ECONOMIC ANALYSIS OF SOYA BEAN PRODUCTION UNDER SASAKAWA GLOBAL 2000 PROJECT IN KADUNA STATE, NIGERIA

BY

Henry John SHALMA
(M.Sc./Agric./01425/2008-09)

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

MARCH, 2014

ECONOMIC ANALYSIS OF SOYA BEAN PRODUCTION UNDER SASAKAWA GLOBAL 2000 PROJECT IN KADUNA STATE, NIGERIA

BY

Henry John SHALMA
(M.Sc./Agric./01425/2008-2009)

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

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

MARCH, 2014

DECLARATION

I hereby declare that this thesis titled **"Economic Analysis of Soya bean Production under Sasakawa Global 2000 Project in Kaduna State, Nigeria"** has been written by me and it is a record of my research work. No part of this work has been presented in any previous application for another degree or diploma at any institution. All borrowed ideas have been acknowledged in the text and a list of references provided.

_____ _____

Henry John SHALMA **Date**
(Student)

CERTIFICATION

This thesis titled **"Economic Analysis of Soya bean Production under Sasakawa Global 2000 Project in Kaduna State, Nigeria"** by Henry John SHALMA meets the regulations governing the award of Master of Science Degree (Agricultural Economics) of Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

Prof. R. A. Omolehin Chairman, Supervisory Committee	**Date**
Prof. Z. Abdulsalam Member, Supervisory Committee	**Date**
Prof. Z. Abdulsalam Head of Department Agricultural Economics and Rural Sociology	**Date**
Prof. A. A. Joshua Dean, School of Postgraduate Studies, Ahmadu Bello University, Zaria.	**Date**

DEDICATION

This thesis is dedicated to The Almighty God and to my late mother, Mrs. Margaret John Shalma. Mummy, may your gentle soul rest in peace. Amen.

ACKNOWLEDGMENTS

I am very grateful to the Almighty God for His provision, strength and guidance throughout the period of my study. My genuine appreciation goes to my supervisors: Prof. R. A. Omolehin and Prof. Z. Abdulsalam for their constructive comments, guidance and encouragement towards the success of this work.

I say a big thanks to my mother, Mrs. Margaret John Shalma (Late) who laid a foundation for my life. Mum, you taught me the principles of hardwork, determination and patience which have aided my success in this programme. May your soul rest in perfect peace.

I thank the Head of Department of Agricultural Economics and Rural Sociology, ABU, Zaria, Professor Zakari Abdulsalam, and all lecturers and staff of the Department for their contributions to the success of this research work.

I am specially indebted to my father, Mr. John Tudak Shalma, my beloved wife, Mrs. Rita Banwai Shalma, my beloved siblings: Catherine, Philip, Kenneth, Emmanuel, Stella, Veronica, Blessed, Blessing and Elizabeth. I say a big thanks to you all for your endurance, understanding, encouragement, supports and prayers.

I will like to say "thank you" to the families of Dr. and Mrs. Usman Sarki, Mr. and Mrs. Andy Eke, Mr. and Mrs. Anthony Chioke, as well as Barr. and Mrs. Charles Okungbowa, for their consistent advice and supports. God bless you immensely.

Finally, I am grateful to my friends and classmates: James Nandi, Wahe Buba, Raphael Mathew, Alexander Anthony Abisan, Jagaba Cornelius, Mr. Ashikor Terfa, Mr. Evans Yurkushi, Mr. M.I. Abubakar, Mr. Jerry Auta. I equally remain grateful to Sola Oyewole, Ahmed Monday, Oyakhilome Oyinbo and others for their support and scholarly advice.

