PROFITABILITY AND PRODUCTION EFFICIENCY IN COTTON PRODUCTION IN NORTH-WEST NIGERIA

BY

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A THESIS SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES AHMADU BELLO UNIVERSITY, ZARIA, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF DOCTOR OF PHILOSOPHY IN AGRICULTURAL ECONOMICS

DEPARTMENT OF AGRICULTURAL ECONOMICS AND RURAL SOCIOLOGY
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FEBRUARY, 2016

DECLARATION

I hereby declare that this thesis titled**"Profitability and Production Efficiency in Cotton Production in North-West, 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 borrowed information has been acknowledged in the text and a list of references provided.

_____ _____

Abdu UmarBABANGIDA **Date**

CERTIFICATION

This thesis titled **"Profitability and Production Efficiency in Cotton Production in North-West, Nigeria"** by Abdu UmarBabangida meets the regulations governing the award of the degree of Doctor of Philosophy of Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literacy presentation.

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ABSTRACT

The main objective of the study was to estimate the profitability and production efficiency in cotton production in North-West Nigeria. The study usedon primary data generated during the 2013/2014 cotton production season. Data were collected through the use of structured questionnaire administered to three hundred and fifty five cotton farmers. The data were analyzed using descriptive statistics, net-farm income model and stochastic frontier production model. The results of the socio-economic characteristics of the farmers showed that the mean age of the farmers was 49 years and average years of farming experience was 12 years. The results also showed that very few farmers (18%) were registered with a cooperative for an average period of five years. Farm sizes in the study area were small with an average of 1.3 hectares. About 98% of these farmers were married with average household size of 9 persons per household. Also 94% of the farmers did not have access to credit. Result of average net farm income was ₦41525 per hectare. Results of the estimated determinants of technical efficiency in cotton production showed that age was positive and significant at 10%, while cooperative association and extension contact were positive and significant at 1% level of probability. The average levels of technical, allocative and economic efficiencies in cotton production were 0.65, 0.72 and 0.48 respectively. The socioeconomic factors that significantly influenced technical inefficiency were age of farmer, access to credit, membership of cooperatives, and farming experience; those that influenced allocative inefficiency were education, extension contacts and farming experience; and those that influenced economic inefficiency were age of farmers, access to credit, cooperative membership and farming experience. Major constraints to cotton production were low price of cotton, high cost of fertilizer, poor soil fertility, pests and diseases, inadequate rainfall, poor extension contacts, and farmers-Fulani clash. It was recommended that farmers should increase the levels of utilization of each of these inputs (fertilizer and agrochemicals) that result in an increase in the level of output of cotton. Farmers should therefore be encouraged to increase the use of these inputs to the recommended levels so as to increase the low levels of technical, allocative and economic efficiencies recorded. Governments at various levels in collaboration with private extension outfit should put in place policy measures aimed at increasing extension contacts and building the educational capacities of farmers so as to strengthen their managerial capacities which will lead to a substantial reduction in technical, allocative and economic inefficiencies. It is also recommended that farmers should be encouraged to form goal driven cooperative groups and pool their resources together to improve their bargaining power, input procurement and greater access to credit in order to increase output and income. Finally and most importantly policy measures aimed at regulating the price of cotton are hereby recommended.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Cotton (*Gossypium* spp) is one of the most important vegetable natural fibre crops. It is a soft fiber shrub, native to tropical and sub-tropical regions around the world including America, India, and Africa (Idem, 1999). The largest volume of cotton production in the world is concentrated in countries like China, United States, India, Pakistan and Brazil. These countries produced more than three quarters of world output. However, low-income countries also depend on cotton to earn foreign exchange (Anderson and Valenzuela, 2006). Anderson and Valenzuela (2006) also stated that exports of lint cotton in US, Australia, Uzbekistan and Brazil account for almost two-third of the world export. The well-known lint cotton-importing countries in the world are Pakistan, India, Egypt, United Arab Emirates, China, Korea and South Africa (Hussein, 2010).

Hussein (2010) observed that cotton has been at the heart of an agricultural revolution in cotton-producing countries in West and Central Africa. Although cotton production in Africa is not significant on a global scale, a large number of African countries remained heavily dependent on cotton. For instance, cotton accounts for 60% of foreign exchange earnings in Benin. The West and Central African producers, which had a very marginal rank in the world market forty years ago, have considerably increased their production capacity , and now account for more than one million tonnes, representing over 4% of the world production (ICAC, 2013). Between 1990 and 2007, West African cotton yield per hectare was approximately 1.1 tonnes (FAOSTAT, 2010). The area put under cotton production in West Africa and Central Africa has been estimated to be 2.4 million hectares (Alam *et al*., 2013).

The role of the crop in the economy of West and Central Africa has been very prominent. It contributes 1.3% of Gross Domestic Products (GDP) in Cameroun, 8.8% in Benin Republic and 5% in Nigeria (Levi, 2010; Fortucci, 2012; and Huseyn, 2014).

More than half of the cotton lint produced is used for making clothing and household textiles. The remainder is used to make carpet, belt, bag twins and tyre-cords (Morse *et al.,* 2011). It represents 38% of the world fibre materials. In Nigeria, prior to the oil boom, cotton was one of the main sources of foreign exchange and second largest employer of labour after the public sector (Gbadegesin *et al.,* 2007; NBS, 2013).

The seed could be processed to produce cotton-seed oil; one of the most important of the world's non-drying oils, which when processed can be used as cooking oil or margarine for soap making. As a result of its numeral industrial uses, it plays a vital role in international trade.

In Nigeria, the cultivation of cotton is not restricted to the northern savannah zones, but has spread to the derived savanna areas of Kwara, Osun, Ogun, Ondo and Edo State in the course of the last twenty years (Gbadegesin *et al.,* 2007). The cotton-producing areas in Nigeria are divided into three ecological zones, namely, the Northern cotton zone which comprises, Kaduna, Kano, Katsina, Jigawa, Sokoto, Kebbbi and Zamfara States. The North-West zone provides 60 – 65% of the cotton in Nigeria. The Eastern cotton zone comprises of Adamawa, Taraba, Yobe, Maiduguri, Bauchi and Gombe States, and produces 30 – 35% of cotton in Nigeria. The third ecological zone known as the Southern cotton zone is made up of Kwara, Niger, Kogi, Oyo, Osun, Ondo and Edo

States and contributes 5% of the total cotton production in Nigeria (Gbadegesin *et al.*, 2007; CBN, 2011).

Cotton production has a relatively long history in Nigeria. The cultivation of the crop started well before the colonial era even though it was not produced in commercial quantity until the onset of the activities of the British Cotton Growers Association (BCGA) in 1903. In 1974 the BCGA was replaced by the cotton marketing board to develop, market and gin the produce. Since then, considerable attention and resources have been devoted to the improvement of cotton production and utilization by both public and private organizations.

Cotton is grown as a cash crop by about 0.8million farmers on a total estimated area ranging from 0.6 -0.8.million hectares (Gbadegesin *et al.*, 2007). The major feature of cotton production in Nigeria is that about 80% of total production is by peasant farmers under rainfed conditions with simple tools and animal drawn-implements (Onu and Atala, 1992; Adeniji, 2007). This has resulted in farmers in tropical Africa usually obtaining low yields averaging 300 and 500 kilogram per hectare of seed cotton for July (late) and June (early) sown cotton, respectively (USDA, 2014). This yield figure is very low compared with that of her neighbours. For instance cotton yield in Ghana is 0.8 tonnes per hectare, that of Benin and Burkina Faso are 1.5 tonnes ha and 1.3 tonnes per hectare respectively (FAOSTAT, 2010). World average yield of cotton is about 1.5 tonnes per hectare (International Cotton Advisory Committee, 2013). In the year 2014, the average Nigeria yield is 232 kilogram per hectare (USDA, 2014)

Statistics on Nigerian cotton production and yield shows a fluctuating pattern, but on the average it exhibits a negative downward trend over the last ten years as revealed in Table 1.1 below:

Table 1.1 Nigerian cotton production and yield (1994 – 20014)

Year	**Production (1000 480lb.Bales)**	**Growth rate (%)**	**Yield (kg/ha)**	**Growth rate (%)**
1994	299	25.1	310	30.80
1995	459	53.51	454	46.45
1996	436	-5.01	452	-0.44
1997	322	-26.15	200	-55.75
1998	300	-6.83	218	9.00
1999	230	-23.33	179	-17.89
2000	400	73.91	249	39.11
2001	450	12.50	261	4.82
2002	390	-13.33	250	-4.21
2003	415	6.41	241	-3.60
2004	420	1.20	241	0.00
2005	400	−4.76	229	04.98
2006	400	0.00	229	0.00
2007	450	12.50	248	8.30
2008	425	−5.56	234	−565
2009	450	5.88	248	5.98
2010	475	5.56	252	1.61
2011	325	−31.58	218	−13.49
2012	325	0.00	236	8.26
2013	300	−5.69	225	−4.66
2014	320	6.67	232	3.11

Source; United State Department of Agriculture (USDA), 2014.

The peak period of cotton production in Nigeria was the year 1995 when 459,000 bales (183.43kg/bale) at a growth rate of 53% was achieved and a corresponding peak period of highest yield record of 454kg/ha at a growth rate of 46.45% (USDA, 2014). Thereafter, production started declining to the current status of about half production and yield of the year 1995. What is more disturbing is the fact that not all the reasons for the fluctuation and the general downward trend in production and growth are known. Cotton production and yield fluctuation may be due to cumulative effects of production, such as cotton farmers' technical, allocative and economic inefficiency, marketing inefficiency, and inefficiency of government policies or other institutional factors (Alam *et al.*, 2013). The impact of this is decline in farm household welfare, foreign exchange earnings and lack of raw materials for the textiles and oil mills. In the 1980s, Nigeria earned over 8.9 billion US dollars and hence the contribution of cotton to GDP dropped to an insignificant level of less than 5% (Huseyn, 2014). Also out of the 51 ginneries in operation across the country in the 1980s, only 10 are currently operating at low capacity.

1.2 Problem Statement

Cotton is one of the most important sources of income for smallholder farmers in many of the arid and semi-arid regions of Africa (UNDP, 2012). It is the number one natural fibre crop, used in textiles and it plays a very great role in international trade.

One outstanding feature of cotton production in Nigeria is the low average yield that has resulted in low marginal profitability for small-scale producers. In some cases farmers' yield fall within the range of 300 – 500kg/ha, while the yield potential of popular Institute for Agricultural Research (IAR) varieties like SAMCOT-11 and SAMCOT-12

could be up to 1200 – 1500kg/ha (Gbadegesin *et al.*, 2007). In the year 2014, the actual average yield of cotton in Nigeria stood at 232kg/ha (USDA, 2014). Because of the low production, low productivity and vulnerability to low cotton prices, climate, pests and diseases., farmers often resort to growing alternative cash crops (like sesame) to diversify their business and provide themselves with greater security and a regular supply of food resources and regular income.

Statistics on Nigerian cotton production and yield shows significant fluctuation, but on average it is on a downward trend over the last twenty years. The peak period of cotton production in Nigeria was the year 1995 when 459, 000 bales (183.45kg/bale) at a growth rate of 53.51% and a corresponding peak period of yield record of 454kg/ha representing a growth rate of 46.45% (USDA, 2014). Thereafter production started declining to the current production status of 320, 000 bales (6.6% growth rate) and yield states of 232kg/ha (3.11% growth rate) which is about half the figures of 1995. The impact of this is decline in foreign exchange, lack of raw materials for textiles and oil mills (World Bank, 2003; Bureau of African Affairs, 2010).

In the 1980s Nigeria earned over 8.9 billion US dollars from cotton. This amount represented more than 25% of the nation's GDP. The country's earning from cotton however dwindled to a mere 300 million US dollars in 2013 (Huseyn, 2014). In 1993 cotton output was roughly equivalent to the requirement of the textile industry (Andrea and Beckman, 2007). RMRDC (2004) and ICAC (2010) observed that the supply of cotton lint to textile industries in Nigeria is less than 100,000 tonnes per annum whereas the demand is over 215,000 tonnes per annum. Thus, the textile mills are forced to import over 115,000 tonnes to cover up the shortfall in local supply. The United States

Department of Agriculture(USDA) reported that in 2013 cotton production in Nigeria could only account for 38% of the requirement of the textile industries, while the remaining 62% was imported (USDA, 2014).

It is against this background of declining cotton production and yield of farmers that the federal government of Nigeria, non-government organizations, research institutes and other stakeholders in the cotton industry have teamed up with a view to address the problems of the industry in a holistic manner. A few of these efforts after the disbandment of the cotton marketing board in 1986 are the setting up of Cotton Consultative Committee (CCC) in 1994 charged with the responsibility of implementing all budget proposal on cotton development. It was also to serve in an advising capacity to the public sector and setting up of Cotton Revolving Fund Scheme (CRFS) established in 2001. In 2005, the Cotton Development Committee (CDC) was established which subsumed both the CCC and the CRFS. The CDC is a body composed of all stakeholders, both from the organized private and public sector in the cotton/textile/garment value chain aimed at re-establishing a sustainable cotton-seed multiplication/seed supply scheme.

Despite all these effort and awareness of cotton production in Nigeria, both the production and yield status are on a dwindling downward trend. This might be as a result of farmers' or other institutional factors responsible for inefficiencies in the production process. The presence of inefficiency in production connotes inability of increasing output without using additional inputs and new technology.

The decline in cotton production and other related commercial crops led to the establishment of the Raw Materials Research and Development Council (RMRDC) by the Federal Ministry of Science and Technology (RMRDC, 2004). The council was mandated to work out the modalities for improving the output of specific crops of which cotton was among these crops. Other crops covered by the RMRDC mandate are groundnut, gum Arabic, ginger, soybean and cocoa among others. This was the initial stage of collaborative effort of the RMRDC and the West African Cotton Company (WACOT) to improve the production of various varieties of cotton, based on their agro-ecological requirements (RMRDC, 2004). Similarly, research work on breeding of high-yielding, long- fibre and pest- resistant varieties of cotton has been going at the Institute for Agricultural Research (IAR), Samaru -Zaria, in Nigeria. The intention is to produce high-yielding, long staple and pest-resistant varieties for farmers. The institute has improved technological packages capable of significantly boosting cotton production in the country. In addition to the improved high-yielding varieties and disease- resistant cotton varieties earlier released which included Samaru 71 (SAMCOT-6), Samaru 77(SAMCOT-8), SAMCOT-9 and SAMCOT-10, IAR has recently released other three new varieties; SAMCOT- 11, SAMCOT-12 and SAMCOT-13. These are long staple fibre cotton with excellent fibre quality, moderate resistance to pests and diseases and high- yielding (Gbadegesin *et al.*, 2007). Long staple cotton is in great demand because of the specific fabrics that can be made with them. A complementary break-through is the determination of appropriate and adequate quantities of fertilizer needed for the different varieties of cotton. Based on the IAR recommendation, cotton requires nitrogen, phosphorus, and boron in certain cotton zones(eastern and southern cotton zone). Potassium may be necessary as well. Nitrogen (N) should be applied at the rate of 50kg N/ha, which is equivalent to 200kg (or 4bags) of Nitrochalk or CAN per hectare

in all the zones. Also, phosphorus (p_2o_5) and Boron (B) should be applied at the rates of 25kg P_2O_5/ha and 0.7 B/ha which is equivalent 140kg (or 3 bags) of boronated single super phosphate per hectare. Cotton farmers in eastern and southern cotton zones must apply 20 k/ha which is equivalent to 50kg muriate of potash (or 1 bag) per hectare (Ogunlela, 2004; Gbadegesin *et al*., 2007). These improved packages if adopted by most of peasant farmers could induce a turnaround in the ailing cotton production sector (Gbadegesin *et al.*, 2007).

Some other policy measures conceived, planned and implemented to solve some of the problems militating against increased cotton production was the institutionalization of the Federal Government Transformation agenda on cotton. Some of the policy guide lines are those enshrined in the Agricultural Transformation Action plan (ATAP) of 2012 and the federal government partnership with WACOT through signing of memorandum of understanding (MoU) aimed at increasing farmers income (Adejini, 2007).

Additionally, the federal government in September 2012 released N54 billion to boost mass production of cotton in the country (CBN, 2011). It is expected that 200, 000 hectares of land would be acquired for cultivation (Huseyn, 2014). The establishment of Cotton Consultative Committee (CCC), Cotton Revolving Fund (CRF) and Cotton Development Committee in 2005 are all parts of the policy measures aimed at boosting cotton production at various time periods in Nigeria.

It is in view of the above aforementioned that this research is desired to be undertaken. Though a number of researches have been carried out on cotton like those of Kumar and

Ogunlela (1991), Lombi and Ogunlela (1981), Ogunlela and Lombi (1991), Lagoke and Dadari (1996), the focus has been on the agronomic aspect of the crop. Little attention has been given to the economic analysis of the production technology. Even where such is considered like the studies of Alam *et al.* (2013), Adeniji (2007), Daniel *et al.* (2010), the scope and methodologies are usually limited to the traditional descriptive statistics and least square econometric approaches. Additionally most of these researches are limited to States, parts of the States and local government areas of Nigeria.

As a matter of fact,empirical studies on profitability and production efficiency in cotton farming covering the north-west zone are scanty.

In a bid to find out why this problem of low productivity is still prevalent, it then becomes necessary to analyse the profitability, productivity and resource use efficiency of cotton farmers. This study therefore seeks to find answers to the following research questions:

i. What are the socio-economic characteristics of cotton farmers in the study area?

ii. What are the costs and returns in cotton production in the study area?

iii. What are the levels oftechnical, allocative and economic efficiencies in cotton production in the study area?

iv. What are the determinants of technical, allocative and economic efficiencies in cotton production in the study area?

v. What are the constraints associated with cotton production in the study area?

1.3 Objectives of the Study

The broad objective of this study is to evaluate the profitability and production efficiency in cotton production in North-West, Nigeria. The specific objectives are to:

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

ii. determine the costs, returns and profitability of cotton production in the study area.

iii. estimate the levels of technical, allocative and economic efficiencies of cotton farmers in the study area.

iv. determine the socio-economic and institutional factors influencing the technical, allocative and economic efficiencies of cotton farmers in the study area.

v. identify and describe the constraints associated with cotton production in the study area.

1.4 Research Hypotheses

The following hypotheses were tested:

i. Cotton production is not profitable in the study area study area.

ii. There were no inefficiency effects in the model.

iii. There is no significant relationship between cotton farmers' socio-economic and institutional characteristics and their technical, allocative and economic efficiency

1.5 Justification for the Study

In spite of the economic importance of cotton for the Nigerian economy, big fluctuation in area, production, and yield still persist. During the period from 1995 to 2013 cotton production and yield dropped on the average by 50 and 45 percent respectively (USDA, 2014). On the other hand, Nigeria's cotton productivity is remarkably low compared to other cotton producing countries where best practice productivity are achievable comparable to the results achievable in research stations (Table 1.2). Cotton production fluctuations affect cotton's contribution to Nigeria's export revenue from 8.9 billion US dollars in 1980 to mere 300 million US dollars in 2013. This amount also represents a drop in cotton contribution to nation's GDP from 25 percent to less than 5 percent (USDA, 2014).

Table 1.2: Nigeria average productivity of cotton compared to the various countries.

Country	**Productivity (kg/ha)**	**Relative to Nigerian Productivity**
Nigeria	500	100
Sudan	1261	40
Egypt	2365	21
Bangladesh	1719	29
China	2668	19
Brazil	1362	37
Australia	3578	14
Pakistan	1749	29
Developing Countries	1439	35
Developed Countries	2081	24

Source: Food and Agricultural Organization (FAO), 2013.

This study is therefore very essential because of the immense contribution of cotton as a cash crop to the national economy of Nigeria. The increasing need for the country to diversify its economy and revenue base to non-oil alternatives, increasing demand for cotton lint and seed to meet the needs of textile and oil-processing and feed industries has made the study necessary as it would identify the cotton production constraints and determine the efficiency of resources used with a view to making appropriate recommendations for increased cotton production.

Efficiency is an important factor in productivity growth. In an economy where resources are scarce and opportunity for new technologies is lacking, it is possible to demonstrate the possibility of raising productivity by improving efficiency without increasing the resource base or developing new technology. Measurement of the extent and determinants of efficiency indicates which aspects of farm characteristics can be addressed by public investment to improve efficiency. Therefore it is important to identify and examine the socio-economic attributes of cotton farmers, production constraints, resources use and utilization pattern so as to determine their effects on seed cotton profitability and production efficiency. The result of this study will be of immense benefit to the farmers, and stakeholders in the agricultural industry and institutions, as it will help highlight those variables that could be better managed to improve productivity and production efficiency in cotton farming. The study will also guide policy makers and researchers in conducting researches for improving the production of cotton in Nigeria through the evaluation of strategies that will lead to increased yields and pest and disease-resistant varieties as well as provide solutions to the problems of declining cotton production in Nigeria. It will also help policy makers

in making policies for the improvement of the welfare of cotton farmers, which will give room for the expansion of cotton production, increased employment and the overall economic growth of the nation.

