do you have any relevant information that you can add which was not asked earlier?**
Commend…….……
……
……...……
……...……
……...……
……...……