TABLE OF CONTENTS

CONTENT **PAGE**

Title Page---------- i

Declaration---------- ii

Certification---------- iii

Dedication---------- iv

Acknowledgement---------- v

Table of Content---------- vii

List of Tables---------- x

List of Appendices---------- xi

Abstract---------- xii

CHAPTER 1----------1

INTRODUCTION----------1

1.1 Background Information---------- 1

1.2 Statement of the Problem---------- 3

1.3 Objectives of the Study---------- 5

1.4 Research Hypotheses---------- 6

1.5 Justification of the Study---------- 6

CHAPTER 2----------8

LITERATURE REVIEW----------8

2.1 Historical Overview of Soya Bean ----------8

2.2 Importance of Soya Bean ----------9

2.3 Soya Bean as a Protein Supplement---------- 10

2.4 Development of Improved Soya Bean Varieties---------- 11

2.5 Nigeria's Contribution to World Soya Bean Production----------13

2.6 Historical Background of Sasakawa Global 2000 (SG 2000) Project ----------14

2.7 The Underlying Principles of SG 2000's Actions in West Africa---------- 16

2.7.1 Close collaboration with the ministry of agriculture---------- 16

2.7.2 Direct farmer participation in technology transfer---------- 16

2.7.3 Promote agricultural intensification with appropriate, financially viable technology---------- 16

2.8 Production Function Analysis---------- 19

2.9 Theoretical Framework for Efficiency Measurement---------- 20

2.9.1 Model specification of stochastic frontier function---------- 22

2.9.2 Empirical studies utilizing the stochastic frontier approach---------- 23

2.10 Profitability Analysis ---------- 28

2.10.1 Gross margin analysis ---------- 28

CHAPTER 3---------- 31

METHODOLOGY---------- 31

3.1 Description of the Study Area ---------- 31

3.2 Sampling Procedure----------32

3.3 Data Collection---------- 33

3.4 Analytical Techniques---------- 35

3.4.1 Descriptive statistics---------- 35

3.4.2 Gross margin analysis ---------- 35

3.4.3 The stochastic frontier model ---------- 36

CHAPTER 4----------40

RESULTS AND DISCUSSION---------- 40

4.1 Socio-economic Characteristics of the Respondents ---------- 40

4.1.1 Age ---------- 40

4.1.2 Educational level ---------- 41

4.1.3 Farm size ---------- 41

4.1.4 Amount of credit received---------- 42

4.1.5 Membership of cooperative organization ---------- 43

4.2 Costs and Returns Analysis ---------- 44

4.3 Measurement of Efficiencies---------- 46

4.3.1 Technical efficiency ---------- 46

4.3.2 Technical inefficiency ----------49

4.3.3 Allocative efficiency --------- 51

4.3.4 Allocative inefficiency ---------- 55

4.3.5 Economic efficiency ---------- 57

4.4 Distribution of technical, allocative and economic efficiencies ---------- 60

4.5 Constraints Encountered by Sasakawa Global 2000 Soya Bean Farmers ---------62

CHAPTER 5----------66

SUMMARY, CONCLUSION AND RECOMMENDATIONS----------66

5.1 Summary---------- 66

5.2 Conclusion---------- 69

5.3 Recommendations ---------- 70

5.4 Contribution to Knowledge----------71

References---------- 72

LIST OF TABLES

TABLE **PAGE**

1: Nutrient Content (%) in Soya bean compared to other food stuffs per 100g---11

2: Recommended Varieties for Guinea Savannah Ecological Zones in Nigeria---13

3: World Soya bean Production (in million metric tonnes) ----------13

4: Distribution of SG 2000 Soyabean Farmers in Kagarko and Sanga LGAs of Kaduna State, Nigeria ----------32

5: Distribution of Respondents According to Age---------- 40

6: Distribution of Respondents According to Educational Attainment----------41

7: Distribution of Respondents According to Farm Size---------- 42

8: Distribution of Respondents Based on Amount of Credit Obtained---------- 43

9: Distribution of Respondents According to Membership Cooperative Organization---------- 44

10: Gross Margin Analysis of SG 2000 Soya Bean Farmers Per Hectare Cultivated- ---------- 45

11: Technical Efficiency of Sasakawa Global 2000 Project Respondents---------- 47

12: Allocative Efficiency of Sasakawa Global 2000 Project Respondents-------- 52

13: Economic Efficiency of Sasakawa Global 2000 Project Respondents--------- 59

14: Distribution of Efficiencies for Sasakawa Global 2000 Project Soya Bean Respondents---------- 61

15: Constraints Encountered by Sasakawa Global 2000 Project Soya Bean Respondents---------- 64