Furthermore, the research will serve as a "spring-board" for further research by public and private institutions particularly on the aspects not covered in this study. The outcome of the study should provide information on the profitability or otherwise of cotton production so that investors, donor agencies, none governmental organizations, development partners and private companies wishing to invest and sponsor intervention programs that will improve on the production efficiency and profitability of cotton farming decisions in the study area.

CHAPTER TWO

LITERATURE REVIEW

2.1 Origin and Distribution of Cotton

The English word cotton (*Gossypium hirsitum*) comes from the Arabic word *Qutun* or *Kutun*. Cotton is the most important of all fibrous plants used by man for clothing. The time cotton fibre was first used by man is not known. The oldest archaeological record of cotton textile dated back to about 3,000B.C which was found in the valley of the Indus River in West Pakistan (Fisher, 1969).

Americans grew their own species of new world cotton. Majority of the true-to-type cotton are cultivated and most of those found wild can be identified as escapes from cultivation. The earlier botanist regarded the cultivated forms as having been domesticated from wild cotton species (Prentice, 1972). The exact origin of the crop is not known with any degree of certainty. According to Cooper (1990), cotton might have originated from Central and South America.

Globally, cotton is the most important commercial crop and plays key role in economic, political and social affairs of the world (ICAC, 2013). It is cultivated in about 60 countries of the world and 10 countries, namely USA, former USSR, China, India, Brazil, Pakistan, Turkey, Mexico, Egypt and Sudan, account for nearly 85 percent of total production.

2.2 Economic Importance of Cotton

In producing cotton, the main product is lint. For purpose of processing into usable items, cotton seed is divided into five main products namely, cotton lint, cotton seed, cotton seed oil cotton seed cake or meal and cotton seed hulls.

The lint is the soft hair around the seed called floss. It is made of cellulose which serves as raw material in the textile industries for the manufacture of large proportions of adsorbent fabric for clothing as a natural textile fibre. Despite the declining trend of cotton share in textile fibres since 1970s, cotton still remains the most important natural fibre of the 20^{th} century and represents 30% of the fibre market in the early 2000s(Horton and Mackoy, 2003). The lint is used extensively to produce thread after spinning. This forms the basis of the textile and fabric industries which depend on mass utilization of thread to weave and produce fabric and cloths.

Moreover, cotton is a fibre which is highly valued for apparel. Another aspect of cottons versatility lies in its adoptability for use to manufacture wears suitable for warm as well as cold weather (Maigizoh, 1981). Cotton is also used widely in hospitals, medical centres and clinics for cleaning and dressing of wounds in surgical operation and other orthopaedic uses. At home, it is used domestically as bedding and cushioning materials. The lint is also used as wick when soaked in oil to serve as illuminant in the rural areas.

More than half of the cotton lint produced is used to make clothing and household textiles. The reminder is used in industry to make bag, belts, twins, and tyre-cords. The short lint is used in carpet, batting and as filling materials for pads and cushions. The fuzz (linters) on the seed is used to make felts, upholstery, mattresses, twin, carpets,

surgical cotton, and in chemical industries for the production of rayon, plastics, paper and photographic film.

Cotton seed contains 30% hulls, 60% kernels or meats, 5% fuzz and 5% waste. The chemical composition of cotton seed is 30% starch, 25% semi-drying oil, and 16-20% protein (Huseyn, 2014). Cotton seed is processed to produce cotton seed oil, one of the most important of the world's nondrying oils. After it has been refined, the oil is used for cooking, in the manufacture of lard substitutes and margarines, and for making soap. Cotton- seed meat, containing up to 41% protein by weight, is now used as protein supplement in human diet (Fortucci, 2012).

Cotton-seed cake, containing 21% protein, constitutes a high protein feed for ruminants. It is somewhat toxic for poultry unless it is treated to eliminate the toxin, gossypol (ICAC, 2013). It may also be used as a nitrogenous fertilizer. Cotton-seed hulls are used as roughage for livestock and as livestock bedding, fertilizer and fuel. The dried plant is used as fuel.

The importance of any commodity to the nation depends on its usefulness to the development and growth of the economy. Prior to the discovery of petroleum in large quantities in Nigeria, agriculture contributed over half of the Gross Domestic Product (GDP) (Joshua, 1999). Cotton contributed substantially to the agricultural share of the GDP (Idem, 1999). Over 70% of Nigerian population is engaged in agriculture. It was also estimated that about 0.8 million farmers grow cotton on a total estimated farmland of between 700,000 and 800,000 hectares (Olukosi and Isitor, 1990; Idem, 1999). In 1980s, Nigeria earned over 8.9 billion United States Dollars from cotton. This amount

represented more than 25% of the Nations GDP (Huseyn, 2014). As at 1982, textile mills were estimated to have in their employment about 100,000 workers, this is apart from other employment opportunities created by industries such as tailoring, hospital dressing producers, oil mills, specialty paper mills, insulation and packaging companies and feed mills which use cotton as primary raw materials. Annual business revenue stimulated by cotton in the Nigerian national economy is in excess of one hundred billion Naira and contributed over one million jobs. This therefore makes cotton Nigeria's number one value-added crop (FMARD, 2013).

2.3 Cotton Production in Nigeria

2.3.1 Cotton production zones in Nigeria

Production of cotton in Nigeria was traditionally aimed at overseas market, which required lint of relatively short staple that is about one inch in length (Foster, 1966). According to Foster (1966), Jones (1968), Maigizoh, (1981) and Idem (1999), commercial production of cotton in Nigeria was pioneered by the British Cotton Growing Association (BCGA) in 1903, but is presently known as Cotton and Agricultural processors Limited (CAPL). However, the first recorded commercial production was in 1939/40 when 47,270 bales were produced and exported. The year 1969/70 was the year Nigeria made the most significant efforts in cotton production (ACE, 2003; Bello, 2004).

Foster (1966) identified Bauchi as most promising area in the eastern cotton zone where longer staple cotton could be produced at full capacity even without irrigation system. He stated further that strict supervision would be essential if 10,000 acres expected to satisfy the needs of the industry were to be cultivated. He added that longer staple

cotton could also be grown in south-west of Lake-Chad (Yobe and Ekezi Rivers) and north-west of Sokoto province under irrigation system.

According to Idem (1999), cotton production started from the south-west zone of Nigeria but commercial cotton production in the last fifty years has been ongoing in two major zones in the northern States of Nigeria. The northern cotton zone which is made up of the present north-west zone, comprising Kaduna, Kebbi, Sokoto, Zamfara, Katsina and Kano States. The north-west zone produces about 60 percent of total cotton crop. The north-east zone which accounts for about 35 percent of the total production comprises Borno, Adamawa, Gombe Yobe, Bauchi Taraba and Jigawa States. The remaining 5 percent comes from the southern cotton zone which is designated as the central zone comprising Niger, Kwara, Kogi, Nasarawa, Taraba, Plateau and Benue States (Idem, 1999 and Mshelia, 1991)

Both the northern and eastern cotton zones produce short to medium staple length cotton while the central zone produce long and extra-long staple cotton because of the longer duration of rainfall in the latter. Today, Katsina State has become the largest producer cotton producing 90,000 – 100,000 metric tons of cotton over the last five years (FMARD, 2013).

According to RMRDC (2004) consumption of cotton lint by textile industries in Nigeria is about 100,000 metric tonnes plus or minus 15%. Textile mills are therefore forced to import 15,000 metric tonnes of cotton in order to cover the shortfall in local supply and for certain specific requirements for finer yarns such as 30-40 inches, which is not grown locally. It is therefore clear that local supply is not enough to meet the demand

for the product. The report further stated that against a total demand of about 80,000 metric tonnes of lint per annum (240,000 metric tonnes of seed cotton) by textile mills, the total production of lint has been less, thus resulting in a gap between demand and supply. It is expected that this gap will widen further as the steps taken by government to revive the textile industry may lead to increases in capacity utilization, thus resulting in higher demand for cotton (Alam *et al*., 2013). Table 2 below based on USDA (2014) statistics give a summary of cotton import and export in Nigeria over the last twenty years (1994-2014). The table shows steady importation cotton over the six years (2009-2014) and so also steady growth rate of importation of cotton in the country. This is a reflection of the inability of local supply to meet local demand. The export growth rate was unsteady with variations over the same period.

Table 2.1 Nigeria cotton import and export by year (1000 480lb Bales) 1994-2014

Market year	Import	Growth Rate (%)	Export	Growth Rate
1994	115	15.00	0.00	NA
1995	46	-60.00	0.00	NA
1996	46	0.00	70	NA
1997	69	50.00	0	-100.00
1998	70	1.45	90	NA
1999	70	0.00	75	-16.67
2000	70	0.00	135	80.00
2001	70	0.00	75	-44.44
2002	70	0.00	100	33.33
2003	70	0.00	90	-10.00
2004	70	0.00	100	11.11
2005	70	0.00	126	25.00
2006	75	7.14	125	0.00
2007	70	-6.67	150	20.00
2008	50	-28.5	126	-16.67
2009	50	0.00	225	80.00
2010	50	0.00	225	0.00
2011	50	0.00	100	-55.56
2012	50	0.00	100	0.00
2013	50	0.00	90	-10.00
2014	50	0.00	100	11.11

SOURCE**:** United States Department of Agriculture (USDA), 2014.

2.3.2 Nigeria's cotton development programmes: past and present

The Nigerian cotton sector has suffered major disorganization since the dissolution of the Cotton Marketing Board (CMB) in 1986. The disorganization has not only resulted in significant reduction in output, but has also caused a major fall in quality. The decline in quality has aggravated to the extent that Nigerian cotton was declared in 2001/2002

as “contaminated”. This implies that it did not meet any international standard, hence cannot be traded in international markets.

Concerned about the decline in quantity and quality, the Federal Government of Nigeria (FGN) with the collaboration of a number of cotton-producing states, and the private sector established a Cotton Consultative Committee (CCC) in 1994, and a Cotton-Revolving Fund Scheme to rehabilitate the seed production system. In response to concerns expressed by international Cotton Advisory Council (ICAC), on the quality of Nigerian Cotton.

The Federal Ministry of Commerce commissioned in 1999, a study to provide recommendations for the improvement of the performance of the cotton sector. The report of the study was submitted in June 2000 but no progress was made on implementation of the recommendations until March, 2002. The National Committee on Cotton Improvement was inaugurated and charged with the responsibilities of implementation of measures to rehabilitate the cotton sector. These measures involve re-establishing an orderly process for the production, processing, marketing, and trading of cotton to ensure the production of high-quality cotton. Later in 2005, the NCC metamorphosed into the Cotton Development Committee (CDC). The CDC is a body composed of all stakeholders, both from the organized private and the public sectors in the cotton/textile/garment value chain. The mission of the Committee includes:

(i) to re-establish a sustainable cotton-seed multiplication/seed supply scheme for annual planting;

(ii) to sanitize the cotton quality control/assurance system and reduce contamination to the barest minimum by gradual placement of polypropylene with cotton clothes or jute bags in the immediate medium terms;

(iii) to revive the cotton textile mills, most of which have shut down in recent times, and establish a Textile Development Fund, to upgrade obsolete mills in liaison with the Presidential Committee on Revival of the textile Industry;

(iv) sensitize the public, especially stakeholders with business opportunities and the need for better management practices, and the production of non-contaminated cotton.

In furtherance of the objectives of the cotton development committee, in 2007 season, about 14,000 hectares of pure seed (Breeder, Foundation, and Certified) are cultivated across all growing zones, to source and supply certified seed for planting in the 2008-2009 season. Besides training on better management practices have been conducted for all project operatives, while assorted publications (guides, bulletins, posters leaflets, etc.) have been produced and distributed to the 24 cotton growing States to educate and guide stakeholders (FMARD, 2013).

Research on cotton is primarily the responsibility of the Institute for Agricultural Research (IAR), Ahmadu Bello University, Samaru-Zaria. Its cotton and fibre crop development program handles development of packages of recommendations for use by cotton farmers. The main components of the packages include improved varieties, time of planting, plant density, fertilizer recommendation and crop protection (Gbadegesin *et al*., 2007)

2.3.3 Cotton in the Nigerian farming system

Majority of farmers involved in cotton production in Nigeria are small-holders. They produce many crops of interest to them. This category of farmers cultivate between 0.3 to 2 hectares of farmland, intercropped with food crops like maize, sorghum, millet and cowpea (Idem, 1999). However, many of the cotton merchants are large-scale growers, who grow sole cotton crop and even sponsor some small-scale farmers in cotton production alongside their farms under the out growers or contract grower scheme.

2.4 Socio-Economic and Institutional Characteristics of Cotton Farmers in Nigeria

In a study on resource use efficiency in cotton product in a Gassol local government area of Taraba State, Nigeria, Gwandi *et al*. (2010) found that 88.2% of the cotton farmers were between 21 to 60yrs of age. This indicated that they were young and energetic people. Similarly, in a study of economic analysis of cotton production in selected local government areas of Taraba State, Nigeria. Alam *et al.* (2013) found the mean average age of cotton farmers to be 35 years. They all suggested the reason for the predominance of younger people in cotton production to be due to its labor intensive nature in production which requires young and energetic farmers. Other reasons suggested were that young farmers are more agile, aggressive, energetic and capable of making good production decisions. Young farmers also have the potentials for productivity, and hence are likely to be more efficient in cotton production than older farmers. This finding agrees with the finding of Ibrahim (2008) who reported a significant relationship between farmers' age and efficiency. The result also suggests that a lot of young people can be gainfully employed in the cotton farming enterprise.

As for the experience of the farmer in cotton farming, Daniel *et al.* (2010) found that only 40% of cotton farmers had 6 to 10 years of experience in cotton production, while Alam *et al.* (2013) reported that 30% of the farmers had 6 – 10 years.

Gender analysis of cotton farmers by Alam *et al.* (2013); Daniel *et al.* (2010) and Gwandi *et al.* (2010) showed that on average 85% of cotton farmers in all their studies were male showing the dominance of male in the cotton farming enterprise, again signifying the intensive capital requirement and hard labour associated with cotton production. The level of education of cotton farmers in all the studies was not encouraging. Daniel *et al*. (2010) in their studies found that 43% of the cotton farmers did not have any formal education.

In their separate studies Daniel *et al.* (2010), Gwandi *et al.* (2010) and Alam *et al.* (2013) found that over 80% of the farmers have an average farm size ranging from 0.5 – 4 hectares. Similarly, the average family size of 11 persons and above was recorded by over 60% of the cotton farmers. This larger family size implies availability of family labour to meet the labour requirement for most of farm operation in cotton production.

The major source of capital for financing the cotton production enterprise was through personal saving as reported by Gwandi *et al.* (2010). 67% of cotton farmers sourced their capital through personal saving. However, Daniel *et al. (2010)* in his study found that 65% of the cotton farmers got their credit from one institutional source (Afcott Nigeria Plc). The existence of some cotton companies (WACOTT and Afcott Nigeria Plc) in Adamawa State boosted the extension contact with cotton farmers as all the farmers in the study by Daniel *et al.* (2010) have had contact with extension agents of

which 59% were contacts with extension agents of Afcott Nigeria Plc, 30% claimed to have their extension contact from West African Cotton Company (WACOTT) and 11% has their extension contacts with Agricultural Development Project (ADP) staff. In the absence of these private extension contact outfits, the cotton farmer to extension officer ratio would have been very low, so also would have been the level of financing. Extension contacts are channels through which Agricultural innovations are passed to farmers for improvement in their standard of living (Daniel *et al*., 2010).These agents are also responsible for helping farmers source for quality and affordable form inputs like fertilizer, improve seeds and chemical (Alam *et al.,* 2013)

2.5 Profitability and Production Efficiency in Cotton Production in Nigeria

2.5.1 Net farm income

Odedokun (2014) in his study on economic analysis of cotton production and supply trend estimation in Zamfara State, Nigeria using net farm income method revealed that the net farm income realized was N64,419.33 when only hired labour was valued. When both family and hired labour were valued the estimated net farm income becomes reduced to N51, 414.51. Alam *et al*. (2013) estimated a net farm income of N21, 172.12 in Taraba State, Nigeria.Daniel *et al.* (2010) estimated a net farm income of N10, 178.15 per hectare for Adamawa State, Nigeria. In a similar study by Ibrahim (2008) on the economics of sole cotton production, N0.76 was estimated as the return to investment in Taraba State. This therefore indicated that cotton production was a profitable farming enterprise in all these studies.

2.5.2 Input-output relationship in cotton production

Daniel *et al*. (2010) in his study on net income analysis and efficiency of resource use among cotton farmers in southern Adamawa State, Nigeria estimated the coefficient of multiple determination (R^2) of 0.86 and the coefficients of land, seed and labour were positively related to farmers' output. Odedokun(2014) in his study on cotton production and supply trend estimation in Zanfara State, Nigeria showed that the estimated coefficients for most inputs were positive except for family lobour and hired labour which were negative. These results showed the importance of land and labour in cotton production especially in Nigeria where cotton harvesting is done manually. Daniel *et al*. (2010) further states that "despite the role of chemicals to control pests and fertilizer to augment soil fertility, these variables were not significant and have negative effects on farmers' income". They attributed this to high cost of inputs thus increasing the farmers' cost of production making them inaccessible to most farmers or where applied are not adequate enough. In a similar study, Gwandi *et al*. (2010) in his study on resources use efficiency in cotton production in Gassol local government area of Taraba State, Nigeria using the Cob-Douglas production function estimated an R^2 value of 0.82 indicating that about 82 of the variation in output of cotton is explained by the factor inputs. Similarly, all the estimated variables have positive coefficients except farm size and family labour which have negative relationship with output. Cotton production has an increasing return to scale of 17 for the sum of elasticity of production (Gwandi *et al*., 2010).

2.5.3 Resource-use efficiency in cotton production

In their study on resource-use efficiency, Daniel *et al*. (2010) revealed that none of the resources was efficiently allocated by the famers. Land, chemical and transport were greater than unity, while labour seed and fertilizer were less than unity. Similarly, Gwadi *et al.* (2010) noted that these resources were over utilized in cotton production.

Odedokun (2014) derived the sum of elasticity from Cobb-Douglas equation as 0.791 in Zamfara State, Nigeria. This is positive decreasing return to scale at stage II of production process where every farmer strives to maximize profit and minimize cost of production. On cotton farmers' technical efficiency indices, the result from the study in Zamfara State showed the maximum technical efficiency score index was 0.97 with a mean technical efficiency index of 0.67. This showed that output falls by 23% due to farmers' technical inefficiency Similarly, the result revealed a maximum allocative efficiency score index was 0.97 and the mean allocative efficiency score index was 0.64 in cotton production This implied that cotton farmers' output fall by 36% due to farmers' allocative inefficiency in Zamfara State. The farmers' mean economic efficiency score index was 0.44 with the minimum being 0.01 while the maximum economic efficiency score was 0.81. The result showed that farmers' output fall by 56% due to economic inefficiency.

2.6 Increasing the Profitability and Production Efficiency in Cotton Production

Cotton in one of the most important sources of income for small-holder farmers in many of the arid and semi-arid regions of Africa. However, profitability for small producers is often marginal due to average yields that are well below the potential of the varieties grown under rainfall conditions (Gwandi *et al*., 2010). Cotton yield (and hence profitability) are low mainly due to poor quality planting seeds, poor and untimely land

preparation, inadequate pest control measures, unattractive commodity prices and climatic influences.

Increasing the profitability from cotton growing is through the adoption of best practices for production of cotton. These practices include cotton variety selection and seed health, agronomic and tillage practices, soil health and fertility management, harvesting and post harvesting management (Samarendu *et al.*, 2013). It also requires developing the farmers' skills and knowledge to understand the economic fundamentals of farm management. Appropriate agronomic practices that produce a high-quality uniform crop will generally contribute to good harvesting efficiency.

There is a wide scope for improvement in production efficiency and hence profitability in the small holder cotton sector. This may be done by placing the initial emphasis on profitability for the grower, rather than increasing yields. This can be addressed by ensuring that systems are in place to maximize the benefits of input use through integrated crop management practices, backed by greater investment in the provision of technology and associated support services. One way to do this is to encourage input and service delivery by the private sector (ginning companies) through vertically integrated commodity chain (Anthony, 2011).

For better yield and profitability in cotton production cultural practices such as fertilizer application and cultivation during the growing season should be carefully managed to produce uniform crops of well-developed cotton. Current production trend in cotton production is towards a shorter season and one-time harvest cotton crop.

Other notable areas of cotton production for better profitability are the timing of harvesting and storage. Fibre quality is highest the day cotton ball opens. So, prolonged delay in harvest reduces cotton fibre quality. The moisture content of cotton before and during storage is critical as excess moisture causes stored cotton to overheat, resulting in lint discoloration, lower seed germination and possibly spontaneous combustion. Seed cotton with moisture above 12% should not be stored (Gbadegesin *et al.*, 2007).

For better profitability and marketability it is important for cotton farmers to note the many factors that indicate quality of cotton fibre are variables upon which international market fixes the prices of cotton. The most important ones include strength, fibre length uniformity, maturity, fineness, trash content, colour, seed coat fragment content, and stickiness (Anthony, 2011).

Several factors that play an important role in achieving a good stand of cotton plant include seed-bed preparation, soil moisture, soil temperature, seed quality, seed disease infestation, fungicide and soil salinity. Cotton free of weeds is essential to obtain high lint yield and quality. Cotton yields and harvesting efficiency can be reduced by as much as 30% by weed (Gwandi *et al.*, 2010).