LIST OF APPENDICES

APPENDIX **PAGE**

1: Research Questionnaire ----------82

ABSTRACT

The study was conducted to evaluate economics of soyabean production under Sasakawa Global 2000 project in Kaduna State, Nigeria. The specific objectives of the study were to describe the relevant socio-economic characteristics of soya bean producers under SG 2000 Project, analyse costs and returns to soya bean production under SG 2000 Project, examine the relationship between inputs and output of the project's soya bean farmers, determine the technical, allocative and economic efficiencies as well as evaluate the determinants of inefficiencies in soya bean production among SG 2000 participating farmers, and identify the challenges encountered by SG 2000 Project soya bean farmers in the study area. A purposive sampling technique was used to select 107 Sasakawa maize farmers. Primary data were collected with the aid of structured questionnaire. The data were analysed using descriptive statistics, gross margin analysis and stochastic frontier function. The results showed that the mean age of the farmers was 49 years. Majority of respondents (89%) were literate and most of them (78%) cultivate on small scale farms (0.1-1.0ha) and 62% had access to credit facilities while 74% were not members of any cooperative group. Soya bean production under sasakawa project was found to be profitable as a gross margin of ₦240,952/ha was achieved. The mean efficiencies were 89%, 73% and 65% for technical, allocative and economic efficiencies hence; there is room for improvement of the farmers' efficiencies to increase outputs. Farm size, quantity of seeds and quantity of fertilizer had positive effects on both technical and economic efficiencies just as costs of farmland, seeds, fertilizer, agrochemicals, labour and output were seen to have positive effects on allocative efficiency. Determinants of inefficiencies of the farmers were educational level, household size, farming experience, amount of credit received and membership of cooperative organization. Major constraints encountered by the farmers were insufficient credit, inadequate land, absence of threshing machines and equipment, bad roads and inadequate labour. It was therefore recommended that inputs such as seeds, fertilizers and agrochemicals which were the major inputs that increase the output of soya bean production in the study area should be made available on time, in right amounts and at affordable prices to the farmers by SG 2000 project and other stakeholders in agriculture. Participating SG 2000 farmers should be encouraged to form themselves into cooperative groups in order to enhance their accessibility to interventions and subsidies provided by the project and other stakeholders as well.

CHAPTER 1

INTRODUCTION

1.1 Background Information

Nigeria with an estimated population of 161,004,058 people (Indexmundi, 2012) is Africa's most populous country and agriculture is the centre of activity of her people. Although, the economy now relies heavily on the petroleum sector (which generates three quarters of government revenues and more than 90% of foreign exchange earnings), agriculture continues to play an important role in the economy (Ugwu, 2009). The sector currently contributes 26% to the Gross Domestic Product (GDP), with crop production accounting for an estimated 85% of this total, livestock contributing 10% with the remainder made up by forestry and fisheries (Ugwu, 2009). According to the Federal Ministry of Agriculture and Rural Development (FMARD, 2006), the agricultural sector generates about 90% of the non oil export revenues, employs about one-third of the total labour force and provides a livelihood for the bulk of the rural population.

One of the major food problems in Nigeria is the gross deficiency in protein intake, both in quantity and quality (Dashiell, 1998). Although, protein in human diet is derived from both plant and animal sources, the declining consumption of animal protein due to its high prices requires alternative sources. Soya bean provides a cheaper and high protein rich alternative substitute to animal protein. It is an important crop in the world and has been the dominant oilseed since the 1960s (Smith and Huyser, 1987). It is a multipurpose crop and its importance ranges from its use in milk production, oil processing, livestock feeds, medical, industrial and human consumption and more recently, as a source of bio-energy (Adedoyin, et al., 1998 and Myaka *et al*., 2005).

Soya bean is the richest source of plant protein known to man (Odusanya, 2002). It is also an important source of income.