2.7Theoretical and Conceptual Framework

The purpose of this section is to review the theories and concepts related to this study.

2.7.1 Concept of productivity in agriculture

Agricultural productivity may be defined in general terms as the ratio of the value of total farm output to the value of total inputs used in farm production (Olayide and

Heady, 1982). The ultimate objective or the interest of economist in productivity should be to find ways of increasing output per unit of input, and of attaining desirable inter-firm, intra-firm, and inter-sector transfer of production resources, thereby providing the means of raising the standard of living. A meaningful assessment of productivity depends upon a clear and precise definition of inputs in such a way that their movements over time are not equal. Determining which inputs and outputs are consistent with the particular concept of productivity in question is important. Sometimes one is faced with separate and distinct conditions when measuring labour, capital, or land productivity (IFPRI, 2013). In other words, "resource productivity" may be defined in terms of an individual resource input or in terms of a combination of such inputs. Maximum resource productivity implies obtaining the maximum possible output from the minimum possible set of inputs. A change in productivity overtime will depend upon changes in the types and quantities of inputs.

The basic concepts in productivity measurement are Average Product (AP), Marginal Product (MP), Marginal Rate of Substitution (MRS), Elasticity of Production (E.P) and Returns to Scale (RTS). The average product of an input is total product divided by the amount of the input used to produce this output. Thus average product is the output-input ratio for each level of output and the corresponding volume of input. The marginal product of an input is the addition to total product attributable to the addition of one unit of variable input to the production process, the fixed input remaining unchanged. The marginal rate of substitution measures the reduction in one input per unit increase in the other that is just sufficient to maintain a constant level of output. According to Olayide and Heady (1982), elasticity of production is the relative change in output divided by relative change in input used. We can establish the rate of return in three main ways as

discussed in orthodox economic theory. The first of these returns is the case of constant returns. This states that each additional unit of input results in a constant rate of increase in output. The second of these rates of return is that of increasing returns. This states that each additional input of productive resources results in a larger increase in product than the preceding unit. The last of the three returns is the case of decreasing and/or diminishing returns. This is the case in which each additional unit of input results in a smaller increase in product than the preceding unit (Olayide and Heady, 1982).

2.7.2 Input and output relations in a production process

The production process is one whereby some goods and services, called inputs are transformed into other goods and services, called output. In agriculture, the physical inputs are usually land, labour, capital management, and, of recent water resources. These resources can be organized into a farm-firm or a production unit, whose ultimate objectives may be profit maximization, output maximization, cost minimization, or maximization of satisfaction, or a combination of all of these motives of enterprise (Olayide and Heady, 1982).

Inputs are usually mixed in a production process to produce output. Inputs can be combined in many different ways and levels to result in output. According to Olayide and Heady (1982), inputs could he fixed or variable. A fixed input is necessary for production but its quantity remains constant irrespective of quantity of output produced. However, the quantity of variable input changes with the level of output produced.

The technical relationship between inputs and outputs in any production process is usually expressed as a production function (Olayide and Heady, 1982). However, the

Cobb Douglas functional form is commonly used for its simplicity and flexibility coupled with the empirical support it has received from data for various industries and countries (Desai, 1976). The non-linear form of the Cobb-Douglas production function is given as thus;

$Y = b_o X_1^{b1} X_2^{b2} ..... X_n^{bn} + e.$

The linearised Cobb-Douglas production function is widely used in economic analysis can be expressed as follows:

$LogY = b_0 + b_1 logX_1 + b_2 logX_2 + \ldots\ldots\ldots\ldots\ldots\ldots + b_n logX_n + e$

Where:

Log Y = output

log X_1 …..logX_n = various inputs used in the production process

e = random error term

b_0 = constant term

Three functional forms of the above equation, linear, double log and quadratic are normally estimated to find the best fit and used as the lead equation. Selection of the best is based on the value of the coefficient of multiple determination (R^2 value), the sign of the regression coefficient and the significance of the t-value.

2.7.3Concept of production efficiency in agriculture

The production efficiency of a farm/firm refers to its success in producing as large amount of output as possible given a set of inputs (Olayide and Heady, 1982). It is the

use of resources in such a way as to maximize the production of goods and services (Olukosi and Erhabo, 2008).

The crucial role of efficiency in increasing agricultural output has been widely recognized by researchers and policy makers alike. It is no surprise; therefore, that considerable effort has been devoted to the analysis of farm production efficiency in developing countries (Tanko and Opara, 2010). An underlying premise behind much of this work is that if farmers were not making efficient use of existing technology, then efforts designed to improve efficiency would be more cost-effective than introducing new technologies as a means of increasing agricultural output (Belbase and Grabowski, 2005). Optimal productivity of resources implies an efficient utilization of resources in the production process.

2.7.4 Approaches to measuring resource use efficiency

The marginal value product (MVP) of the resources used is estimated by multiplying the marginal physical product (MPP) and the price of the output. The value is then compared with the cost of the resources (marginal factor costs MFC) in order to make inference on efficiency of resources used. The following is estimated to determine the efficiency of resources used.

$$r - \frac{MVP}{MFC} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \; 1$$

Where:

r = resources use efficiency ratio

r = 1, implies resources employed by farmer are efficiently utilized

$r > 1$, implies resource employed by the farmer are under utilized

$r < 1$, implies resources employed by the farmer are over-utilized.

The elasticity of production is the measure of the percentage change in output relative to percentage change in input, while return to scale is the behaviour of output when all the inputs are varied simultaneously in the same proportion that is, the responsiveness of output to a proportionate change in the input.

The sum of all the elasticity of input used in the production process indicates the nature of the return to scale associated with the production system. According to Gujarati (2004) if this sum is equal to 1, there is a constant return to scale, indicating that a 1% increase in the specified inputs will result in a 1% increase in output. If the sum of elasticities is less than 1, there is a decreasing return to scale which implies increasing the utilization of each of these inputs by 1% will contribute to less than 1% increase in output,and if elasticity is greater than 1, there is increasing return to scale, which shows that a proportionate change in all the variable inputs would lead to a more than proportionate change in the output.

The constant return to scale principle states that each additional unit of input results in a constant rate of increase in output. The second of these rates of return is that of increasing return to scale. This states that additional input of productive resources results in a larger increase in product than the preceding unit. The decreasing return to scale is the case in which each additional unit of input result in a smaller increase in product than the preceding unit (Olayide and Heady, 1982).

2.7.5 Measurement of production efficiency in agriculture

In order to assess farm/firm efficiency in production economics, complementary observations of the operator's behaviour can be modelled, depending on the research question and data availability (Okoruwa and Ogundele, 2008). The operator theoretically behaves as a profit-maximizer or cost-minimizer when choosing the optimal bundle for the farming process. Efficiency measures provide an indicator of performance. In conformity with micro-economic theory, production processes are technical relations of employed inputs to maximum attainable output.

To prevent waste of resources, efficiency is of great importance for every sector of the economy. Olukosi and Erhabor (2008) defined efficiency as the quantity of output (Y) per unit of input (X) used in the production process. According to Olayide and Heady 1982 and Tim *et al.* (2012), there are three types of efficiencies; these are technical, allocative and economic (or cost) efficiency.

(i) Technical efficiency. Farrell (1957) defined technical efficiency (TE) as the ability of a firm to produce maximum output from a given set of inputs. It reflects the ability of a firm to choose an optimal set of inputs. Omotosho *et al.* (2008) point out that technical inefficiency arises when actual or observed output from a given input mix is less than the maximum possible. Okoruwa and Ogundele (2008) maintained that the technical efficiency of a firm is characterized by the relationship between observed (actual) production and some ideal or potential production. The measurement of firm specific technical efficiency is based upon deviation of observed output from the best production or efficient production frontier. Accordingly, if a firm's production point lies on the frontier, the firm is perfectly efficient. If it lies below the frontier, it is

technically inefficient, with the ratio of the actual to the potential defining the level of efficiency of the firm/farm (Okoruwa and Ogundele, 2008). Technical efficiency improves in any of the following situations:

(a) Where it is possible for a firm to produce with the given know-how, a large amount of output from the same inputs or

(b) Thesame output with less of one or more inputs without increasing the amount of other inputs (Yusuf and Adenegan, 2007).

(ii)Allocative efficiency (AE) is the ability of a firm to choose optimal input levels for a given factor price (Ogundari and Ojo, 2006., Okoruwa and Ogundele, 2008). It is the ability to choose the level of input that maximizes profit given factor prices. According to Olukosi and Ogungbile (1989) and Haruna *et al. (*2008), allocative efficiency is the extent to which farmers make efficient decisions by using input up to the level at which their marginal contribution to production value is equal to the cost of the factor or input. Allocative efficiency is achieved at the point when the marginal value product (MVP) equal the marginal factor cost (MFC). The MVP is calculated from the respective regression coefficient using appropriate optimum level of output price, depending on the lead equation of the functional form. The MFC is the market price of one unit input. An efficiency ratio of unit means economically optimum allocative efficiency. A ratio of less than one implies that input is being over-utilized while a ratio of greater than one means the input is under-utilized (Olukosi and Ogungbile 1989; Haruna*et al.*, 2008).

(iii) **Economic efficiency** (EE) also referred to as the overall performance measure and is equal to the product of TE and AE (That is, EE = TE X AE). An economically efficient input/output combination would be both on the production frontier and

the expansion path (Ogundari and Ojo, 2006).Economic efficiency is concerned with the relativity of value of unit output to unit cost of resources used in production. It exists when the marginal value product (MVP) is not different from the marginal factor cost (MFC) (where MVP=MFC). In other words, to achieve economic efficiency, the ratio of MVP and MFC must be equal to one. It occurs when a firm chooses resources and enterprises in such a way as to attain an economic optimum, so as to achieve maximum profit. Economic efficiency, however, depends on market forces, which in turn, are influenced by the sectorial and marketing policies of government (Nwachukwu and Onyenweaku, 2007). Maximum efficiency of a firm is attained when it becomes impossible to reshuffle a given resource combination without decreasing the total output (Umoh, 2006).

In general, efficiency measurement has given rise to specification of various estimation methods. Kalaitzandonakes *et al.* (1992) grouped these methods into two broad categories: parametric and non-parametric methods.

2.7.5.1 Data envelopment analysis

Data envelopment analysis (DEA) is a non-parametric deterministic methodology for determining relatively efficient production frontier, based on the empirical data on chosen inputs and outputs of a number of entities called decision-making units from the set of available data. It applies the mathematical programming to measure efficiency, not imposing restrictions on the data set. DEA identify reference points (relatively efficient decision making units that define the efficient frontiers (as the best practice production technology, and evaluates the inefficiency of others interior points (relative inefficient decision making units) that are below that frontier. Theoretically, a

production frontier defines the maximum output attainable for a given level of input use (Neff *et al.*, 2010).

The essential characteristics of a linear programming problem are that, there is a function or objective to be maximised or minimised, there are limited resources to be used in the satisfaction of this objective and there are numerous means of using the resources available. Most resource allocation decisions faced by farm managers which have these characteristics can be evaluated through DEA.

DEA approach as a linear programming method construct a surface, or frontier around the data, thus efficiency is measured relative to this frontier, where all deviations from frontier is assumed inefficiency (Hazell and Norton, 2006). The DEA as a linear programming model may be specified as follows based on Kumbhakar and Lovell (2000).

Max. gross return Z = $\sum_{j=1}^{n} C_j X_j$ [j = 1, 2, 3……n]

Subject to

$$\sum_{j=i}^{m} a_{ij} X_j \leq b_i$$

Where;

Z = objective function

X_j = the quantities of the activities where there are n activities to be achieved

C_j = net price per unit of activity with n activities

a_{ij}……α_{ij} = resources required per unit of activity.

b_i= available productive resources in limited supply

m = number of resources

n = number of activities.

Alternatively, the DEA model for estimating technical, allocative and economic efficiency may be specified as follows based on Coelli *et al*., (2002)

$$\text{Min}_{\theta}\ \theta$$

Subject to

$$-yi + Y\lambda \geq 0,$$

$$\theta\chi_i - X\lambda > 0,$$

$$N1^{i}\lambda = 1,$$

$$\lambda = 0,$$

Where θ is a scalar, *N*1 is an*N*x1 vector of ones, and λ is an *N*x1 vector of constant. The value of θ obtained is the technical efficiency score for the i-th farmer. It will satisfy: θ ≥1, with a value of 1 indicating a point on the frontier and hence a technically efficient farmer, according to Farrel (1957). The linear programming problem must be solved *N* times to obtain the value of θ for each farmer, firm or farm if comparing for farms.

The DEA problem in the above equation has an intuitive interpretation. The problem takes the i-th farmer and then radially contracts the input vector, $\chi_{i,}$ as much as possible, while remaining within the feasible input set.

The allocative and cost efficiency are obtained by solving the following additional cost minimising DEA problem:

$$\text{Min}_{\lambda\chi i} \cdot w_i^{'}\chi^{*},$$

Subject to

$$-y_i + Y\lambda \geq 0,$$

$$\chi^{*}_{i} - X\lambda \geq 0,$$

$$N1^{'}\lambda = 1,$$

$$\lambda \geq 0,$$

Where:

w = vector of inputs prices for the i-th farmer

χ^* = the cost-minimising vector of input quantities for the i-th farmer, given the input prices w and the output levels y_i.

The total cost efficiency (CE) of the i-th farmer is calculated as;

$$CE = w'_i \chi^*_I / w'_i \chi_i.$$

That is, CE is the ratio of minimum cost to the observed cost for the i-th farmer. The allocative efficiency (AE) is calculated using

$$AE = CE/TE.$$

Compared to the regression analysis, Data Envelopment Analysis provides an alternative approach, while regression analysis relies on central tendencies. The DEA is based on external observations, while in regression approach, a single estimated regression equation is assumed to apply to each observation vector. DEA analyses each vector separately, producing individual efficiency measures relative to the entire set under evaluation (Desai, 1976).

The main advantage of DEA is that, unlike the regression analysis, it does not require a prior assumption about the analytical form of the production function, instead, it constructs the best practice production function solely on the basis of observed data and therefore the possibility of misspecification of the production technology is minimized (Mal *et al.*, 2011). Other outstanding advantages of the DEA are that it can accommodate multiple outputs and inputs. In addition, the econometric theory has yet to develop for in cooperating spatial correlation into stochastic frontier model (Helfand and Levine, 2004). DAE is less data demanding, works with small sample, and does not

require knowledge of the proper functional forms of the frontier, error and inefficiency structure.

On the other hand the main disadvantage of DEA is that the frontier is sensitive to extreme observations and measurement errors (the basic assumption is that random errors do not exist and that all deviations from the frontier indicate inefficiency. In other words, the DEA method has been criticized for its inability to account for errors and to test for significance of the efficiency measures (Mal *et al*., 2011).

2.7.5.2Stochastic frontier approach

The stochastic frontier production function was independently proposed by Aigner *et al.* (1977) and Meeusen and Van den Broeck (1977). The stochastic production function as defined Aiger *et al*. (1977) is expressed as;

$$Y_i = f(x_b\beta) + E_i \quad \ldots\ldots 4$$

$$E_i = v_i - u_i \quad \ldots\ldots 5$$

Where;

Y_i = the observed output of the i^{th} sample farm, $f(x_b\beta)$ is a suitable functional form.

β = vector of the unknown parameters to be estimated.

E_i = the error term made up of two components.

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

v_i = the random error having zero mean which is associated with random factors outside the farmers control such as topography, weather, measurement errors, disruptions of supplies and is assumed to be independently and identically distributed normal

random variable with mean zero and constant variance (0, $\delta^2 v$) and independent of u_i. The u_i is a non-negative truncated half-normal random variable associated with farm-specific factors, which lead to the i^{th} farm not attaining maximum efficiency of production. u_i is associated with technical inefficiency of the farm and ranges between zero and one.

The stochastic frontier production model is estimated using the maximum-likelihood estimation (MLE) procedure (Bakhsh, 2007). The technical efficiency of a firm is defined in terms of the observed output (Y_i) to the corresponding frontier output (Y_i*) given the available technology.

$TE_i = Y_i/Y_i^*$…… 6

$TE_i = f(x_b\beta)\exp(v_i-u_i)/f(x_b\beta)\exp(v_i)=\exp(-u_i)$…… 7

So that$0 \leq TEi \leq 1$

Therefore the technical inefficiency is equal to 1-TE.

The stochastic cost frontier function which is the basis for estimating allocative efficiency is specified as follows:

$C_i = g(p_i\alpha)\exp(v_i+u_i)$…….…….…….. 8

Where:

C_i = the total cost of production the i^{th} farm

g =is a suitable functional form

p_i = input prices employed by the i^{th} farm

α=parameters to be estimated.

v_i and u_i are the random error terms defined earlier. However inefficiencies are assumed to always increase cost and, therefore, error components have positive signs.

From the stochastic frontier function, the cost efficiency is obtained as the observed cost divided by the minimum cost. But economic efficiency is inverse of cost efficiency. That is EE=1/CE (Ogundari and Ojo, 2006).The economic efficiency (EEi) of an individual farm is defined in terms of the ratio of the predicted minimum cost to the observed cost.

The strength of the stochastic frontier approach is that it deals with the stochastic noise and permits statistical tests of hypotheses pertaining to the structure and degree of inefficiencies and random disturbances due to climate factors, chance, etc (Coellli, 1996; Lilienfeld and Asmild, 2007)

According to Aigner and Chu (1968) the limitations of the stochastic frontier production function are:

(i) There is no a priori justification for the selection of any particular distribution for the technical inefficiencies affecting ui.

(ii) Efficiency measures may still be sensitive to distributional assumptions

2.7.6 Profitability concept in agriculture

Profit maximization is one of the important goals of farm business. Profit is generally described as the differences between total revenue and total cost. The total revenue is the product of output sold and the unit price. Total cost is divided into fixed and

variable costs. According to Olukosi and Ogungbile (1989), fixed costs are those costs incurred on fixed inputs which cannot be used up during one production process, while variable costs are those costs associated with variable inputs and do change with changes in output level.

Farm budgeting technique is one of the simplest and oldest tools of analysis in farm management and production economics studies. According to Olukosi and Ogungbile (1989). Net farm income gives an overall level of profitability of an enterprise. It involves the determination of gross or total revenue and gross or total costs. The difference between the two constitutes the net farm income. Net farm income technique is more applicable where the fixed cost of production is negligible (Olukosi and Erhabor, 2008).

Gross margin analysis forms an alternative basis for farm profitability analysis. It involves accurate collection of different costs of variable inputs and the gross income obtained from a particular enterprise (Bernard, 2003). Essentially, gross margin is a budgeting tool needed to estimate total variable cost of production and revenue. Gross margin is the difference between gross income and total variable cost.

2.8 Empirical Studies on Production Efficiency Using Stochastic Frontier Production Approach

Stochastic frontier approaches have found wide acceptance within the agricultural economics literature because of their consistency with theory, versality and relative ease of estimation. The measurement of efficiency (technical, allocative and economic) has remained anarea of important research, both in the developing and developed countries,

where resources aremeagre and opportunities for developing and adopting better technologies are dwindling(Kibaara, 2005).

Adzawla *et al*. (2013) estimated the technical efficiency of cotton farmers in Yendi Municipality in Northern Ghana. They observed that the average technical efficiency level was 0.88, ranging from 0.77 to 0.99. The wide difference in technical efficiency among the least practice and best practice farmer indicates an opportunity for efficiency improvement.

Amaza (2002) used the stochastic frontier Cobb-Douglas production function to estimate technical inefficiency in food production in Gombe State of Nigeria. The study revealed that variability in technical efficiency among farmers ranged between 0.13 and 0.89 and a mean technical efficiency of 0.69.

Belen *et al*. (2003) made an assessment of technical efficiency of horticultural production in Navarra, Spain. They estimated that tomato-producing farms were80 per cent efficient while those that raised asparagus were 90 per cent efficient. Theyconcluded that there existed a potential for improving farm incomes by improving efficiency.

Rahji (2003) studied the-technical, allocative and economic efficiencies of broiler farms in Ibadan, Oyo State of Nigeria. The result showed average technical, allocative and economic efficiencies of 80.3, 74.9 and 60.3 per cent respectively. This means that the sampled broiler farms would be able to reduce their cost by 19.7 and 25.1 per cent by operating at technically and allocativelyefficient levels.

Amaza and Maurice (2005) investigated factors influencing technical efficiency in rice-based production among *fadamas* farmers in Adamawa State of Nigeria. The result showed an efficiency of*80* per cent among the rice farmers.

Kibaara (2005) studied the technical efficiency in maize production in Kenya and found out that the technical efficiency was 49 per cent. Idiong (2007) studied the farm-level technical efficiency in small-scale swamp rice production in Cross River State of Nigeria. The result indicated mean efficiency of 77 per cent and thus the presence of 23 per cent inefficiency level.

Bakhsh (2007) examined the profitability and technical efficiency of growing potato, carrots, radish and bitter gourd in Punjab, Pakistan. The mean level of technical efficiency was 82 per cent for radish, 72 per cent for carrots, 70 per cent for potato and 66 per cent for bitter gourd, indicating that there exist potential for increasing vegetable production by using existing resources more efficiently.

Adeleke *et al.* (2008) studied technical efficiency of cassava farmers in Oluyeole and Akinleye Local Government Areas of Oyo State of Nigeria. They found out that the mean technical efficiency was 68.98 percent. Thus, in the short-run, an average cassava farmer has the scope of increasing his/her cassava production by about 34.02 percent by adopting the technology and technique used by the best cassava farmers.

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 sesame production by 43 percent by adopting the technology and techniques for the best sesame farmers.

Seyoum *et al*. (2009) in their assessment of technical efficiency of maize farmers in eastern Ethiopia for farmers within and outside Sasakawa-Global 2000 project using a translog stochastic production function and a Cobb-Douglas Production Function. The mean technical efficiency of farmers within SG 2000 project was estimated to be 0.94, while that of farmers outside the project was 0.79.

Yassin (2004) in a study on economic analysis of irrigated cotton production constraints in Sudan's Gezira Scheme using the stochastic frontier production analysis found that the mean technical efficiency of the farmers with respect to cotton production was 0.52. This means that the farmers in the scheme produced only 52 percent of cotton yield attainable by the best practices. It also implied that farmers can increase their cotton output by 48 percent using current level of inputs if farmers are technically efficient and the scheme management carries out its task properly.

2.9 Socio-Economic and Institutional Factors Influencing Technical Efficiency

It should be noted that the socio-economic and institutional variables used in the technical efficiency model are the determinants of inefficiency and not efficiency. This implies that the variables with negative coefficients have negative relation with inefficiency but positive relation with efficiency and vice versa.

The socio-economic characteristics of farmers are known to have effect on their production efficiency. A study by Nandi *et al*. (2011) found that farmers within the age

of 39-59 were more productive than farmers who were 60 years and above. Udoh and Falake (2006) found that the age of farmers positively affect their technical efficiency. They noted that as the farmers advance in age, inefficiency in resource use decreases while technical efficiency increases. Ajibefun *et al*. (2003); Seyoum *et al. (2009)* and Idiong (2007) found that increasing age could lead to increased technical efficiency.

Years of farming experience is another factor that influences production efficiency among farming households. Farmers with more years of farming experience have been observed to have higher farm output than those with lesser years of farming experience (Udoh *et al.*, 2006 and Yao, 1997). For example, Ajibefun and Abdulkadir (2004) and Ajibefun *et al.* (2003) observed that production efficiency in the humid forest and moist Savanna agro-ecological zones of Nigeria were positively associated with more experience in farming. In a study on estimating technical efficiency of cotton production in Yendi Municipality, northern Ghana, Adzawla *et al.* (2013) found that the coefficient of farmers' experience (number of years in cotton production) was negative and significant at 5% implying that farmers cultivating cotton for longer years were less technically inefficient. This was perhaps due to their ability to draw on past experiences to suit their farming conditions. Gul *et al.* (2010) also found years of farming experience to positively affect technical efficiency and stressed that technical know-how obtained through experience increased technical efficiency.

Gender is an important variable influencing agricultural production efficiency. In most African societies, inputs like land and machineries are mostly inherited by the male descendants (Udoh and Nyienakuna, 2008). In their study on resource use efficiency of maize farmers in rural Nigeria, Oluwolaye *et al.* (2008) found that only 8.5% of women

in their study area owned farms. Although women are less productive in farming, the general consensus is that they are no less efficient than men in their use of resources. Rather a lack of complementary inputs leads to a lower labour productivity for female farmers (Udry *et al*., 1995). Saito *et al*. (1994) noted that the gross value of output per hectare from male managed plots was 8 percent above that of female-managed plots. They further noted that if women were to use the same resources as men, their productivity would increase by about 22 percent.

Nweke *et al.* (2002) found that women's labour inputs for production, harvesting, transport and processing are very substantial and is on the increase. They suggested that targeted policies with regard to credit, gender-sensitive extension services and technological and institutional changes geared towards women would further increase output of agriculture.

The need for education in agriculture cannot be overstressed, since the level of education of a farmer not only increases his productivity but also enhances his ability to understand and evaluate new production techniques (Amanze *et al*., 2010). Studies by Ajibefun and Abdulkadir (2004) and Ajibefun *et al.* (2003) found that education was key to enhanced productivity among farming households in Nigeria and New England. This is because good education propels farmers to adopt new innovations and technologies that are vital to enhancing farm productivity. Bamidele *et al*. (2008) also noted that when farmers are educated, they would appreciate improved technologies and even use them appropriately in order to enhance their output. Adeyemo *et al*. (2010) revealed that education will obviously improve the efficiency of farmers as it will

enable them to access improved technologies and select the best available ones, thereby increasing their output level.

Mwakalobo (2000) in his study observed that large farm sizes diminish the timeliness of farm operations and input usage. Thus, it becomes more difficult for farmers with large farm sizes to conduct their farm operations at optimal times, hence inefficiency in the use of resources. He also stated that given the importance of inputs in the farming system and the low access to these inputs together with their high cost, increasing the area cultivated implies a wider application of insufficient inputs. Yassin (2004) also observed that farmers who cultivated a large area of cotton tended to be less technically efficient than those who cultivated small areas. This is in contrast to the findings of SANEI (2007), Thapa (2007) and Gul *et al.* (2010) who found positive relationship between farm size and technical efficiency which indicated that larger farm sizes are more technically efficient than small farms in rice production. This may be partly because large-scale farmers can afford timely and adequate supply of resources and partly because of scale factor (SANEI, 2007 and Tiwari, 1982). Large farms also tended to have access to institutional and public goods (such as credit, electricity, technical assistance, market access and membership of cooperatives) as well as more intensive use of the technologies and inputs. These variables are all associated with lower inefficiency.

Ajibefun and Abdulkadir (2004), Ajibefun *et al.* (2002), Amaza (2002), all assessed how labour affected farm productivity. They are of the opinion that hired labour as an input if not properly utilized could lead to increased cost of production, hence a reduced economic efficiency in farming.

Shehu *et al.* (2007) in their study on productivity and technical efficiency of small-scale rice farmers in Adamawa state of Nigeria found the coefficient of household size to be positive, meaning that increases in household size lead to increases in technical inefficiency. The reason advanced was that as number of people in a household increased, household consumption expenditure increases, thereby making little money available for further purchase of necessary farm inputs and in meeting other farm financial obligations, which results in decreased output. Kehinde and Awotide (2012) in their study of technical efficiency of mechanized arable crop farming in Osun State of Nigeria also observed that household size was positively related to technical inefficiency. Their reason for this relationship was that farmers with large household sizes may have easy access to family labour and thus over-employ them or commit more resources than necessary to member of his household thus resulting in technical inefficiency. However, Adzawla *et al*. (2013) in their study on technical efficiency of cotton production in Yendi Municipality, northern Ghana, stated that "generally technical efficiency reduces with increasing household size''. They found that farmers with family size of between 1 and 5 to have the highest technical efficiency of 0.93.

Studies by Apata *et al.* (2008), Yassin (2004) and Rahman (2002) revealed that there was a significant positive relationship between number of contacts with extension agents and technical efficiency. All the results indicated that farmers with more contact with extension agents had less technical inefficiency. Increased contacts with extension agents would lead to more knowledge on improved production technologies that could have a strong influence on farm output. Adzawla *et al*. (2013) found the technical efficiency to be highest (0.91) for farmers who received between 5 to 6 extension visits during the cropping season.

Credit can improve the productivity, incomes and welfare of rural people. Short-term credit may alleviate seasonal needs for working capital or problems arising from crop failure. Credit if properly utilized could lead to increases in crop area, more input application, and more yield (Shah *et al.,* 2008). Yassin (2004) in his study observed that farmers who are not constrained by credit are more technically efficient than those who are. Similarly, Hassan (2014), Tanko and Opara (2004) reported a positive relationship between credit and technical efficiency. This implies that farmers who have access to credit tended to be more efficient in production. To be more effective in increasing farmers' productivity, it is suggested that institutional credit should be of low interest rate, procedures of advancing loan should be made simple to peasant farmers and credit should be made available on time (Shah *et al.,* 2008).

Membership of farmers' association has an influence on the level of efficiency particularly for small-scale farmers, because it facilitates access to markets and increases the income level of farmers as well as technical assistance. Idiong *et al.* (2006) and Hassan (2014) observed that membership of association was positively related to technical efficiency, and resulted in increase in output.

2.10Measurement and Rationalization of Variables in the Technical and Allocative Inefficiency Models

It should be noted that a negative inefficiency coefficient signifies a positive relationship with technical efficiency and vice-versa (Chukwuji, *et al*., 2004).

i. **Age:** This variable was measured as the chronological years of the farmer. The variable is expected to be positively related with technical inefficiency. The

reason is that as farmers advance in age, inefficiency in resource use decreases, while technical efficiency increases

ii. **Household size**: This variable was measured as the number of persons in the household. This variable is could be both positively and negatively related with technical inefficiency. The reason for negative relationship with technical inefficiency could be due to the fact that the more the number of people in a household the more likely their contribution to family labour. It may affect technical inefficiency positively, as increased household size increases the financial burden on the household head thus, reducing the cash surplus for farm needs and expansion.

iii. **Educational status**: This variable was measured as the number of years in schooling. The variable is expected to be negatively related with technical inefficiency. The reason is that education encourages adoption of better management systems and promotes consciousness to maximize the full benefits of resource use. It also propels farmers to adopt new innovations.

iv. **Years of experience in cotton farming:** This variable was measured as the number of years a farmer is involved in cotton production. The variable is expected to be negatively related with technical inefficiency. The reason is that the more the number of years engaged in cotton production, the more the technical know-how a farmer acquires.

v. **Cooperative society membership**: This variable was measured as the number of years of participation in cooperative society. The variable is expected to be negatively related with technical inefficiency. The reason is that, membership of cooperative society facilitates access to markets as well as greater chances of financial assistance from institutional sources of credit necessary for increased efficiency.

vi. **Access to credit**: This variable was measured as the amount of loan obtained in the year. The variable is expected to be negatively related with technical inefficiency. The reason is that credit may alleviate seasonal needs for working capital and could lead to increase in crop area.

vii. **Extension visits**: This variable was measured as the number of visits by extension agent to the farmer within the year. The variable is expected to be positively related with technical inefficiency. The reason is that increased contact with extension agents will lead to more knowledge on improved production technologies that could have strong influence on farm output.

viii. **Sex of farmer**: This variable was measured as dummy (male=1, female=2). The variable is expected to be negatively related with technical inefficiency if the farmer is a male. The reason is that males have greater access to inputs like land and machinery, and finance as male are heirs to most inheritance in Africa.

ix. **Quantity of fertilizer used**: This variable was measured in kilogram per hectare as the amount of synthetic chemical used to enhance soil fertility. The variable is

expected to be positively related with allocative efficiency. The reason is that it helps in increasing farmers' output if well managed.

x. **Labour:** This variable was measured as the number of hours per day engaged by both family and hired labourers. The variable is expected to be positively related with allocative efficiency. The reason is that it helps to boost farmers' output if judiciously managed.

xi. **Quantity of seed planted**: This variable was measured in kilogram per hectare as the amount of seed planted. The variable is expected to be positively related with allocative efficiency if applied at the recommended rate. The reason is that it helps in good crop establishment which affect farmers' output.

xii. **Quantity of agro-chemical used**: This variable was measured as the amount of pesticide and insecticide (liters per hectare) used. The variable is expected to be positively related with allocative efficiency if applied at the recommended rate, if otherwise, it could positively related with inefficiency. The reason is that it helps in healthy crop establishment and development necessary for increased output.

xiii. **Farm output**: This variable was measured in kilogram per hectare as the total yield of cotton obtained by the farmer. The variable is expected to be positively related with allocative efficiency if the yield is good and negative if otherwise.

xiv. **Cost of production**: This variable was measured in naira to include costs such as seed, fertilizer, agrochemical, land (if rented) and depreciation. The variable is expected to be negatively related with allocative efficiency if the cost of production is high and positively related if the cost of production is low. The reason is that the cost of production affects the whole revenue profile of the farmer.

2.11 Cotton Production Constraints in Nigeria

2.11.1 Climate

The inter-annual variability of rainfall in particular results in climatic hazards that reduce crop yield of cotton. The recommended sowing date for cotton in the major growing zones is Mid-June which is always the time rains have established so that the crop can take full advantage of the growing season. As farmers have to grow food crops first, cotton seed yield reduction was attributed to delayed planting due to late rainfall establishment (Ogunlela, 2004; Gbadegesin *et al*., 2007).

2.11.2 Soil

Agricultural production in most of Africa is also hampered by the predominance of fragile ecosystems and low inherent soil fertility. Cotton, being a deep-rooted crop, requires adequate soil fertility at all the root zone of crop growth. The declining soil fertility due to soil nutrient mining is a major cause of decreased cotton yield. Population pressure now forces farmers to grow crop after crop, "mining" or depleting the soil nutrients while giving nothing back to the soil. Odedokun (2014) revealed in his study that 52.3% of the farmers recorded inadequate soil fertility as their major constrain in cotton production.

2.11.3 Pests and diseases

Cotton as a crop is susceptible to attack by numerous insects and diseases throughout its life cycle and the effective control of these is inevitable if reasonable yield is expected (Adeniji, 2007). The most important group of insects in terms of economic costs is the bollworm. A part from their ability to reduce yield, certain pests can also cause reduction in lint quality *Dysdercus* SP for example, causes discoloration of the lint. Other pests include aphids, thrips and white flies. Bacterial blight, dowson and alternaria blight are the major diseases of cotton in Nigeria. Alam *et al*. (2013) and Adeniji (2007) in their separate studies noted that, pests and disease infestation ranked second among the major constraints affecting cotton production.

2.11.4 Poverty

Cotton in Nigeria is predominantly grown by small-scale resource poor farmers (Idem, 1999). This group of farmers does not have adequate resources to purchase the needed quality inputs necessary for improved productivity of cotton. These inputs include improved seeds, fertilizer, chemicals for pest control etc. The poverty and lack of storage facilities also compel most farmers to sell cotton immediately after harvest and it is possible that the price at this time is not high enough to enable farmers to break even, let alone make profit from the enterprise.

2.11.5 Marketing

In a study on constraints to cotton production in Katsina by Adeniji (2007), 40 per cent of the farmers agreed that marketing is a constraint to cotton production. The marketing system as it operates presently is unsatisfactory and this was acknowledged not only by

farmers but also by other major actors in the cotton industry (Gusau, 1998). In spite of efforts being made to increase production, the marketing arrangement did not ensure acceptable cotton-buying structure to provide conducive atmosphere to encourage the farmers to produce more. Most of the farmers suffer in the hands of unscrupulous middlemen who often exploit and rob them of benefits of their effort. The problem is compounded because of interference by government on matters affecting marketing and pricing of cotton (Chikwendu, 1993). Gbadegisin *et al.* (2007) reported that the principal factor responsible for contributing to the decline in cotton production is the low price offered to cotton farmers. In a study on cotton production in some selected local government areas of Taraba State of Nigeria, 73% of the respondents reported low price of cotton as being their major constraint. This constraint was therefore ranked first among others. (Alam *et al*., 2013). Ubi (1987) states that "poor marketing arrangement has been considered as one of the key factors affecting cotton production in Nigeria".

Nigeria has liberalized its commodity market in recent years and cotton is one of the commodities freely traded. The dissolution of the marketing board in 1986 allows supply and demand forces to determine cotton prices. This disrupted the organizational framework of cotton production, processing and finance (Adeniji, 2007). The overall effect of this is fluctuation in market price of cotton lint, seeds and other inputs needed by farmers.

2.11.6 Illiteracy and poor extension delivery system to farmers

Majority of Nigeria's farmers cannot read and write. This impedes their ability to adopt new technologies that could enhance productivity. The present extension system in Nigeria is ineffective. The Agricultural Development Projects (ADPs) are responsible

for extension delivery at every state level. For most of the ADPs, the target ratio of extension agents to farmers of 1:100 could not be realized due to problems ranging from under-funding to the unavailability of adequate and appropriate trained personnel. This has had a negative on the effectiveness and coverage of the various cells/circles in a given locality (FMANR, 2000). In relation to cotton, these inadequate extension services limit awareness of the availability of improved cotton varieties despite the sound research efforts of the Institute for Agricultural Research, Samaru Zaria in Nigeria.

2.11.7 Insecurity

One critical constraint to the attainment of sustainable cotton production in Nigeria is persistence of insecurity, due to the continued prevalence of ethnic, religious and political conflicts. No development strategy, however important and well-meant will ensure sustainable agricultural production unless there is peace. (Adeniji, 2007). The conflict that is most relevant to cotton farmers is the conflict with cattle herdsmen (Fulani). This makes most of the farmers abandon their cotton fields which is a late season crop even before the final picking (harvesting) is done. This grossly lowers their returns.

2.11.8 High cost of inputs and seed adulteration

High cost of inputs, especially fertilizer which is a major variable input in cotton production constrains cotton production. Seeds for planting are mainly sourced from the ginneries that buy their raw materials from the farmers. Most farmers are in the habit of pouring water on the cotton in order to attract higher weight before selling to ginneries. The seed obtained from such cotton has very poor germination percentage. Some agrochemical marketers are also in the habit of adulterating chemicals sold to farmers (Adeniji and Jirgi, 2010).

CHAPTER THREE

METHODOLOGY

3.1 Description of the Study Area

The study area was the north-west agro-ecological zone of Nigeria. The north-west zone lies between latitudes 9^0 N and 14^0 N and longitudes 7^0E and 60^0E of the Greenwich Meridian (UNDP, 2012). The zone comprises of seven States, namely, Jigawa, Kano, Katsina, Zamfara, Sokoto, Kebbi, and Kaduna. According to the 2006 national population census, the total population of the zone is estimated at 35.7 million with an average population density of 103 persons per square kilometre (NPC, 2006). The projected population of the zone is about 44.1 million as at 2013, based on an annual population growth rate of 3.2%. However, the study was conducted in only three States, namely, Kano, Katsina and Zamfara which are known for large-scale cotton production. The projected population of these three states in 2014 is 23,719,567 million. The vegetation of the north-west zone is typically savanna and grassland ecology, spread across by the Sahel, Sudan and Northern Guinea Savanna. The climate of the zone is essentially tropical climate, generally characterized by alternating wet and dry seasons. The mean annual rainfall in the zone ranges from 500mm to nearly 1200mm. The rains usually commence in May/June and ends in October/November. The temperature ranges between 20 and 25^0C. The farming season in the zone is determined by the seasonality and duration of rainfall. The rainfall pattern is uni-modal, with peak period in August. The water regime in the zone favours the production of a wide variety of crops ranging from vegetables (tomato, onion, carrot, lettuce, spinach, pepper), cereal (sorghum, millet, maize, rice), root and tuber crops (yam, sweet potato, cocoyam), legume (groundnut, cowpea), and fibre crops (cotton, kenaf). The vast grassland vegetation and

absence of tsetse fly also favours large-scale livestock (cattle, sheep, goat, donkey, camel and poultry) production by the farmers.

Katsina State is located in the northern fringes of the country. It is surrounded by Kaduna State to the south, Zamfara State to the west, Kano State to the east and Republic of Niger to the north. The State lies between latitude $11^{0}03^{'}$ and $13^{0}05^{'}$N, longitude 07^{0}W and $09^{0}02^{'}$E (Katsina, 2008). Its population is put at 5,801,584 people in 2006 (NPC, 2006) and a projected population of 7452628 in 2014 at a projected growth rate of 3.2 per cent per annum. The State has a land area of about 25,938km^{2} out of which 1.64 million hectares are arable land (Katsina, 2008). It has two climatic seasons: rainy and dry seasons. The mean annual rainfall is 400-1300mm with the highest amount recorded in August, while the mean annual temperature ranges between 29-39^{0}C (Katsina, 2008). The climate of the area favors the production of crops such as cotton cowpea, groundnut, millet, sorghum, maize, sugarcane and a wide range of vegetable crops such as onion, tomato and pepper. The state has three ADP zones.

Kano State lies between latitudes 13^{0} and 11^{0}N and longitudes 8^{0} and 10^{0}E of the equator (KNARDA, 2008). The State is bordered to the north by Jigawa State, to the south by Bauchj and Kaduna States and to the west by Kaduna and Katsina States. It has a total land area of 20,760 square kilometres (km^{2}). Its population is put at 9,401,288 people in 2006(NPC, 2006), and it is projected to reach 12072879 in 2014 at a projected growth rate of 3.2 per cent. The climate is characterized by two distinct seasons; rainy and dry seasons. The dry season starts from October to May, while the rainy season starts from June to early October. Annual rainfall ranged between 600-1000mm per annum and the daily temperature ranged between 30-35^{0}c (Alhaji, 1997). The major

crops grown are millet, sorghum, groundnut, rice, cowpea, cotton, maize and a wide range of vegetable (tomato, onion and pepper) (KNARDA, 2008).