Owolabi *et al*. (1996) said that extension service efforts are necessary in Nigeria and other African countries to increase soya bean production and consumption. As recognized by (Doss 2003 and 2006), one way of improving agricultural productivity, in particular and rural livelihood in general, is through the introduction of improved agricultural technologies to farmers. Doss et al. (2003) also opined that adoption of improved technologies is an important means to increase the productivity of small holder agriculture in Africa, thereby fostering economic growth and improved wellbeing for millions of the poor households. Ouma et al. (2006) suggested that the use of improved technologies will continue to be a critical input for improved farm productivity.

Sasakawa-Global 2000 (SG 2000) is a Non-Governmental Organization established to develop programmes for technology demonstration in various African countries, in cooperation with National and International Research Institutes, Federal and State Ministries of Agriculture, State Agricultural Development Projects, Agricultural input organizations and farmers (SG 2000, 2010). The objectives are to diffuse improved Agricultural Technology to farmers in order to increase output, assist in developing quality extension services through trainings and demonstration and strengthening of linkages amongst research extension services, private sector agricultural organizations and farmers (SG 2000, 2010).

Since the commencement of the SG 2000 project in 1992, improved varieties of soya bean and other agronomic technologies were introduced to enhance production and alleviate poverty among the farming population. Based on literatures reviewed, a lot of researches have been conducted in the area of agronomic practices of soya bean production but not much research has been done in the aspect of economic analysis of the crop and resource use efficiency. Hence, this study was designed in an attempt to fill the research gap.

1.2 Statement of the Problem

The agricultural sector in Nigeria has suffered many reversals during the past couple of decades. From era of booming of export trade in agricultural commodities, the Nigerian agricultural sector has degenerated to an import dependent one (Ojo and Ehinmowo, 2010). Subsequently, it has failed to generate significant foreign exchange, feed agro-allied industries, improve the living standards of farming households and rural dwellers and provide effective demand for industrial goods and services. Increasing food production however is vital for enhancing future food security in the country as this is no longer debatable but a necessity. To achieve this, good knowledge of the current efficiency or inefficiency inherent in the crop production sub-sector as well as factors responsible for the level of efficiency and inefficiency must be critically examined.

Rapid population growth and crippling economic problems in many African countries including Nigeria and most recently the global economic meltdown have reduced living standards and adversely affected eating habits causing widespread malnutrition (Ugwu and Nnaji, 2010). In addition, the high cost of livestock and poultry feeds derived from cereal and leguminous plant, had made it economically imperative that soya bean

production and its economic and nutritive values should be developed further in Africa since its proteinous sources of about 40% and 20% oil content make it more nutritive to use in the formation of poultry feeds compared to maize grain (Dashiell, 1998). In an attempt to thereby increase soya bean production in Nigeria, the SG 2000 has been promoting its production using improved practices in Kaduna State.

Soya bean is an important crop produced mainly in the Guinea Savannah zone of Nigeria. However, it was reported that the crop is grown in rather small holder farms in most African countries including Nigeria (Olorunsanya *et al*., 2009). Available statistics on world soya bean production shows that although production tends to increase between the year 2000 and 2006, there is a marked decline in the production of soya bean in the year 2007. Also, the contribution of Nigeria to world soya bean production which stood at an average of 0.28% in 2006, declined to about 0.26% in 2007 (FAOSTATS, 2009). Research has shown that the problems of small scale agriculture in Nigeria include the lack of high yielding cultivars, inadequate information about new production technology, inadequate basic farm inputs and the use of traditional technology of low productivity. These problems identified have given rise to the following research questions:

i. What are the relevant socio economic characteristics of soya bean producers under SG 2000 project in the study area?

ii. How profitable is soya bean production under SG 2000 project?

iii. What is the relationship between inputs and output of the project's soya bean producers?

iv. What are the technical, allocative and economic efficiencies in soya bean production among SG 2000 participating farmers?

v. What are the determinants of inefficiencies (technical, allocative and economic) in soya bean production among SG 2000 participating farmers?

vi. What are the challenges encountered by SG 2000 project soya bean farmers in the study area?

1.3 Objectives of the Study

The broad objective of the study is to evaluate the economics of SG 2000 soya bean production in Kaduna State.

The specific objectives are to:

i. describe the relevant socio-economic characteristics of soya bean producers under SG 2000 project;

ii. analyse costs and returns to soya bean production under SG 2000 project;

iii. examine the relationship between inputs and output of the project's soya bean farmers;

iv. determine the technical, allocative and economic efficiencies in soya bean production among SG 2000 participating farmers;

v. evaluate the determinants of inefficiencies (technical, allocative and economic) in soya bean production among SG 2000 participating farmers;

vi. identify the challenges faced by SG 2000 project soya bean farmers in the study area.

1.4 Research Hypotheses

The research hypotheses which are postulated for testing in this study are stated in the null form as follows

Ho: (i) Sasakawa Global 2000 soya bean production is not profitable.

(ii) Sasakawa Global 2000 Project participating soya bean producers are technically and allocatively not efficient.

(iii) Socio-economic characteristics of soya bean farmers under Sasakawa 2000 Project do not influence the technical and allocative efficiencies of soya bean production in the study area.

1.5 Justification of the Study

Various agricultural development programmes and organizations, governmental and non-governmental, have evolved in Nigeria with the aim of modernizing and improving farmers' technical knowledge and skills for greater output and higher standard of living (Akino and Hayami, 1975). The SG 2000 is one of such Non-Governmental Organizations which is promoting the production, processing and utilization of crops such as soya bean, maize, millet, rice, sorghum, wheat, cowpea and sesame through the Agricultural Development Projects. However, based on the review of relevant literatures, it was revealed that there has been little or no studies conducted on the

economic evaluation of soya bean production in the study area with respect to SG 2000 project. There is, therefore, the need to have such research information and hence the necessity for this study.

Despite efforts by SG 2000, Nigeria is still ranked amongst the lowest soya bean producing countries in the world (Faostat, 2009). This can be attributed to poor and inefficient usage of resources by farmers. Resource use efficiency study is very important for increased output and profitability of farmers. It is widely held that efficiency is at the heart of agricultural production. This is because the scope of agricultural production can be expanded and sustained by farmers through efficient use of resources (Udoh, 2000). For these reasons, efficiency has remained an important subject of empirical investigation particularly in developing economies where majority of the farmers are resource-poor.

It is expected that the findings of this study will be useful to agricultural students in providing useful academic information for their studies. Researchers will find the information to be a sort of relevant feedback for their researches which may indicate new areas of interest for improvement. Policy makers will need the findings for agricultural policy formulation that will contribute to the sector's development, while investors will be able to back up their decisions in soya bean production with reliable data. The information from this study will also help to stimulate more adoption of the SG 2000 production technology package by the resource-poor, small-scale farmers in the agricultural sector.

CHAPTER 2

LITERATURE REVIEW

2.1 Historical Overview of Soya bean.

Soya bean, a member of the family leguminoceae, subfamily papiplonaceae, and the genus Glycine Max (L) Merril, has been receiving attention as a source of food capable of increasing the available protein supplies. Consequently, interest in the production, processing and utilization of the crop has been growing (Osho, 1991). Soybean grows in tropical, subtropical, and temperate climates. It was domesticated in the 11th century BC around northeast of China. It is believed that it might have been introduced to Africa in the 19th century by Chinese traders along the eastern coast of Africa (Shurtleff and Aoyagi, 2007). The plant, according to Ryan *et a1*. (1986), is grown in rather small holder farms in most African countries including Nigeria. Ashaya *et a1*. (1975) identified the Guinea savannah zone of Nigeria as the main area of production ranking Benue State first among the specific areas in the Zone. Dashiell (1992) reported that Benue State cultivates about 70% of the national total annual soya grain production. The remaining 30% is gotten from Kaduna, Kwara and Niger States and parts of the Federal Capital Territory (FCT) (FMINO, 2002).

Ezedinma (1965), who reviewed the history of the crop in Nigeria, reported that soybeans were first introduced in 1908 by the British looking for new sources of supply from their colonies. Attempts to grow the crop at Moor Plantation, Ibadan, at that time failed. In 1928 the soybean was successfully introduced to Samaru, where it spread into other parts of Northern Nigeria. To meet the high European demand for oilseeds during World War II, acreage expanded rapidly and in 1947 the first exports of 9 tonnes were recorded. Yields of the popular Malayan variety reached 1,100 kg/ha. The soybean soon

became a cash crop in the Tiv division and Benue Valley of Benue Province, which thereafter was the leading center of production.