Zamfara State lies between latitudes 10^0 and $13^0 38^{'}$N and longitudes $4^0 16^{'}$ and $7^0 18^{'}$E. It has a land area of 39,762 Km^2 (ZADP, 2010). The State shares common borders with Sokoto and the Republic of Niger to the north, Katsina and Kaduna States to the east, and Niger and Kebbi States to the south (Yakubu, 2005., Zamfara State,2010). The State had a population of 3,259,846 in 2006(NPC, 2006). This is projected to 4194060 people in 2014 at an annual growth rate of 3.2 per cent. The climate is characterized by alternate wet and dry seasons. Mean annual rain rainfall ranges between 969mm and 1086mm and mean annual temperature variation from 29^0C to 37^0C (Zamfara State, 2010). The State produces a wide range of cereal, legume, vegetable and fibre crops. The state has three ADP zones with zonal headquarters at Kauran Namoda (northern zone), Gusau (central zone) and Gummi (eastern zone).

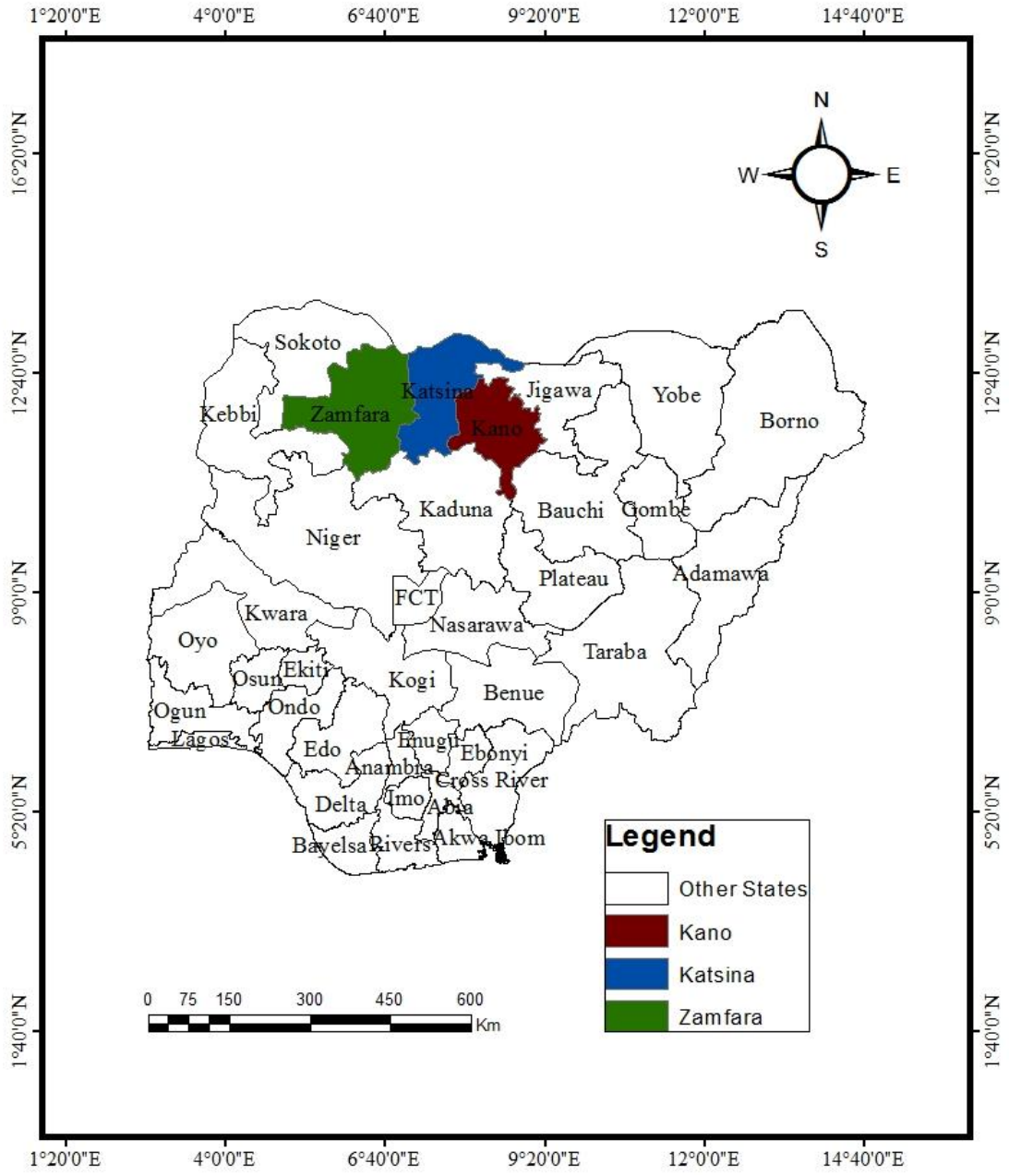


Figure 3.1: Map of Nigeria showing study States.

3.2Sampling Procedure and Sampling Size

Multi-stage sampling technique was used to select respondents for this study. In the first stage, three States were purposively selected from the seven States that make up the North-West zone based on their scale of cotton production. The States selected were Kano, Katsina and Zamfara. The second stage involved a purposive selection of two Agricultural Development Project (ADP) Zones from each State. The ADP zones were selected based on their prominence in cotton production. In the third stage, two Local Government Areas were also be purposively selected from each of the ADP Zones based on their scale of cotton production. In the fourth stage, two villages were purposively selected based on their prominence in cotton production from the selected Local Government Areas. Finally, a 15% proportionate random selection of cotton farmers was done from the selected villages given a total of 355 respondents as shown on Table 3.1.

Table 3.1: Summary of Sample and Sample Location

States	ADP Zone	LGA	Villages	Registered Cotton Farmers	Number of Farmers Selected at 15% proportion
Kano	I	Gwarzo	Getso	120	18
			Gangara	54	8
		Karaye	Karaye	133	20
			Hawan Dutse	100	15
	II	Tsanyawa	Tsanyawa	106	16
			Yandadi	33	5
		Kabo	Kanye	66	10
			Daro	54	8
	II	Malumfashi	Dayi	140	21
Katsina			Layin Minista	160	24
		Kankara	Yargoje	90	14
			Tudu	184	28
	III	Matazu	Sayaya	101	15
			Dissi	120	18
		Musawa	Sabon Layi	133	20
			Danjanku	120	16
Zamfara	I	Tsafe	Tsafe	148	20
			Yanware	88	13
		Bungudu	KwatarKwashi	151	21
			Tashar Rawaya	90	12
	II	Gummi	Rafi	43	6
			Bardoki	66	10
		Bukkuyum	Kyaran	54	8
			Adekpo	62	9
Total	**3**	**6**	**12**	**24**	**2415**	**355**

Source: Reconnaissance survey and ZAMCODA, 2014

Note: ZAMCODA: Zamfara Accelerated Cotton Development Agency.

3.3 Sources of Data

The study used primary data. The primary data pertaining to this study were collected using structured questionnaire. The data was collected based on the 2013/2014 cotton cropping season. To facilitate the collection of the data, the services of agricultural extension agents was engaged. Some training was given to the extension agents to acquaint them with the content of the questionnaire. The data collected included:

(i) Socio-economic and institutional characteristics of the cotton farmers, for example, age, sex, educational level, family size, farming experience, marital status, access to credit, membership of cooperative societies and contact with extension agents.

(ii) Farm production and market information which included: farm size, hired and family used, fertilizer used, quantity of agrochemicals used, quantity of seed used, farm output, farm input costs, market prices of output, and constraints to cotton production.

3.4 Analytical Techniques

The analytical tools that were used for achieving the objectives of the study include: descriptive statistics, net farm income, and stochastic frontier production function.

3.4.1 Descriptive statistics

Simple descriptive statistics was used to achieve objectives **one**and **five**of the study. It involves the use of measures of central tendency such as means, ranges, frequency distribution and percentages.

3.4.2 Farm budgeting technique

In order to determine the costs and returns in cotton production, farm budget technique was used to achieveobjective**two**of the study. It is a tool used to estimate total cost and total revenue for a given production period (Osifor, 1970).Farm budgeting technique was used to analyse costs, returns and profitability level of cotton production. The farm budgeting technique used was the net farm income (NFI) model.

The net farm income is the difference between gross income (GI) and the total cost (TC) of production (Olukosi and Erhabor, 1988 and Onyenweaku *et el*, 2004). Net income statement is defined as the surplus from business operations, which could be withdrawn without reducing the future scale of the business. It is sometime referred to as farm income or operating statement. An income statement is a flow concept, which applies to a period of time. For example, for the purpose of farm income statement, four types of records are required. These are farm inventory, receipt record, home consumption records and expenses records (Olukosi and Erhabo, 1988).

Gross income: this is also called total return or total value product (TVP), which is defined as the total output multiplied by the price per unit produce.

Net Farm Income (NFI) = Gross Income (GI) – Total Cost (TC) of production

NFI = TVP – TC

TVP = Total Value of Product

TC = Total Cost of Production

Total Cost (TC) of Production –Total Variable Cost (TVC) + Total Fixed Cost (TFC)

The model used for estimating net farm income can be presented by equation 9

$$NFI = \sum_{i=1}^{n} P_{yi}Y_i - \sum_{j=1}^{m} P_{xj}X_j - \sum_{k-1}^{K} fk \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 9$$

Where;

NFI	=	Net Farm Income (Naira)
Yi	=	Cotton output (kg)
Pyi	=	Unit Price of cotton (Naira/kg)
Xj	=	Quantity of the variable inputs (where J=1,2,3…m inputs)
Pxj	=	Price/Unit of variable inputs
Fk	=	Costs of fixed inputs (where K=1,2,3……k fixed input

The Total variable cost (TVC) included items like the cost of labour, fertilizer, seed, and chemicals. While the total fixed cost (TFC) included depreciation on farm tools like hoes, cutlasses, and the cost of renting land. The gross revenue included total output of cotton multiplied by price per unit of cotton. The open market price of cotton for the year 2014/2015 was used.

Profitability index (return to naira invested) in cotton production was calculated to ascertain the profitability of the enterprise. This was found by dividing NFI per hectare with total cost of production per hectare. This is mathematically expressed as follows;

$$RNI = \frac{NFI}{TC} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 10$$

Where;

RNI = Return to every Naira invested per hectare

NFI = Net farm income (N)

TC = Total Cost of Production (N)

The fixed assets were depreciated because they are not normally used up in a production cycle. The fixed inputswere depreciated using straight-line method. Depreciation (D) under this method, is the difference between the purchase value (P) and the salvage value (S), divided by the number of years of life of the asset (N). This is expressed as:

$$D = \frac{P-s}{N} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ 11$$

The NFI might not be a sufficient indicator of financial success in the production process (Olukosi and Erhabor, 2008 and Onwuchukwu, 2008), this made it necessary to calculate other measures of profitability. These are:

i. Capital turnover (CTO), that is , $= \frac{TR}{TC}$ ………………………………..12

   Where TR = total revenue and TC = total cost

   Capital turnover ratio (return per naira invested) describes roughly how much revenue the farm enterprise can generate for each naira invested over a given period. This ratio should be greater than one for the production to be profitable.

ii. Gross ratio: Olukosi and Erharbor (2008) described the gross ratio (GR) as the total farm expenses (TFE) divided by the total revenue (TR), that is,

$$GR = \frac{TFE}{TR} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. 13$$

The total farm expenses were obtained by summing the operating and fixed cost figures. A less than 1 ratio is desirable for any production process to be described as profitable.

The lower the ratio, the higher the return per naira used in the production process. A greater than 1 ratio is disastrous for any farm production process and might indicate over utilization of certain resources. If this happens, farmers should consider ways of reducing costs and increasing gross income. The GR measures the overall financial success of a production process (Troke, 1981)

iii. Operating ratio: According to Olukosi and Erharbor (2008), the operating ratio (OR) is the total operating cost (TOC) divided by the gross income, that is;

$$OR = \frac{TOC}{GI} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. 14$$

An operating ratio of 1 means the gross income barely covers the expenses on the variable inputs used in the production process. In other words, such a production process could survive only in the short run and could fold up if correct adjustment is not made to improve the usage of variable resources in terms of reducing costs and/or increasing gross income (Olayemi and Oni, 1979)

3.4.3 The stochastic frontier production model

The stochastic frontier model was used to achieve objectives **three** and **four**of the study. The stochastic frontier as an economic method of efficiency measurement in production systems is built around the premise that a production system is bounded by a set of smooth and continuously differential concave production transformation functions for which the frontier offers the limit to the range of all production possibilities (Sharma

et al., 1999). It has the advantage of allowing simultaneous estimation of individual farmer as determinant of technical efficiency (Battese and Coelli, 1995).

3.4.3.1 Specification of the stochastic frontier production function.

This approach was taken up by Aigner and others which subsequently resulted in the development of this method in econometric studies Aigner and Chu (1968), Aigner *et al.* (1977), and Bettese *et al*. (2004) This model is defined by:

$$Yi = f(Xi, \beta)\, e_i \quad \text{.....15}$$

Where Yi = Output of the i^{th} farm

Xi = Quantity of input used.

β = Scalar parameter (vector) to be estimated,

e_i = error term = $V_i - U_i$ = composite error term

The V_i is a random error which account for random variation in output due to factors outside farmers' control such as weather, disease and measurement errors in production. The random error (V_is) are assumed to be independently and identically distributed normal random variables with mean zero and constant variance δv^2, independent of the U_is.

The technical efficiency model may be explicitly expressed as:

$$LnYi=\beta_0+\beta_1 LnX_1+\beta_2 LnX_2+\beta_3 LnX_3+\beta_4 LnX_4+V_1+U_i \quad \text{..... 16}$$

Where:

Ln = natural logarithm

Yi = output of cotton from the i^{th} farmer (Kg)

x_1= quantity of seed (ha)

X_2 = quantity of fertilizer used (kg)

X_3 = quantity of agrochemicals used (liter)

X_4= total labour used (man day))

β_1-β_4= regression coefficients

Vi = A random variable in production which accounts for the random variation is output by factors beyond the control of farmers.

Ui = random variable called technical inefficiency effects

β_0 = intercept

The model will be estimated by maximum likelihood estimation (MLE) technique available in the computer program called FRONTIER VERSION 4.1 developed by Coelli (1996).

$$Hence, TE = {}^{Y^a}/_{\hat{Y}} = actual\ output/frontier\ output$$

$$= f(xi,\beta)\ e^{v}\ e^{-u}/f(xi,\beta)\ e^{v}$$

$$\therefore TE = e^{-u} \quad \text{..... 17 (Aiger } \textit{et al.}\text{, 1977)}$$

This is the technical efficiency (TE) which is defined as the ratio of observed output to maximum feasible output which is called frontier output.

When TE = 1, it shows that a farmer obtains maximum feasible output, while if TE<1 means a shortfall of the observed output to the frontier output.

3.4.3.2 Stochastic frontier cost function.

The stochastic frontier cost function is a Cobb-Douglas functional form. It was used to estimate the allocative efficiencies (AE) of cotton farmers. It is specified as follows:

$$Ci = f(P_{xi}, Y_i \lambda) \exp. (V_i + U_i), i = 1,2,3,.....,n..... \quad 18$$

Where:

Ci = total production cost of the i^{th} cotton farmer

f = functional form represented by Cobb-Douglass function

P_{xi} = prices of inputs employed by the cotton farmers

Y_i = cotton output

λ = unknown parameters to be estimated

$V_i + U_i$ = random error term

V_i = cost frontier

U_i = non-negative cost inefficiency effect

However, because inefficiencies are assumed to always increase costs, error components have positive signs (Coelli *et al*., 2002).

The economically efficient input vector for the i^{th} farmer, $x_i e_i$ is derived by applying Shepard's lemmar (Shepard, 1970) to obtain:

$\delta Ci/\delta Pi = {}_{Xi}\, e\ (P, \dot{y}, \lambda)$..... 19

This is a system of minimum cost input demand equation (Bravo-Ureta and Evenson, 1994; Xu and Jeffery, 1998; and Nwaru *et al*., 2011). Substituting a farmer's input prices and quantity of output in equation (18) yields the economically efficient input vector $X_i c$. With observed level of output given, the corresponding technically and economically efficient costs of production will be equal to $X_{ii}\, P$ and $X_i C$, respectively, while the actual operating input combination of the farm is $X_i P$. The cost measures were then used to compute the technical efficiency (TE) and economic efficiency (EE) score indices as follows:

TE = (XiiP)/(X;P)..... 20

E = (Xie.P)/(XiP)..... 21

Alternatively the allocative efficiency of the individual farmer can be defined in terms of the ratio of the predicted minimum cost (C*i) to the observed cost (Ci) from equation (18); that is,

AEi = C*i/Ci

.: $AE_i = f\ (P_{xi}, \lambda)\ e^v\ e^{ui}/f(Pxi, \lambda)\ \exp Vi + \exp Ui$..... 22

AE = exp (Ui)

The allocative efficiency score index for each farmer also ranges between O and 1. Hence, the specification of the cost frontier function is in accordance with the Cobb-Douglas function illustrated in the allocative efficiency expressed below;

$\ln Ci = \beta_0 + \beta_1 \ln X_2 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 +$ Vi-Ui..... 23

Where:

Ln = natural logarithm

Ci= total cost of production in naira (₦)

X_1 = cost of seed (₦)

X_2 = cost of fertilizer (₦)

X_3 = cost of labour (₦)

X_4 = cost of agrochemicals **(**₦)

β_0 = constant term

β_1- β_4 = vector of costs function of parameters to be estimated

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

Ui = deviation from maximum potential output attributable to technical inefficiency.

3.4.3.3The economic efficiency function

This is the product of technical efficiency (TE) and allocative efficiency (AE) of the individual cotton farmer. Therefore the economic efficiency is given as;

EE = TE x AE..... 24

AE = EE/TE (i.e, O<AE1) (Matin and Taylor, 2003. And Ogundari and Ojo, 2006), and

TE = EE/AE

3.4.3.4 Technical inefficiency model.

Apart from determining the farmer's technical efficiency in cotton production, this study also identified the determinants of farmer's technical efficiency in terms of socio-economic and institutional variables. In this respect, an inefficiency model which assumes that the inefficiency effects are independently distributed having $N(O,\propto^2 u)$ distribution and mean Ui. The model is specified as follows;

$$Ui = \propto_0 + \propto_1 w_1 + \propto_2 w_2 + \propto_3 w_3 + \propto_4 w_4 + \propto_5 w_5 + \propto_6 w_6 + \propto_7 w_7 + \propto_8 w_8 + \propto_9 w_9 + Ei \quad \ldots\ldots 25$$

Where Ui = technical inefficiency of the i^{th} farmer

W_1 = age of household head (in years)

, w_2 = number of years spent in formal education

w_3 = amount of loan obtained in Nigerian Naira (NGN)

w_4 = Household size.

w_5 = Years of participation in cooperative activities.

w_6 = Number of visits made by extension agent to the farmer in the year.

w_7 = Number of years engaged in cotton farming.

w_8 = marital status (dummy; married=1, single=2)

w_9 = Gender of farmer (dummy; male=1, female=2)

α_1- α_9 = parameters to be estimated

α_0 = intercept

E_i = error term

The variances of the random errors, $\delta^2 V$,and that of technical inefficiency effects, δ^2U, as the overall variance of the model, δ^2, are related as follows:

$\delta^2 = \delta^2 V + \delta^2 U$..... 26

And the ratio $\propto = \delta^2 V/\delta^2$

Equation (26) measures the total variance of output which can be attributed to technical inefficiency (Battese and Coelli, 1995); its value is expected to be between 0 and 1.

3.4.3.5Specification of the stochastic frontier cost function

In this study, Battese and Coelli (1995) model was used to specify a stochastic frontier cost function. The stochastic frontier cost function was used to achieve objective **four**of the study. The model is specified as follows:

$LnCi = \propto_0 + \propto_1 LnP_1 i + \propto_2 LnP_2 i + \propto_3 LnP_3 i + \propto_4 LnP_4 i + LnYi + Vi + Ui$..... 27

Where:

Ln = natural logarithm

Ci = total cost of i^{th} cotton farmer in Naira

P_1 = cost of seed (₦/kg)

P_2 = cost of fertilizer (₦/kg)

P_3 = cost of agro-chemicals (₦/litre)

P_4 = cost of labour (₦/man-day)

Yi = output of cotton (kg)

$\propto_0$ = intercept

$\propto_1$, $\propto_2$,..... $\propto_4$ = coefficients of the parameters to estimated

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

Ui = deviation from the cost frontier attributable to allocative inefficiency.

3.5 A priori Expectations

The following are the *a priori* expectations of the determinant of inefficiency estimated.