2.2 Importance of Soya bean

Undoubtedly, Soya bean is one of nature's most efficient protein producers. According to Ryan *et. a1*. (1986), it yields more protein per acre than any other commonly cultivated crop, at least three times more than rice , wheat or maize. Sachel and Litchfield (1965) measured about 40 percent high quality protein in Soya bean and that while most plant protein sources are seriously deficient in one or more of nine essential amino acids, Soya bean is an exception. According to them, Soya bean is an excellent source of unsaturated oil with most varieties averaging a content of about 20 percent. Onochie (1965) discussed the potential value of Soya bean as a protein supplement in Nigerian diet. He observed that Soya bean has a higher total digestible nutrient percentage of (91. 99%) than cowpea (79.52%) and therefore more metabolizable energy and a higher content of lysine (6.0 to 6.5%) than all other common vegetable protein sources. Soya bean nutritional values account for the various ways it is used in human diets today. It is used as a soup condiment especially for thickening purposes, There is Soyamilk, Soyadrink, Soyagari, Soyaeba and Nune or "Dawadawa". The chaff obtained after threshing can be fed to animals and the cake after extracting oil is widely used in the production of livestock feed. Soya bean is also very important in the treatment of some sicknesses. Naganawa *et. a1*. (1988) observed that it would be helpful to give a diet with Soya bean protein to patients with Cirrhosis to prevent protein malnutrition. Also, Chandrasekhar and Paul (1989) reported that supplementation of Cancer patients' diets with Soya flour for 3 months improved their nutritional profile. Another study by Lee (1991) showed that Soya bean products may

be a protection against breast cancer in younger women since these foods are rich in phyto-oestrogens.

2.3 Soya bean as a Protein Supplement

Soya bean has a lot of high quality protein, Uwaegbute (1992) reported that Soya bean is one of the cheapest foods available to man when judged by the amount of protein, mineral, vitamins and energy obtainable per unit cost, and its high protein content makes it a very useful food for curing protein energy malnutrition. The grain legume proteins are usually the least expensive source for both rural and urban population, and nutritionally, the protein of Soya bean is similar to that of animal protein. The amino acid analysis of Soya bean protein and Casein are remarkably similar (Masefield, l977). Norman (1978) reported that the thought for utilization of Soya bean protein products in human foods has increased dramatically because of the population pressure on the food supply and the quest for alternative source of protein. This is more so in developing countries where there is great shortage of animal protein leading to a lot of nutritional hazards. A great effort has to be made to enrich some foods with Soya bean.

The low protein content of cereals/grains such as Maize 10.5%, Millet 7.5%, Sorghum 12.4%, Wheat 12.3%, Rice 8.7%, Cowpea 25.3% and Groundnut 27.1% (Nigerian Grain Board, 1962) and their deficiency in some essential amino acids make them inadequate for satisfactory growth of babies and for body maintenance. The protein supplement of cereals is required but Soya bean then becomes heavily involved in this aspect of promotion. The proteins of meat, poultry, fish , milk and eggs are very expensive compared with vegetable proteins, and Soya bean protein is superior to all other proposed protein supplement (Anazonwu, 1978). Norman (1978) also reported

that the protein content of Soya bean (40%) is considered higher than dairy products of 26.7%, as shown in Table 1. The Soya bean by virtue of its high protein content and oil contents is valued as a high energy protein source.

Table 1: Nutrient Content (%) in Soya bean compared to other food stuffs per 100gm

Food type	Water	Energy	Protein	Oil	Calcium	Iron
Common beans	10	334	25.0	1.7	110	8.0
Peas	10	337	25.0	1.0	70	5.0
Pigeon peas	10	328	26.0	2.0	100	5.0
Soya beans	8	382	40.0	20.0	200	7.0
Meat	66	202	20.0	14.0	10	3.0
Milk	74	140	7.0	8.0	260	0.2
Egg	74	158	13.0	11.5	55	2.0
Ground nuts	6	579	27.0	45.0	50	2.5
Wheat flour	13	346	11.0	1.6	20	2.5
Finger millet flour	12	332	5.5	0.8	350	5.0
Maize flour	12	362	9.5	4.0	12	2.5
Cassava flour	12	342	1.5	0.0	55	2.0
Plantain (banana)	67	128	1.5	0.2	7	0.5
Round potatoes	80	75	2.0	0.0	10	0.7
Sweet potatoes	70	114	1.5	0.0	25	1.0

Source: Malema, 2005 (Soya bean Production and Utilization in Tanzania).