Z_1= Age is expected to bepositive or negative

Z_2= Education is expected to benegative

Z_3 = Access to credit is expected to be negative

Z_4 = Household size; this variable is expected be negative or positive

Z_5 = Cooperative membership; this variable is expected to be negative

Z_6 = Extension contacts; this variable is expected be negative

Z_7 = Farming experience; this variable is expected to be negative

Z_8 = Marital status; this variable is expected to be negative

Z_9 = Gender; this variable is expected to be negative

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Socio-Economic Characteristics of Respondents

The identification and description of the socio-economic characteristics of the respondents will be used to achieve objective (**i**) of the study.It is treated as thus;

4.1.1 Age

The study revealed that about 2% of the cotton farmers were within the age range of 20 and 29 years, 22.3% were between 30 and 39 years, 29% were between the ages of 40 and 49 and about 40% of the respondents are between 50 and 59 years. Elderly farmers who were more than 60 years of age make up about 7% of the sampled farmers (Table4.1). This implies that cotton farming in the study area is embraced predominantly by middle-aged men between the ages of 30 and 49 years (51.3%). The average age of cotton farmers in the study area was 49 years. This result agrees with the findings of Sabo *et al*., (2009) in his study economic analysis of cotton production in Adamawa State, Nigeria. They found the mean age of cotton farmers was 45 years. This shows 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 cotton production, which invariably means better efficiency in production. This finding is similar to that of Gwandi *et al*. (2010) which observed that youth constitute the majority of the cotton farmers in the study area. This result is also in line with the findings of Alam *et al*. (1999) who observed that youth constitute the majority of the cottonfarmers. Younger farmers are more flexible to new ideas and risk; hence they are expected to adopt innovations more readily than older farmers.They all suggested the reason for the predominance of younger people in cotton production to be due to its labor intensive nature in production which requires young

and energetic farmers. Other reasons suggested were that young farmers are more agile, aggressive, energetic and capable of making good production decisions. Young farmers also have the potentials for productivity, and hence are likely to be more efficient in cotton production than older farmers. This finding agrees with the finding of Ibrahim (2008) who reported a significant relationship between farmers' age and efficiency. The result also suggests that a lot of young people can be gainfully employed in the cotton farming enterprise.

Table4.1: Age distribution of cotton farmers

Age	**Frequency**	**Percentage**
20-29	12	1.7
30-39	73	22.3
40-49	103	29.0
50-59	20	39.7
>60	147	7.3
Total	355	100
Mean = 49		

4.1.2 Educational level of the respondents

The result in Table4.2 shows that 49% of the farmers had no formal education, about29% of the respondent had only primary education and 11.8% had secondary education while 11% had tertiary education. This indicates that the farmers' educational level is low.

Education is an important socio-economic factor that influence farmer's decision making because of its influence of farmers' awareness, perception and adoption of innovations that can bring about increase in productivity. According to Amaza (2002), education has a positive and significant impact on farmers' efficiency in production. Thus, literacy level will greatly influence the decision making and adoption of innovation by farmers, which may bring about increase in productivity. Studies by

Ajibefun and Abdulkadir (2004) and Ajibefun *et al.* (2003) found that education was key to enhanced productivity among farming households in Nigeria and New England. This is because good education propels farmers to adopt new innovations and technologies that are vital to enhancing farm productivity. Bamidele *et al*. (2008) also noted that when farmers are educated, they would appreciate improved technologies and even use them appropriately in order to enhance their output. Adeyemo *et al*. (2010) revealed that education will obviously improve the efficiency of farmers as it will enable them to access improved technologies and select the best available ones, thereby increasing their output level.

Table 4.2: Educational level of cotton farmers

Educational level	**Frequency**	**Percentage**
No formal education	174	49.0
Primary education	102	28.7
Secondary education	42	11.8
Tertiary education	37	10.5
Total	**355**	**100**

4.1.3 Household size

Table 4.3 shows the distribution of respondents based on household size. About 17% of the respondents had between 1 and 5 people. 33.8% of the farmers had household size that ranged from 6 – 10 persons, implying that there is appreciable number of family labour supply to accomplish various farm operations. According to the report of (Oluwatayo *et al*., 2008), there is a positive and significant relationship between household size and farmers' efficiency in production. However, the absolute number of people in a certain family cannot be used to justify the potential for productive farm

work. This is because it can be affected by some important factors namely; age, sex and health status. The mean household size was 9 persons

Table 4.3: Household size of cotton farmers

Household size	Frequency	Percentage
1-5	61	17.2
6-10	120	33.8
11-15	63	17.7
16-20	60	16.9
>21	51	14.4
Total	**355**	**100**
Mean = 9		

4.1.4 Membership of cooperative society

The result in Table 4.4 shows the membership of cooperative association. About 83% of cotton farmers do not participate in any cooperative association and the reasons for this include: being small scale and unawareness of any association while 17.2% participated with average of 2.4 years. The effect of this result is that most of the cotton farmers in the study area do not enjoy the assumed benefits accrued to cooperative societies through pooling of resources together for a better expansion, efficiency and effective management of resources and for profit maximization.

Table 4.4 Membership of cooperative society

Membership of cooperative society	Frequency	Percentage
Non	294	82.8
Yes	61	17.2
Total	**355**	**100**

Membership of farmers' association has an influence on the level of efficiency particularly for small-scale farmers, because it facilitates access to markets and increases the income level of farmers as well as technical assistance. Idiong *et al.* (2006) and Hassan (2014) observed that membership of association was positively related to technical efficiency, and resulted in increase in output.

4.1.5 Number of years in cooperative society

The result in Table 4.5 showed that out of the total number of 61 farmers belonging to cooperative association, an average of 5 years was spent in the cooperative society. Majority of the respondents (55.7%) had between 1-5 years of cooperative membership. Number of years spent cooperative have positive relationship to farmers efficiency in terms of accessibility to credit, market and input supply.

Table 4.5: Number of years spent in cooperative society

Years spent in cooperative society	Frequency	Percentage
1-5	34	55.7
6-10	19	31.1
11-15	5	8.2
>16	3	5.00
Total	**61**	**100**
Mean = 5		

4.1.6 Extension contacts

The result in Table 4.6 revealed that about 85% of cotton farmers in the study area have no access to extension service while 15.5% have access to extension service with average of 0.4 extension visits. This could be attributed to low extension agent-farmers' ratio in the study area.

Table 4.6 Extension visits

Extension visits	Frequency	Percentage
Yes	300	84.5
No	55	15.5
Total	**355**	**100**

4.1.7Number of extension visits

The result in Table 4.7 showed the number of visits by the extension agent to only 55 farmers visited. Majority (78.2%) were visited only 1- 3 times over the entire cotton cropping season. The number of visits to farmers by extension agents has a positive relationship with farmer' efficiency as revealed in the studies by Apata *et al.* (2008), Yassin (2004) and Rahman (2002). Their studies revealed that there was a significant positive relationship between number of contacts with extension agents and technical efficiency. All the results indicated that farmers with more contact with extension agents had less technical inefficiency. Increased contacts with extension agents would lead to more knowledge on improved production technologies that could have a strong influence on farm output. Adzawla *et al*. (2013) found the technical efficiency to be highest (0.91) for farmers who received between 5 to 6 extension visits during the cropping season.

Table 4.7: Extension visit

Number of extension visits	Frequency	Percentage
1-3	43	78.2
4-6	8	14.5
>7	4	7.3
Total	**55**	**100**
Mean = 0.5		

4.1.8Access to credit by cotton farming

The result presented in Table 4.8 shows that about94% of the respondents financed their cotton production from personal savings, while 6.2% sourced credit through Bank of Agriculture. The low access to credit could be attributed to the fact that government seldom grants financial credit to farmer. Yassin (2004) in his study on irrigated cotton production constraints Sudan; the case study of Gezira scheme observed that farmers who are not constrained by credit are more technically efficient than those who are. Similarly, Hassan (2014), Tanko and Opara (2004) reported a positive relationship between credit and technical efficiency. This implies that farmers who have access to credit tended to be more efficient in production. To be more effective in increasing farmers' productivity, it is suggested that institutional credit should be of low interest rate, procedures of advancing loan should be made simple to peasant farmers and credit should be made available on time (Shah *et al.*, 2008)

Table4.8: Access to Credit

Access to credit	**Frequency**	**Percentage**
Non	333	93.8
Yes	22	6.2
Total	**355**	**100**

4.1.9Distribution of respondent based on years of farming experience

Table 4.9 shows the distribution of respondent based on years of farming experience. The result shows that 53% of cotton farmers in the study area had experience in the cotton production from one and ten years, 33% had been producing cotton for eleven and fifteen years, 14% had experience in cotton production for more than twenty years. The mean years of experience for cotton farmers were 13 years.

Years of farming experience is an important factor that influences production efficiency among farming households. Farmers with more years of farming experience have been observed to have higher farm output than those with lesser years of farming experience (Udoh and Falake, 2006).

Table 4.9: Years of experience in cotton farming

Years of farming experience	Frequency	Percentage
1-5	75	21
6-10	114	32
11-15	118	33
>15	48	14
Total	355	100
Mean = 12		

4.1.10Distribution of respondent based on farm size

The respondent's cotton farm sizes are shown in Table 4.10. Majority (66.7%) of the farmers had farm size of 0.5 to 2.5hectares, 21.7% had farm size of 3 to 5 hectares, 8.3% of the farmers had farm size of 5.5 to 7.5 hectares, and 3.3% had farmssizes of more than 7.5 hectares. The average farm size was 1.3 hectares. The distribution of farmers according to farm size indicates that the majority(88%) of cotton farmers were small-scale farmers based on Olayide and Heady (1982) classification of farmers as follows;0.1 to 5.0 hectares (small scale); 5.5 to 10 hectares (medium scale);and 10 hectares and above (large scale). Since the majority of the respondents have farms holdings between 0.1 and 5.0 hectares, it means that those farmers cannot achieve economies of large scale production. Small size farms are impediment to agriculture mechanization because using farm machineries like tractors will be difficult. Gul *et al.* (2010) found positive relationship between farm size and technical efficiency which indicated that larger farm sizes are more technically efficient than small farms in rice

production. This may be partly because large-scale farmers can afford timely and adequate supply of resources and partly because of scale factor (SANEI, 2007).

Table 4.10: Distribution of the respondents by their farm size

Farm size (ha)	Frequency	Percentage
0.5-2.5	234	66.7
3-5	77	21.7
5.5-7.5	29	8.3
>7.5	11	3.3
Total	355	100
Mean = 1.3		

4.1.11 Marital status of cotton farmers

Table 4.11 show the distribution of respondents based on marital status. Majority (85.1%) of the cotton farmers were married. The result shows that 11.8% of the respondents were single, 1.1% were widowed, and 2% were divorced. In their study on gender differential in farm productivity: implication for household efficiency and agricultural policy Udry*et al*.(1995) observed that marital status was positive and significantly related to the technical efficiency of it male farmer.

Table 4.11: Distribution of the respondents by their marital status

Marital status	Frequency	Percentage
Single	42	11.8
Married	302	85.1
Divorced	7	2.0
Widowed	4	1.1
Total	355	100

4.1.12Land acquisition

Land is one of the important resources for cotton production. The study revealed that 65.1% of the cotton farmers acquired their land through inheritance, 10.2% acquired theirs through hiring, 20% through purchase, while the remaining 5% acquired theirs by

leasing. This result is shown in Table 4.12. The reason for the result was due to the nature of land tenure system and inheritance characteristics and the religious (Islam) affiliation of the majority of the respondents in the study area.

Table 4.12: Land Acquisition of cotton Farmers

Land acquisition	**Frequency**	**Percentage**
Inheritance	859	65.1
Hiring	134	10.2
Purchase	264	20.0
Lease	62	4.7
Total	1320*	100

* Multiple Response Allowed

4.2 Costs, Returns and Profitability of Cotton Production in North-West Nigeria

The analysis of the various costs, returns and profitability was used to achieve objective (**ii**) of the study.

4.2.1Costs of cotton production in the study area

Cotton seed used by the farmers in the study area were mainly seeds bought from the ginneries through the local cotton merchants assumed to be from the previous year's harvest. The average quantity of cotton seed used was 45 kg/ha as against the recommended amount 50kg/ha. The average market price of the cotton seed was ₦56per kilogram and this constitutes 4.5% of the total cost of production. The quantity of fertilizer used was 100kg/ha as against the recommended quantity of 200kg/ha. The average open market price of the fertiliser was ₦100 per kilogram (₦5000 per bag) was used and this constitutes about 18% of the total cost of production.

Labour costs consist of cost of land preparation, planting, fertilizer application, weeding, and harvesting. The family labour was computed on the basis of opportunity cost in man-day. The wage rate based on the responses from the returned questionnaire

varied according to farm operation performed. An average wage rate of ₦400 per man-day was used, giving the average labour cost per hectare to be ₦35000.

The total cost of fixed inputs (cost of renting land and depreciation of tools) incurred on cotton production was ₦6350 and this constitutes 11.3% of the total cost of production.

4.2.2 Measurement of profitability in cotton production

4.2.2.1 Net-farm income

The analysis of the net farm income was carried out so as to determine the level of profit associated with cotton production in the study area. The result is presented in Table 4.13. The analysis revealed an average revenue of ₦97,375 per hectare and a total cost of production ₦55,850 per hectare thus, the net farm income realised was ₦41,525.

The total cost of production consist of the costs of fertilise, seed, agrochemicals, labour, costof renting land and depreciation on farm tools. The cost of labour constituted about 63% of the total cost of production in cotton. This indicated that labour is a very important input cotton production. This result is similar to the findings of Odedokun (2014) in his study on cotton production in Zamfara State, Nigeria.He clearly indicated that labour contributed immensely in the cost of cotton production and hence a reduction in net farm income if not properly managed. This compares favourably with the finding of Sabo *et al.*,(2009) who reported that labour accounted for 50% of the total variable cost of production in cotton production in Adamawa State, thus suggesting that cotton production is labour intensive.Agro chemicals accounted for about 4% of the total cost of production, indicating the low level of this input usage by cotton farmers.

The net farm income of ₦41,525 therefore indicated that cotton production is profitable in the study area. This findingagree with similar works of Alam *et al*. (2013) and Gwadi *et al*. (2010) in Taraba State, Nigeria and Daniel *et al.* (2010) in Adamawa State, Nigeria who all reported that cotton production was profitable.

Table 4.13: Average Cost and Return per Hectare of Cotton Production

Variable	**Actual**	**Recommended**	**Value/cost (₦/ha)**	**(%) Contribution**
1.**Total Revenue**			97,375	
2. **Variable Costs**				
(a) seed (kg)	45kg/ha	50kg/ha	2,500	4.5
(b) Fertilizer(kg)	100kg/ha	200kg/ha	10,000	17.9
(c) Labour(man-day)			35,000	62.7
(d) Agro-chemicals	2lts/ha	1lt/ha (3-4 Spray)	2,000	3.6
3. **Total variable Costs(a+b+c+d)**			49,500	88.6
4. **Fixed Costs**				
(a) Cost of Renting Land			5,000	8.9
(b) Depreciation on Tools			1,350	2.4
5. **Total Fixed Cost(4a+4b)**			6,350	11.4
6. Total Cost(3+5)			55,850	100
7. Net-Farm Income(1-6)			41,525	
8. Profitability Index (1/6)			1.7	
9. Gross Ratio (6/1)			0.57	
10. Operating Ratio (3/1)			0.18	

Source: Field survey, 2015

The net farm income might be misleading because it may not be a good reflection of the amount of capital, labour, and management involved in the production process (Olukosi and Erhabor, 2008). The study therefore examined other measures of profitability.

4.2.2.2 Profitability index (Return to investment in cotton production)

Table 4.13 shows the average rate of return on investment per hectare (return per naira invested per hectare) was 1.7, indicating that for every ₦1 invested in cotton production in north-west, Nigeria, a profit of 70 kobo was made. This result is higher than what Odedokun (2014) obtained. Thus, it could be said that Cotton production in the study area though on a small scale, was economically viable.

4.2.2.3 Gross ratio

The gross ratio is the total farm expenses divided by total revenue. In this study the result in Table 4.13 indicated a gross ratio of 0.57. This ratio shows that the total farm costs was about 57% of the gross income. A less than one ratio is desirable for any farm production business. The lower the ratio, the higher the return per naira invested. A greater than one ratio is disastrous for a farm operation and might indicate over utilization of certain resources as is the case with result of this study. It is therefore advisable that cotton farmers in the study area should consider ways of reducing costs and increasing gross income.

4.2.2.4 Operating ratio

The operating ratio is the total operating cost divided by gross income. In this study the result shows the operating ratio to be 0.18. This is quite low as it shows that a high proportion of the net-farm income goes to pay for the operating cost. The operating cost is directly related to the farm variable input usage. An operating ratio of 1 means that the net-farm income barely covers the expenses on the variable inputs used in cotton production in the study area. It is therefore advisable for cotton farmers in the study area to improve the usage of variable resources in terms of reducing costs and/or increasing gross income (Olukosi and Erharbor, 2008).

In conclusion it could be said that profitability in cotton production in the North-West is not encouraging based on the result of the various profitability measures discussed above. The most probable explanation that could be offered was very low price offered to the cotton farmers despite the high cost of inputs.

4.3 Efficiency of Cotton Production

This was used to achieve objectives (**iii**and**iv**) of the study. Ajibefun, (2008) highlights parametric methods to include production, cost, and revenue functions as alternative methods of describing the production technology and estimating efficiency of production.

4.3.1 Estimation of technical efficiency of cotton farmers (input-output relationship)

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 4.15. The

study revealed that the generalized log likelihood function was -542.47. The log likelihood function implies that inefficiency exist in the data set. The value of gamma (γ) is estimated to be 76% and it was highly significant at 1% level of probability. This is consistent with the theory that true γ-value should be greater than zero. This implies that 76% 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 (δ^2) was significantly different from zero level of probability. This indicates a good fit and correctness of the specified distribution 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 cotton farmers.

However, the estimated coefficients of all parameters of production function were positive.Seed and fertilizerwere positive and significant at 1% level of probability, while the coefficient of agrochemical was positive at 5% and hence play a major role in cotton production in the study area. The average technical efficiency for the farmers is 0.762 implying that, on the average the respondents are able to obtain 76% of potential output from a given mixture of production inputs. Thus, in a short run, there is minimal scope (24%) of increasing the efficiency, by adopting the technology and techniques used by the best cotton farmer.

The estimated coefficient for seed was 0.195, which is positive and statistically significant at 1% level. The estimated 0.195 elasticity of seed implies that increasing seed by 1% will increase cotton 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 seed are not used, output will be low even if other inputs are in abundance. This is in line with the findings of Shehu *et al* (2007) who observed that the estimated coefficient of seed and labour inputs were positive as expected and significant at 1% level implies that more seed is applied and the more labour employed the better the output of cotton.

Result of the overall elasticity of production is also shown in Table 4.14. Elasticity of production is a useful guide that enhances farmers to be prudent and rational when allocating and utilizing inputs in production. The elasticities derived from the Cobb-Douglas equation was 0.68.This gives the return to scale which was obtained from the summation of the coefficients of the estimated input elasticities. The behaviour of all the inputs when all the factors of production are changed simultaneously in the same proportion is referred to as return to scale. Since this value(0.68) was less than 1, it shows that it is a positive decreasing return to scale at stage II of production process where every farmer strives to maximize profit and minimize cost of production. The result also shows that if all the inputs included in the production function model are increased by 1%, cotton output will by 0.68%.

Table 4.14: Elasticity of Production and Return to Scale in Cotton Production

Variables	**Parameter**	**Coefficient**
Seed	β_1	0.194643
Fertilizer	β_2	0.357827
Agrochemicals	β_3	0.1143^{**}
Labour	β_4	0.021469
Return to scale (RTS)		**0.68**

The production elasticity of output with respect to quantity of fertilizer was 0.4 which is positive and statistically significant at 1% level. This implies that a 1% increase in fertilizer will increase cotton output by 0.4%. The coefficient of fertiliser also has the highest value. This indicated that fertiliser devoted to cotton production was the most important input to which output was responsive because it has the highest elasticity. Fertilizer is major land augmenting input because it improves the quality of land by raising yields per hectare. This study is in agreement with the findings of Ajibefun and Abdulkadir (2004) in their study on the impact of farm size on resources use efficiency in small-scale food crop farming in south-western Nigeria. Similarly,Bakhsh (2007) had the same opinion in his study on technical efficiency and profitability of growing potato, carrot, radish and bitter gourd in Punjab province of Pakistan.

The coefficient of agro-chemical was 0.11 which was positive and statistically significant at 5% level and has the expected positive sign, which is in conformity to *a priori* expectation. This shows the importance of optimal application ofagrochemicals in cotton farming in the study area. This is in line with several studies by Umoh (2006) which show the importance of optimal agro-chemical usage in farming particularly in developing countries where most farmers operate on small-scale farms.

The coefficient for labour was positive and significant at 5%. This implies that labour positively influences the output of cotton farmers in the study area especially human labour that plays a crucial role in virtually all farming activities. This situation has variously been attributed to the practice of split-plot cropping on small-scattered land holdings and lack of affordable equipment (Umoh, 2006).

Table 4.15: Maximum Likelihood Estimation Result of Stochastic Frontier Production Function

Variables	**Parameter**	**Coefficient**	**Standard-error**	**T-ratio**
Constant	β_0	8.853976	0.888785	9.961886
Seed	β_1	0.194643***	0.06151	3.164429
Fertilizer	β_2	0.357827***	0.105037	3.406666
Agrochemicals	β_3	0.1143**	0.0553	2.065200
Labour	β_4	0.021469	0.030394	0.706335
Diagnostic statistic				
Sigma-squared		1.247729***	0.090693	13.75777
Gamma		65.5*	0.516162	1.937376
Log likelihood function	-542.47			
LR Test	68.466			
Total number of observation	355			
Mean efficiency	0.762			

***P<0.01 **P<0.05 *P<0.10

4.3.2 Estimated stochastic frontier cost functions

The Maximum Likelihood (ML) estimates of the stochastic frontier translog cost parameters for cotton are presented in Table 4.16. For the cost function, the sigma

($\delta^2 = 0.7$) and the gamma ($\gamma = 0.0006$) are quite high for the sigma and very low for the gamma. The high and significant value of sigma square (δ^2) indicated the goodness of fit and correctness of the specified assumption of the composite error terms distribution (Idiong, 2005). The gamma ($\gamma = 0.0006$) shows that 0.06% of the variability in the output of cotton farmers that are unexplained by the function is due to allocative inefficiency.