2.4 Development of Improved Soya bean Varieties

Soybean may have been introduced to Nigeria as early as 1908, but its cultivation as a crop can be attributed to the introduction of the Malayan variety in 1937 by British colonial officers in Benue State (Singh *et al.*, 1987). Until recently, the Malayan variety was virtually the sole variety grown by farmers. This variety is low yielding, susceptible to bacterial diseases and is late maturing (Smith *et al.*, 1995). The latter characteristic exposes soybean to pod shattering due to the desiccating action of the seasonal Harmattan wind. The expansion of the crop was limited by the lack of suitable varieties.

Moreover, most soybean varieties could not nodulate in association with the native rhizobia indigenous to African soils and the seed quickly lost viability, which made it difficult for farmers to store it until the next cropping season (Dashiell *et al*., 1987).

Over the last two decades, IITA has made substantial efforts to improve the productivity of the crop by developing high yielding, early maturing varieties capable of nodulating in association with local rhizobia and possessing other good agronomic traits (IITA, 1994). Improved soybean varieties released in Nigeria include TGx 849-313D, TGx 1019-2EN, TGx 1019-2EB, TGx g1447-2E, TGx 536-02D, TGx 306-036C, TGx 1485-1ED, and TGx 1440-1E (IITA 1994). Others are TGx 1448-2E, TGx 1835-10E, SAMSOY 1 (M-79), and SAMSOY 2 (M-216) (SG 2000, 2010). Early attempts to diffuse improved varieties started in the late 1970s with the introduction of the variety Genyi by the Department of Agriculture. It was not until the late 1980s that other improved varieties became available. In the early 1980s, the varieties Samsoy 1 and Samsoy 2 were released and introduced to farmers. In the late 1980s, the Benue State Agricultural and Rural Development Authority (BNARDA)—the State extension services—introduced the variety TGx 536-O2D developed by IITA for mass adoption. SG 2000 (2010) and Dugje *et al.,* (2009), recommended the varieties contained in table 2 for the Guinea savanna zones of Nigeria.

Table 2: Recommended soybean varieties for Guinea Savannah Ecological Zones in Nigeria

Variety	Ecology	Characteristics	*Striga* control
TGX 1448-2E	Southern and northern Guinea savannas	Medium maturing, high yield, Low shattering, high oil content, excellent grain colour.	Good
TGX 1835-10E	Guinea savanna	Early maturing, rust resistant, pustule resistant.	Not known
TGX 1485-1D	Guinea savanna	Early maturing, pustule resistant, rust susceptible.	Not known

N.B. Early and extra-early maturing varieties are strongly recommended in the Sudan savanna because of the low amount and duration of rainfall in the zone.

Following the development and introduction of improved varieties, many food recipes using soybean were found to be highly acceptable to Nigerians, including their incorporation into traditional local dishes (Osho and Dashiell, 1998). Substantial efforts were made to promote soybean utilization technologies among rural and urban households. National research and extension personnel in many African countries have been trained in soybean production, processing, and utilization techniques. In Nigeria, more than 47 000 persons, including about 30 000 women, have been trained in the production and potential utilization of soybean in their families' diet (Sanginga *et al.,* 1999).

2.5 Nigeria's Contribution to World Soya bean Production.

Table 3 below shows Nigeria's share of the total world production of soya bean. The table reveals a steady rise in the production of soya bean for the period under review, with Nigeria being ranked tenth. World soya bean production rose from 159.8406 million metric tonnes in the year 2000 to 228.3696 million metric tonnes in 2008. Nigeria's contribution stands at 0.4290 million metric tonnes in 2000 and 0.5910 million metric tonnes in 2008. Although production was on the rise between the year

2000 and 2006, there was a marked decline from 0.28% in 2006 to about 0.26% in the year 2007 and remains at that through to 2008 (FAOSTAT, 2009).