The result of translog stochastic frontier cost function for cotton in north-west, Nigeria is shown in Table 4.16. The coefficients of the parameters of the cost function are positive except that of fertilizer, which is negative. The cost variable seed is significant at 10% level while fertilizer and labour are not significantly different from zero.

The coefficient of labour cost (0.61) was the highest.This therefore shows that labour is an important cost component in cotton production. This is also reflection of the result in Table 4.13, which shows that labour accounted for about 63% of the total cost of production in cotton.

The coefficient for cost of planting material (seed) was positive and statistically significant at 10%. This implies that the cost of planting materials (seed) is an important cost component in production ofcotton. The estimated coefficient of this variable input(seed) was positively signed and statistically significant at 10% level indicating that if there is an increase in cotton output the total cost of production will increase. This shows that the cost of production is influenced by the prices of input applied. The result of this research agrees with the findings of Ogundari *et al.* (2006) where they

reported direct effect of input on cost of production in their study on economies of scale and cost efficiency in small maize production in Nigeria.

Table4.16: Maximum Likelihood Estimates Results of Frontier Cost Function (Allocative Efficiency) of Cotton Production

Variables	**Parameters**	**Coefficients**	**Std. error**	**T - Value**
Constant	β_0	7.0601	0.5767	12.24***
Seed	β_1	0.1510	0.0904	1.671*
Fertilizer	β_2	-0.0182	0.0306	0.594
Agro-chemicals	β_3	0.1143	0.0553	2.0652**
Labour	β_4	0.6058	0.1722	0.381
Diagnostic statistic				
Sigma-square	(δ^2)	0.7603	0.10394	7.314***
Gamma	(γ)	0.0006	0.0139	0.044
Log likelihood function	*L/f*	-158.820		
LR rest	5.696			
Total number of observation	355			
Mean efficiency	0.61			

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

4.3.3 Frequency distribution of technical, allocative and economic efficiency estimates of cotton farmers

4.3.3.1 Frequency distribution of technical efficiency estimates of cotton farmers

The frequency distribution of the technical efficiency estimates for cotton farmers in the study area as obtained from the stochastic frontier model presented in Table 4.17. It was observed from the study that the average technical efficiency level is 0.65 ranging from 0.10 to 0.99. This is comparable to the studyof Mohammed-Yusuf (2005)on the effects of market reform on cotton production efficiency in Tajikistan. Similarly, Tsimpo,(2010) in his study on technical efficiency and optimal farm size in the Jajik's cotton sector found a mean technical efficiency of 0.67.Neba *et al*.,(2010) had also a similar finding (mean technical efficiency of 0.83) in their study on determinants of technical efficiency of cotton farmers in northern Cameroon. Adzawla *et al*., (2013) in their study on technical efficiency of cotton production in Yendi Municipality, northern Ghana had mean, maximum and minimum technical efficiency estimates of 0.88, 0.99 and 0.70.

The result of the study in Table 4.17shows that 30% of the farmers had technical efficiency (TE) of 0.81 and above while 70% of the farmers operate at less than 0.8 efficiency level. The farmers with the best and least practice had a technical efficiency of 0.99 and 0.10, while the average technical efficiency index is about 0.65 respectively. This implies that on the average, output fall by 35% from the maximum possible level due to inefficiency. Also 65% of the farmers were estimated to have a technical efficiency exceeding 0.8, indicating there are some 35% technically inefficient farmers in the study area. In another word, the result of the mean technical efficiency of the farmers implies that, on average 65% of output was obtained from the given mix of

production inputs by farmers. This is an indication that cotton output of farmers have fallen by 35%,otherwise there is potential for increasing output by 35% through the adoption of efficient farming practices. However, it can be seen from the result in Table 4.14 that 63% of the respondents had efficiency score of at least 80% and above.

The results also suggest that for the average farmer in the study area to achieve technical efficiency of his most efficient counterpart, he could realize about 35per cent (1 – 0.65/0.99x100) cost savings while on the other hand, the least technically efficient farmers will have about 91per cent (1 – 0.10/0.99x100) cost saving to become the most efficient farmer. The fact that the technical efficiency of all sampled farmers is less than 1, implies that no farmer reached the frontier.

Table 4.17: Frequency distribution of technical efficiency estimates

Technical efficiency	**Frequency**	**Percentage**
0.10-0.20	7	1.972
0.21-0.40	50	14.085
0.41-0.60	70	19.718
0.61-0.80	122	34.366
0.81-1.00	106	29.859
Total	355	100
Average	0.646681	
Maximum	0.994639	
Minimum	0.10338	

4.3.3.2Frequency distribution of allocative efficiency estimates of cotton farmers

The allocative efficiency estimates presented in Table 4.18, indicate that it ranged from 0.10 to 1.00; the mean allocative efficiency is 0.71 ranging from 0.14 and 0.99. The mean allocative efficiency of the farmers implies that on average 71% of output was obtained from the given mix of production inputs prices by the farmers. This is an indication that cotton output has fallen by 29% due to farmers' allocative inefficiency. There is the potential for increasing output 29% through proper use of inputs optimally.It can be seen that as high as about 76% of the respondents had efficiency score of at least 80%. The result also showed that about 44% of the cotton farmers had allocative efficiency of 0.81 and above, while 56% operated at allocative efficiency of less than 0.8. The result indicates that average cotton farmer in the study area would enjoy cost saving of about 28.3 (1-0.71/0.99x100) per cent if he or she is to attain the level of the most allocatively efficient farmer among the respondents. The most allocatively inefficient farmer will have an efficiency gain of 87% (1-0.14/0.99x100) incotton production if he or she is to attain the efficiency level of most allocatively efficient farmer in the state. It is evident from these results that allocative inefficiency constitute a more serious problem than technical inefficiency by comparing the average and least efficient farmers have to attain to reach the level of the most efficient farmer.

Table 4.18: Frequency distribution of allocative efficiency estimates

Allocative Efficiency	Frequency	Percentage
0.10-0.20	1	0.281
0.21-0.40	20	5.634
0.41-0.60	66	18.592
0.61-0.80	112	31.549
0.81-1.00	156	43.944
Total	355	100
Average	0.71854	
Maximum	0.994639	
Minimum	0.141251	

4.3.3.3 Frequency distribution of economic efficiency estimates of cotton farmers

The stochastic frontier production function and cost functions were used to estimate the economic efficiencies indices of the farmers in the study area. Economic efficiency indices were estimated as the product of technical and allocative efficiency indices.

The frequently distribution of the economic efficiency estimates for cotton farmers in the study area as obtained from the stochastic frontier model is presented in Table 4.19. The combined multiplicative effect of technical and allocative efficiency shows that the average economic efficiency indices for the sampled farmers were 0.48 with a low of 0.2 and a high of 0.98. It was observed from the study that 9% of the farmers had economic efficiency (EE) of 0.81 and above while 91% of the farmers operate at less than 0.8 efficiency level. The mean economic efficiency of the 355 sampled farmers in the study area was 0.48. The farmer with the best and least practice had economic efficiencies of 0.98 and 0.02 respectively. This implies that on the average, output fall by 48% from the maximum possible level due to economic inefficiency. Also 9% of the

farmers were estimated to have economic efficiency exceeding 0.8, indicating there are some 20% economic inefficient farmers in the study area.The study also suggest that for the average farmer in the study area to achieve economic efficiency of his most efficient counterpart, he could realize about 51per cent (1 – 0.48/0.98x100) cost saving while on the other hand, the least technically efficient farmers will have about 99 percent (1 – 0.02/0.099x100) cost saving to become the most efficient farmer. However, the average economic efficiency of the cotton farmers was 48per cent. This indicates that cotton farmers were economically inefficient. In his study on cotton production and supply trend in Zamfara State, Nigeria, Odedokun (2014) observed that the farmers had lower values of the mean, minimum and maximum economic efficiency indices of 0.44, 0.01 and 0.81. Also in his study on productivity and economic efficiency of cocoa farmers in the South-West region of Cameroon, Gama, (2012) estimated lower values of mean (0.36), minimum (0.06) and maximum (0.66)economic efficiency indices.

Table 4.19: Frequency distribution of economic efficiency estimates

Economic Efficiency	**Frequency**	**Percentage**
0.10-0.20	45	12.676
0.21-0.40	95	26.761
0.41-0.60	89	25.070
0.61-0.80	93	26.197
0.81-1.00	33	9.296
Total	355	100
Average	0.484223	
Maximum	0.989308	
Minimum	0.019952	

4.3.4 Determinant of technical, allocative and economic inefficiencies

4.3.4.1Determinants of technical inefficiency

Table 4.20 shows the determinants of technical inefficiency in cotton production in North-West Nigeria. It should be noted that the socio-economic and institutional variables used in the technical efficiency model are the determinants of inefficiency and not efficiency. This implies that a negative sign on a parameter means that the variable reduces technical inefficiency and increases technical efficiency, while a positive sign means a variable increases technical inefficiency and thus reduces technical efficiency.

The coefficient for age in this study was positive and significant at 1% level of significant. This shows that increase in age increases technical inefficiency. This is similar to the findings of Adzawla *et al* (2013).Valino and Fleming (2006) in their estimation of excess water use in irrigated agriculture using data envelopment analysis in Punjap found that older farmers were less willing to adopt better practices and less willing to take risks of adopting new innovations and hence more technically inefficient. This is in contrast to the findings of several studies including that of Neba *et al* (2010), Gul *et al* (2009) and Kouser*et al* (2010) who found age to be negatively related to technical inefficiency.The possible reason given may be due to the fact that as the farmers advanced in age, inefficiency in resourceuses decreases, while technical efficiency increases.

Household size showed a negative relationship with predicted technical inefficiency and is not significant. This implies that farmers who have a large household sizes are more technically efficient. The reason for this relationship is that as the number of people in a household increases, a pool of family labour becomes available and this leads to specialization.

Education showed a negative relationship with technical inefficiency and is not significant. The negative coefficient of education reveals that the level of education results in reduction in technical inefficiency of cotton farmers.This is in accordance with *a priori* expectation. The finding also agrees withKalirajan and Shard (1985) in their study on types of education and agricultural productivity in Jamil Nada rice farming.They state that 'education sharpens managerial input and lead to a better assessment of the importance and complexities of good decisions in farming.' Educated farmers are able to gather, understand and use information from research and extension more easily than illiterate farmers. Moreover, educated farmers are likely to be less risk-averse and therefore more willing to try out modern technologies. Kehinde and Awotido (1985) in their study on production efficiency of mechanized arable farming in Osun State, Nigeria observed that education sharpens managerial input and leads to a better assessment of the importance and complexities of good decisions in farming.

The coefficient for extension contact was negative and significant at 1% level. Access to extension services increases the level of cotton farmers' availability of information about technical aspects of crop technologies that play an important role in increasing farm level efficiency. The availability of an extension worker in the community and the usefulness of the extension messages (as perceived by the respondents) are significant determinants of technical efficiency. Furthermore, farmers who are members of extension-related organizations exhibit higher levels of efficiency. For instance, Asongwa *et al.* (2011) in the analysis of the efficiency of Nigerian small-scale farmers in Benue State observed that a marginal increase in access to extension contact of households resulted in 22.23% decline in technical inefficiency among the

respondents.In some cases extension agent are also the channels of input supply to rural farmers. For extension contact to achieve the desired impact in improving technical efficiency, the farmers must be able to adopt the improved technology to their local situation

The coefficient of cooperative membership was positive and significant at 1%. This also contrary to *a priori* expectation as reported by several authors including Gana *et al.*(2000), Odedokun (2014). The reasons might be that although farmers belong to a cooperative association, they do not derive any benefit from their membership, but rather tie down their resources and end up being used in unprofitable ventures. It also shows that membership of cooperative association does not favor cotton marketing or cheap input procurement at all.

The coefficient for farming experience (number of years in cotton production) was negative and significant at 10%. This shows that it increases technical efficiency and decreases technical inefficiency. Udoh *et al.* (2006) in their study on socio-economic characteristics and adoption trend of artisanal fishing in Akwa Ibom State, Nigeria observed that farmers with more years of farming experience have been observed to have higher farm output then those with lesser years of farming experience. In a study on estimating technical efficiency of cotton production in Yendi Municipality, northern Ghana, Adzwala *et al.* (2013) found that the coefficient of farmers' experience was negative and significant at 5% implying that farmer cultivating cotton for longer years were less technically inefficient. This was perhaps due to their ability to draw on past experience to suit their farming condition. Neba *et al*., (2010) also found experience to

positively influence technical efficiency and stressed that technical know-how obtained through experience increases technical efficiency.

The coefficientof access to credit was negative and significant at 1%. This is in accordance with *a priori* expectation, because credit is believed to increase crop area, more input application and more yields (Shah *et al.*, 2008, Taylor and Shinkwiler, 1986). Also Yessin (2004) in his study observed that farmers who are not constrained by credit are more technically efficient that those who are. It must however be noted that for access to credit to positively affect technical efficiency, the credit has to properly managed and sound agronomic practices has to be adopted (Adejoh, 2010).To be more effective in increasing farmers' productivity, it is suggested that institutional credit should be of low interest rate, procedures of advancing loan should be made simple to peasant farmers and credit should be made available on time (Shah *et al.*, 2008).

The coefficient of household size was negative although not significant. This shows that increase in household size decreases technical inefficiency. The more the household size, the more availability of family labours to carryout various farm operations. This agrees with the findings of Kehinde and Awotido (2012).

The co-efficient of marital status was negative and not significant.This shows that marital status reduces technical inefficiency and increase technical efficiency. This disagrees with Rahman and Umar (2009) in their study who found marital status to be positive and significantly related to technical efficiency.

The co-efficient of Gender Dummy (male=1) was negative and not significant. This shows that women farmers can produce Collin more efficiently than men.

This disagrees with the finding of Rahman and Umar (2009) in their study on measurement of technical with determination in crop production in Lafia local government, Nasarawa State,Nigeria, but agrees with Onyeweaku (2009).

Table 4.20: Estimateddeterminants of technical inefficiency

Variable	**Parameter**	**Coefficient**	**Standard error**	**T-value**
Constant	Z_0	0.819296	0.19801	4.138
Age	Z_1	0.002532*	0.001347	1.88
Education	Z_2	-0.00871	0.009596	-0.907
Access to credit	Z_3	-0.155505***	0.041674	-3.731
Household size	Z_4	-0.00017	0.000151	-1.124
Cooperative membership	Z_5	0.008745***	0.001292	6.769
Extension contact	Z_6	-0.00119***	0.001663	0.715
Farming experience	Z_7	-0.003*	0.001588	-1.889
Marital status	Z_8	-0.11229	0.090538	-1.24
Gender	Z_9	-0.03188	0.040713	-0.783

***P<0.01 **P<0.05 *P<0.10

4.3.4.2 Determinants of allocative inefficiency

The result is presented in Table 4.21.The coefficient for educational level of farmers was negative and significant at 10%. Education raises the technical competence of an entrepreneur and enables the entrepreneur to cope with the complexities associated with adoption of improved technologies (Tanko and Opara, 2009). Seyoum *et al* (1998) in their study observed that education enhances a farmer's ability to seek, decipher and make good use of information about production inputs. Educated household heads may

better understand and process information provided by different sources regarding new investments thereby reducing their allocative inefficiency.

The coefficient of access to credit has a positive sign and not significant. This shows that it decreases allocative efficiency and increase allocative inefficiency. This is contrary to *a priori* expectation that access to credit should have positively affected allocative efficiency, or reduces allocative inefficiency. The result might be explained probably due to the fact that the credit obtained was not judiciously allocated in the cotton production process. The credit might have been diverted to other nonfarm household expenditure including marrying an additional wife or payment of children school fees. This confirm to the assertion of Adejoh (2010) in his study on production efficiency and profitability of yam production in Ijumu local government area of Oyo State, Nigeria that access to credit per see does not influence allocative efficiency but the proper management of the credit facility as well as application of sound agronomic practices. Another probable reason for the result might be that the interest rate on the credit was high or the credit was not given on time for the farmers to use during the cropping season. This is in accordance with Shah *et al.*, (2008) in their study on impact of agricultural credit on farm productivity and income of farmers in mountainous agriculture in northern Pakistan. Their study revealed that for institutional credit to be more effective in increasing farmers' productivity, the institutional credit should be of low interest rate, procedures of advancing loan should be made simple to peasant farmers and credit should be made available on time.

Table 4.21: Estimated determinants of allocative inefficiency

Variable	Parameter	Coefficient	Standard Error	T-Value
Constant	Z_0	0.851952	0.160308	5.314
Age	Z_1	0.00149	0.00109	1.367
Education	Z_2	-0.0132*	0.007769	-1.699
Access To Credit	Z_3	0.288170	0.337391	0.854
Household Size	Z_4	-0.00013	0.000122	-1.028
Cooperative Membership	Z_5	0.000143	0.001046	0.137
Extension Contact	Z_6	0.004612***	0.001346	3.426
Farming Experience	Z_7	-0.00386***	0.001286	-3.001
Marital Status	Z_8	-0.03598	0.073299	-0.491
Gender	Z_9	-0.06559*	0.032961	-1.99

***P<0.01 **P<0.05 *P<0.10

The coefficient of household size has a negative sign. This shows that it increase allocative efficiency, and decrease allocative inefficiency. This is because the household size is a determinant factor in labor availability which is very crucial in cotton production by virtue of its contribution to variable cost of production(63%). thus decreasing allocative inefficiency.

The coefficient of farming experience was negative and statistically significant at 1%. This shows that it increase allocative efficiency and decreases allocative inefficiency. This is perhaps due to their ability to draw on past experience and apply to their present farming conditions.

The co-efficient for extension contact was positive and significant at 1% level. This is contrary to the a *priori* expectation.It shows that extension contact increases technical

inefficiency. The probable reason may be that recommended practices were not properly utilized as evident from the comparison of the actual variable inputs applied and the recommended.

The coefficient for age was positive significant and not significant. This shows that age increases allocative inefficiency and decreases allocation efficiency.This is agrees with Coelli *etal.,* (2002).

in his study on technical, allocative, cost and scale efficiency in Bangladesh rice cultivation.They noted that older more experienced farmers were less technical and cost efficient. Although they have more knowledge of their land and traditional practices, but are also less willing to adopt new ideas or take risk in resources allocation,and the second effect is more dominant.

The coefficient for cooperative membership has a positive sign, meaning that it increases allocativeinefficiency. This is contrary to the *a priori* expectation. As noted in the result majority(83%)the farmers do not belong to any cooperative society. The few ones (27%) that belong to cooperative society did not seem to derive any assumed benefit of cooperative such as access to the market, creditfacility, extensioncontact, input procurement etc. Rather thy might have tied down their resources into these not profitable cooperative societies and hence denied the resource for input procurement during the season and hence less allocative efficiency.

The co-efficient for gender dummy (male=1) was negative and significant at 10%.

The co-efficient for marital status was negatively correlated with allocative inefficiency and decreases economic efficiency.

4.3.4.3 Determinants of economic inefficiency

Table 4.22 shows of the estimated parameters of the economic inefficiency model. Educational level, household size, extension contacts, marital status and gender are not statistically significant. The coefficient for educational level was negative. The negative coefficient for education implies that economic inefficiency reduces as this factor increases. Education is a central ingredient in a strategy to improve agricultural productivity especially where the use of modern inputs are emphasized (Adeyemo*et al*., 2010). A study by Joshua (1999) in low-income countries indicated the significant contribution of education towards agricultural production. The study revealed that a farmer who had completed four years of elementary education, obtained on the average 13.2% more output that those with no education. The role of education is important for development and management of low-income agriculture. Education influences the farmer to adopt improved practices in crop production. It also help in changing the outlook of the farmer so that he will be receptive to, and on his own initiative continuously seek to improve his farm productivity. In their estimation of economic efficiency of smallholder sweet potato production in Imo State of Nigeria, Nwaru *et al*., 2011 found that better performance by more educated farmers may be attributed to educational access, which give the farmers the ability to perceive, interpret and respond to new information and improved technologies such as fertilizers, pesticides and planting materials much faster than their less educated counterparts.

The coefficient for extension contact was positive and not statistically significant. This means that economic inefficiency increases with increase in extension contact. It is either that the quality of extension service was poor in the study area (for example, wrong information was passed to the farmers from extension quarters for example overdose of a certain chemical spray) or the farmers did not follow the recommended extension advice This could be true from the fact thatfarmers do not normally apply the recommended production practices in cotton production as can be seen in Table 4.13. Farmers have failed to use the recommended quantities of input hence, the extension contacts have failed to produce the expected results. In addition, farmers have reported high cost of fertiliser as a key input to increased cotton output. Infrequent contacts with extension personnel my result in lack of awareness among the cotton farmers of proper agronomic practices. Nwaru *et al.* (2011) opined that by ensuring resources are better mobilized and more efficiently used, a vibrant and functional extension system could be a solution to the problem of acute scarcity of resources in the rural economy which is complicated by inefficiency of use of such resources.

Table 4.22: Estimated determinants ofeconomic inefficiency

Variable	Parameter	Coefficient	Standard error	T-value
Constant	Z_0	0.701043	0.215874	3.247
Age	Z_1	0.002483*	0.001468	1.691
Education	Z_2	-0.01273	0.010461	-1.217
Access to credit	Z_3	-0.26196***	0.045434	-5.766
Household size	Z_4	-0.0002	0.000165	-1.212
Cooperative membership	Z_5	0.005880***	0.001409	4.173
Extension contact	Z_6	0.000937	0.001813	0.517
Farming experience	Z_7	-0.00391**	0.001731	-2.259
Marital status	Z_8	-0.10872	0.098707	-1.101
Gender	Z_9	-0.05975	0.044386	-1.346

***P<0.01 **P<0.05 *P<0.10

The coefficient for age of cotton farmers was positive and significant at 10%. This means that economic inefficiency increases with increase in age of farmers. This shows that older farmers are economically inefficient that younger ones. This might probably explain the reason why the majority (50%) of farmers in the study were within the ages of 30 and 49 years.

The coefficient for farming experience was negative and significant at 5%. This shows that it increase economics efficiency, and decreases economic inefficiency. This is because with more years of farming experience higher output is obtained which economically imply higher profit.

The coefficient of access to credit was negative and significant at 1% level of probability. This means that themore farmers have access to credit the better resources

at the disposal of the farmer to enhance his agricultural production though adequate and timely input procurement.

The coefficient for cooperative membership was positive and significant at 1%. This is contrary to the *a priori* expectation as reported by Odedokun (2014). The reason might be that members of cooperative society did not derive any benefit from the cooperative association; rather they have tied down their lean resources in the unproductive cooperative associations at the expense of cotton production.

The coefficient of household size was negative although not significant. This shows that it increases economic efficiency and reduces economic inefficiency; Kehinde and Awotide (2012) in their study of economic efficiency of mechanized arable crop farming in Osun State, Nigeria observed that household size was positively related to technical efficiency. Their reason for this relationship was that farmers with large household sizes may have easy access to family labour, thus saving cost of labour input, and improve economic efficiency.

The coefficient for marital status was negatively correlated with economic inefficiency. This shows that marital status decreases economic efficiency and increases economic inefficiency.

The co-efficient for gender dummy (male=1) has negative sign,thus a negative impact on economic inefficiency,meaning that woman can produce more cotton with more efficiency than male.This result agrees with SANEI(2007)in the study of impact of participatory extension programme in technical efficiency of farmers in Nepal.

4.4 Tests of Hypotheses.

Three hypotheses stated in the null form were tested and the results presented as follows:

4.4.1 Test of hypothesis on net farm income (Ho_1).

Test of hypothesis for the net farm income or profitability associated with cotton production was conducted based on the result of the analysis of net farm income estimates of the parameters Ho_1: $\pi = 0$ in Table 4.23 below.

Table 4.23: Test of hypothesis for net farm income associated with cotton production

	Null Hypothesis	Calculated T-value	Critical T-value	Decision
Profit function	H_{O1}: $\pi = 0$	6.94	1.96	Reject H_{O1}
Profit = ₦34,583.48				
Standard error of profit= ₦ 2,137.12				

Theresult of the test signifies that cotton production is a profitable enterprise since the value of the T- statistics was greater than T- critical. The null hypothesis and accept the alternate that cotton production was profitable in the study area. Therefore there is the need to increase the level of awareness of cotton farmers about the profitability of this enterprise through adequate extension services and educationin this regard. Also agricultural administrators and policy makers need to take cognisance of this fact and utilise it for policy purpose. This is in terms of timely provision of production facilities and inputs such as improved and certified seeds, fertiliser, agrochemicals and market incentivesthat will encourage farmers to produce. This result of hypothesis test conforms to that of similar work by Odedokun (2014) in Zamfara State, Nigeria.

4.4.2 Test of hypothesis on inefficiency effects on the model(Ho_2)

The result of the test of hypothesis is presented in Table 4.23 below. This hypothesis states that there is no inefficiency effect in the model. In other words, the model is an average response model, which implies that all the production inefficiencies were due to the factors outside the control of the farmers. This was rejected since the estimated log of likelihood ratio/T-test statistics was significantly different from zeroat one level of significance. This implies that the ordinary average response function is not a suitable specification of cotton production in the study area. Thus factors outside the control of farmers were also responsible for the inefficiencies. This result also agrees with Odedokun (2014) and Adzawla *et al*. (2013) in their separate studies on cotton production Zamfara State, Nigeria and Yendi municipality, northern Ghana.

Table 4.24: T-test of hypothesis for stochastic frontier production function and frontier inefficiency function

	Null Hypothesis	**Log Likelihood Ratio/T-test**	**Critical T-value**	**Decision**
Production function	H_{O2}; $\beta = 0$	542.47	13.76***	Reject H_{O2}
Inefficiency function	H_{O3}: $\gamma = z^2_{\mu} = 0$	90.7	13.76***	Reject H_{O3}

4.4.3 Test of hypothesis of relationship between farmers' socio-economic and institutional characteristic and inefficiency (Ho_3)

This hypothesis test was conducted with the null hypothesis that, the explanatory variables in the in the technical, allocative and economic inefficiency model have a zero coefficient (i.e. Z = 0). That is to say that the socio economic variables do not influence the technical, allocative and cost efficiencies of cotton farmers. The T- ratio test for the parameters of the stochastic frontier inefficiency model was significant at one per cent. Decisively, the null hypothesis which states that there is no significant relationship

between the farmers' socio economic and institutional characteristics and their technical, allocative and economic inefficiencies is rejected and the alternate hypothesis accepted. This implied that the entire Z variables estimated are not different from zero., meaning that the explanatory variables contribute significantly to variation in the inefficiency in cotton production in the study area. This also conforms with the findings of Odedokun (2014) and Adzawla *et al*. (2013). The result is presented in Table 4.24 above.

4.5Constraints of Cotton Production in the Study Area

Cotton farmers faced some constraints in their attempt to produce cotton in the study area. This was used to achieve objective **five** of the study. These constraints are presented in Table 4.25

4.4.1 Poor price and marketing arrangement for seed cotton

Low prices of cotton were listed by majority (22%) of the respondents or 320 of the 355 respondents sampled. The low price offered for cotton relates to the imperfect nature of the rural cotton market in the study area. Since the abolishment of cotton marketing board in 1986, cotton farmers have been left at the mercy of speculative middlemen and cotton merchants to the detriment of the farmers. This result is in agreement with Adeniji (2007) who reported that 40% of the farmers having marketing and price of cotton as the major constraint to cotton production. The marketing system of cotton as it operates presently is unsatisfactory and this was acknowledged not only by farmers but also by other major actors in the cotton industry (Gusau, 1998).

Further reports by Gbadegisin *et al*. (2007) reported that the principal factor responsible for the decline of cotton production is the low price offered to cotton farmers. 73% of cotton farmers in Taraba state reported low price as the major constraint to cotton production (Alam *et al.,* 2013). Also Gwandi *et al.* (2010) states that "poor marking arrangement has been considered as one of the key factors affecting cotton production in Nigeria".

4.4.2 High cost of inputs

High cost of inputs especially fertilizer which is an important variable input in cotton product has been ranked second (22%) constraint to cotton production. Fertilizer is an important input in crop production is that it replenishes the fertility of the soil. However it is not extensively used in the study area due to its high price. This makes most farmers not being able to meet up with the recommended level of application of the input. This results in yield generally being below potential level of cotton varieties as consequently reduced income to the farmers.

4.4.3 Poor soil fertility

This problem ranks third (16%) among the constraints faced by farmers in cotton production. Based on the studies of Odedokun (2014), this constraint was ranked as first (52.3%) among the major constraint faced by farmer. No doubt that cotton is a deep rooted crop that requires adequate soil fertility at all the root zone of crop growth. And that generally the fertility of the soils in the study is becoming unproductive due to continues cultivation and increased desertification. This makes it necessary for farmers to apply more soil nutrient in form of organic or in organic fertilizer so as to augment the lean soil fertility. The high cost of fertilizer makes matters worst for the farmers.

The above assertion was further buttressed by Samarendu *et al.* (2013) who reported that "Increasing the profitability of cotton growing is through the adoption of best practices like cotton variety selection, seed health, agronomic and tillage practices, soil health and fertility management".

Table 4.25: Distribution of constraints faced by cotton farmers in cotton production

Constraints	**Frequency**	**Percentage**	**Ranking Base**
Lack of Adequate Price and Pricing	320	22	1st
High Cost of Fertilizer	283	20	2nd
Poor Soil Fertility	226	16	3rd
Pest and Diseases	203	14	4th
Inadequate Rainfall	163	11	5th
Poor Extension Contacts	127	9	6th
Farmers-Fulani Clash	103	7	7th
Total	1425*	100	

Multiple Response Allowed*

4.4.4 Pest and diseases

This constraint rank fourth as noted by 14% or 203 of the 355 respondents. Alam *et al.* (2013) and Adeniji (2007) noted that, pest and disease infestation constituted 69% of yield reduction in cotton and this rank second among the major constraints affecting cotton production. Cotton crop in susceptible to attach by numerous insects and disease throughout its life cycle and the effective control of these is inevitable if reasonable yield is expected (Adeniji, 2007).

4.4.5 Inadequate rainfall

The inter-annual variability of rainfall in particular results in climatic hazards that reduce crop yield of cotton. The above become a constraint to most farmers as it rank fifth among the constraints in cotton production in the study area. The recommended sowing date for cotton in the major growing zones is mid-June which has not always been feasible in the last two to three years where rains establish late June to early July and ceases late very early September. As farmers have to grow food crops first, cotton seed yield reduction was attributed to late planting as a result of late rainfall establishment (Ogunlela, 2004, Gbadegesin *et al.*, 2007).

4.4.6 Poor extension contacts

This problem ranks sixth among the constraints faced by cotton farmers in the study area. Inadequate extension services limit awareness of the availability of improved cotton varieties and improved production technology currently available at the research stations.

4.4.7 Farmers – Fulani clash

This constraints ranks 7^{th} as 103 of the 355 respondents agreed that farmers-Fulani clash is a problem to cotton production. This persistence of insecurity due to continued prevalence of ethnic, religion and political conflict makes most of the cotton farmer to abandon their cotton fields to Fulani herdsmen even before the final picking (harvesting) in done as cotton is a late season crop planted after food crops. This grossly lowers the yield and by extension income of most farmers.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

The purpose of the study was to examine the profitability and production efficiency of cotton farmers in north-west Nigeria. The specific objectives were to identify and describe the socio-economic characteristic of cotton farmers in the study area, estimate the technical, allocative, and economic efficiencies among cotton farmers in the study area, estimate the socio-economic and institutional factors influencing the technical, allocative and economic efficiencies among cotton farmers, determine the costs, returns and profitability of cotton production, and finally identify and describe the constraints associated with cotton production in the study area. Primary data for the study were collected using structured questionnaire from 355 sampled cotton farmers. Three States (Kano, Katsina and Zamfara) were purposively selected based on their scale of cotton production from the seven States that make up north-west States of Nigeria. Two agricultural development project zones were again purposively selected based on scale of cotton production. In the third stage two local government areas from each of the zone were also purposively selected. In the fourth stage, two villages were purposively selected. Finally a proportionate random selection of cotton farmers was done from the selected villages giving a total sample size of 355 cotton farmers selected in this study.

The statistical tools used to analyse the data were descriptive statistics, stochastic production frontier function model and net farm income. A descriptive analysis of the sampled farmers was done to understand and describe the socio-economic factors influencing cotton production and as well as income made from the production in the study area.

The result of the analysis shows that about 51% of the respondents fall within the age range of 30 – 49 years, the majority of the farmers (49%) had no formal education. The household size ranged from 6 – 10 persons with 33%. Majority of the farmers, (83%) were not members of any cooperative society. The study revealed that constraints of cotton production in the study area were; low cotton price due to poor marketing arrangement (22%)high cost of fertilizer (20%) poor soil fertility (16%) pests and diseases (14%), inadequate rainfall (11%), poor extension services (9%), farmers-fulani clash (7%).

The average cost incurred and revenue obtained per hectare for cotton were estimated to determine the profitability or otherwise of cotton production in the study area (Table 4.11). The total revenue (TR) was ₦97375 while the total cost (TVC + TFC) was ₦55850. The net farm income was therefore ₦41525. The average rate of return on investment (return per naira invested) is 1.7, indicating that for every naira (₦1) invested in cotton production in study area; a profit of 70 kobo was made. Thus, it could be concluded that cotton production in the study area though on a small scale, was economically viable.

The stochastic production function was estimated for technical, allocative and economic efficiency. It was observed from the study that 30% of the farmers had technical efficiency (TE) of 0.81 and above while 70% of the farmers operate at less than 0.8 efficiency level. The mean technical efficiency for the 355 sampled farmers in the study area was 0.65. The results are comparable to Odedokun (2014) in his study on cotton production and supply trend estimate in Zamfara State, Nigeria. He observed the mean, maximum and minimum technical efficiency of 0.67, 0.97 and 0.11. The farmer with

the best practice has a technical efficiency of 0.99 while 0.10 was for the least efficient farmers. This implies that on the average, output fall by 35% from the maximum possible level due to inefficiency. The mean allocative efficiency was 0.72. The result indicates that average cotton farmer in the state would enjoy cost saving of about 28% while allocative inefficient farmer will have an efficiency gain of 72% to attain the level of most efficient farmer among the respondents. The mean economic efficiency was 0.48. The farmer with the best practice has aneconomic efficiency of 0.91 and 0.02 was for the least efficient farmers. This implies that on the average, output fall by 52% from the maximum possible level due to inefficiency. The result also revealed that all the sampled farmers in the study area were operating below the frontier.

The determinants of technical inefficiency model revealed that education, access to credit, household size, extension contact, marital status and farming experience have negative signs on their coefficients; thus reduces technical inefficiency. However, cooperative membership was statistically significant at 1% level and positively related with technical inefficiency. Results of the determinants of allocative inefficiency showed that education was negative and significant at10%, farming experience was negative and significant at1%, while household size was negative, thus not significant. Extension contact was positive and significant statistically at 1%. In terms of economic inefficiency, access to credit and farming experience, were negative and statistically significant at 1% and5%levels of significance. Education and household size were negative, thus not significant.

The seven major constraints associated with cotton production ranked in order of importance were poor price of cotton, high cost of fertilizer, poor soil fertility, pests and

diseases, inadequate rainfall, poor extension contacts and farmers-fulani clash. The constraints were reported by 22%, 20%, 16%, 14%, 11%, 9% and 7% of the farmers.

5.2 Conclusion

The results from the production function showed that the major input variables influencing cotton output were seed, fertilizer and agro chemicals. These results imply that in order to improve output levels in cotton production there is need to increase seed quality, fertilizer and agro chemicals used. The results revealed that the sum of the output elasticities with respect to all inputs is 0.69. This is a positive decreasing return to scale at stage II of the cotton production process where every farmer strives to maximize profit and minimize cost. Furthermore, the estimated mean values for technical, allocative and economic inefficiencies in cotton production suggests that some scope exist for farmers to increase their levels of technical, allocative and economic efficiencies by allocating the existing resources more optimally. These results suggest that substantial gains in output and/or decrease in cost can be attained given existing technology. It could be concluded that despite the role that efficiency levels can have on output, productivity gains stemming from technological innovations remains of critical importance in agriculture.

Results of the determinants of technical, allocative and economic inefficiency indicate that farmers' socio-economic variables should be considered as significant factors influencing inefficiency in cotton production. Conclusions from these findings are that there is ample opportunity to increase the present level of efficiency of cotton production in the study area. This can be achieved through improved farmer-specific

factor which include educational level of farmers, household size, access to credit, extension contact, and membership of cooperatives.

4.3 Recommendations

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

i. The positive and significant relationship between farm size, family labor and agrochemicals with output implies that increasing the levels of utilization of each of these inputs will result in an increase in the level of output of cotton. Farmers should therefore be encouraged to increase their use of these inputs to the recommended levels.

ii. Since the mean levels of technical (0.65), allocative (0.72) and economic (0.48) efficiencies were below the optimum level, there is scope for increasing the levels of technical, allocative and economic efficiencies by 35, 28 and 52% respectively through the adoption of the best technologies or techniques in cotton production.

iii. Education was found to have contributed in increasing technical, allocative and economic inefficiencies in cotton production in the study area. All policy measures that build the educational capacities of farmers and strengthen their managerial capacities will lead to a substantial reduction in technical, allocative and economic inefficiencies. For example, adult literacy programmes could be introduced in rural areas and agricultural sciences introduced as part of these programmes.

iv. The results showed that farmers' membership of cooperative society increases the level of technical, allocative and economic inefficiency of cotton farmers probably due to the inability of members to make the best use of possible benefits of cooperation. Most farmers (83%) do not belong to any cooperative association. The farmers should be recommended to form goal driven cooperative groups and pool their resources together to improve upon their finances and bargaining powers in order to increase their output and income.

v. Extension contactis one of the constraints of cotton farmers. It is generally known that investment in extensions service is critical to reducing the level of inefficiency. There should be improved extension linkages to sensitize cotton farmers on the need to adopt the recommended practices for cotton production. Non-governmental organizations should assist in organizing workshops and trainings for cotton farmers. This will increase the potentials of farmers and bridge the gapbetween potential and actual yield and hence improve the level of efficiency and productivity.

vi. Fertilizer is one of the inputs that positively and significantly influence cotton production in the study area especially with ever increasing soil fertility degradation. This makes fertilizer the second constraint faced by cotton farmers. 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.

vii. The low price of cotton does not encourage most farmers to venture in cotton production. This makes it number one constraint to cotton production. Policy measures aimed at regulating price of cotton are hereby recommended

viii. This research used the stochastic frontier production function to estimate the technical, allocative, and economic efficiencies and their socio-economic determinantsfor cotton farmers in the north-west, Nigeria. Future research should explore the robustness of the result presented here by comparing them with estimates from Data Envelopment Analysis (DEA)

Based on the findings of this study, it could be concluded that cotton production in the study area, though profitable, still has a lot of room for improvement especially the issue of improving the technical and economic efficiencies as well as farm gate price of cotton. This result call for policies aimed at encouraging new entrants especially the youths to cultivate cotton and the experienced to remain in cotton farming. The farm specific technical efficiency distribution reveals that none of the farmers achieved the maximum efficiency level.

5.4 Contributions of the Study to Knowledge

i. The study revealed that cotton production in the study area is profitable with net farm income ₦41525 despite the problems identified.

ii. The study discovered low price of cotton and high cost of fertilizer as major constraints affecting cotton, thereby leading the crop into near extinction.

iii. It was discovered that cotton farmers were economically inefficient in the study area having a meaneconomic efficiency of forty eight (48) per cent.

iv. The study revealed that cotton farmers in the study area achieved a mean technical efficiency of sixty five (65) per cent and allocative efficiency of seventy two (72) per cent.

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APPENDIX 1

PROFITABILITY AND PRODUCTION EFFICIENCY OF COTTON PRODUCTION IN NORTH-WEST NIGERIA.

Dear Respondent,

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

Village/Community……L.G.A…….STATE……

A. SOCIO –ECONOMIC CHARACTERISTICS

1. Name of farmer……

2. Sex: Male ( ) Female ( )

3. Age (years)……

4. Marital status: Married ( ) Single ( )

5. Highest level of Education:

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

Education ( ) (d) Tertiary Education ( )

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

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

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

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

10. What benefit did you derive as a member?

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

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

d. Money Lenders (Borrow) ( )

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

a. commercial bank( ) b. Nigeria Agricultural Cooperative And Rural Development bank( )

c. Cooperative Society ( ) d. Money Lenders ( ) e. Friends and Family ( )

f. Others(specify)……

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

SOURCE OF LOAN	AMOUNT(₦)	INTEREST RATE (%)
Commercial Bank		
Nigeria agricultural Cooperative And Rural Development Bank		
Cooperative Societies		
Money Lenders		
Friends And Relatives		
Others (Specify)		

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

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

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

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

18. Do you have any other sources of income apart from farming? if yes specify

……

B. INFORMATIONS ON INPUTS

(1) Farm size (Ha)

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

Plot NO	Plot Size (Ha)
1	
2	
3	

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

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

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

(II) Variable inputs (last production cycle)

(ii)Seed (Kg)

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

(iii).Fertilizer

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

(iv) Labour input

(a) Land preparation

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

(b)Planting

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

(c) Fertilizer Application

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

(e) First Weeding

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

(f) Second Weeding

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

(g).Replacement (if any)

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

(h)Harvesting

Plot No	Hire Labour Cost			Family Labour Cost		
1						
2						
3						

(i) Information on the sales of cotton

Plot No	Quantity produced (KG)	Total sales (N)
1		
2		
3		

What is your total profit made from cotton in the last one year? ……

CONSTRAINTS OF COTTON PRODUCTION

S/n	CONSTRAINTS
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Suggest possible solution to the constraints in cotton production.

1……
2……
3……
4……
5……
6……
7……
8……
9……
10……

Thanks for your Attention