Table 3: World Soybean Production (In Million Metric Tonnes)

Country	2000	2003	2006	2007	2008
Usa	75.0537	66.7814	86.9989	72.8577	80.7487
Brazil	32.7350	51.9194	52.4646	57.8572	59.2423
Argentina	20.1358	34.8186	40.5374	47.4828	46.2381
China	15.4115	15.3933	15.5002	12.7252	15.5451
India	5.2758	7.8189	8.8570	10.9680	9.9050
Paraguay	2.9801	4.2049	3.8000	6.0000	6.3118
Canada	2.7030	2.2733	3.4655	2.6957	3.3359
Bolivia	1.1973	1.5860	1.6190	1.5960	1.2597
Indonesia	1.0176	0.6716	0.7476	0.5926	0.7765
Italy	0.9035	0.3970	0.5513	0.4085	0.3463
Nigeria	**0.4290**	**0.4940**	**0.6050**	**0.5800**	**0.5910**
Others	1.9983	1.9157	4.3875	3.7034	4.0692

Source: FAOSTAT, 2009.

2.6 Historical Background of Sasakawa Global 2000 (SG 2000) Project

SG 2000 had its origins during the Ethiopian famine of 1984/85 when the Japanese philanthropist, the late Ryoichi Sasakawa, mobilised funds to send emergency food aid to Ethiopia and other stricken countries in the region. The Sasakawa Association for Africa and Global 2000 of the Carter Presidential Center in Atlanta formed a partnership to create a non-governmental organization, Sasakawa Global 2000, to undertake agricultural projects in Africa (Galiba, 1993). The programme was funded, from its onset, by the Nippon Foundation of Japan (then the Japan Shipbuilding Industries Foundation) (Sasakawa Africa Association (SSA), 2010). SG 2000's first food crop technology transfer projects were established in Ghana and Sudan in 1986.

Then-as now-the focus was Africa's small-scale farmers dramatically increasing their yields of staple food crops. Since that time, as a direct result of SG 2000 projects in 14 African countries, millions of farmers across the continent have doubled, and sometimes tripled, their yields of staple food crops (Galiba, 1993).

In Nigeria, the SG 2000 project began in 1992 in collaboration with the Federal Ministry of Agriculture and Natural Resources and the Agricultural Development Programmes (ADPs) of two northern states— Kano and Kaduna. The chief objective was to rapidly introduce improved technologies in wheat and maize in northern Nigeria (Valencia and Breth, 1999). The principal tool for the demonstration is the management training plot (MTP), a farmer's field of a quarter to a half hectare in which the farmer practices the full technological package SG 2000 recommends (Seyoum, Battese and Fleming, 1998).

The project began in the Kaduna State Agricultural Development Project (KADP) in 1992 with maize and wheat crops but was later extended to accommodate staple food crops as rice, soya bean, millet, sorghum, cowpea, and some others (SG 2000, 2010). The project aims at helping many small scale farmers as possible to become richer, more knowledgeable and more in control of their economic destinies (Valencia and Breth,1999).

2.7 The Underlying Principles of SG 2000's Actions in West Africa

In order to ensure success of its programmes aimed at driving appropriate technology packages to farmers, the SG 2000 project has adopted the following principles for enhanced performance. These include:

2.7.1 Close collaboration with the ministry of agriculture

Rather than creating a parallel structure, SG 2000 works in close collaboration with Ministries of Agriculture. Extension programs are jointly developed and ministry personnel serve as field agents. SG 2000 works exclusively with food crops, restoring and maintaining soil fertility and developing functioning cooperatives. It collaborates with research institutes and other development organizations in order to support the extension program (Nubukpo and Galiba, 1999).

2.7.2 Direct farmer participation in technology transfer

Extension efforts centre on the production test plot (PTP): a half-hectare parcel owned or managed by a participant farmer who agrees to test the new technology on his/her own field. Testing on farmers' fields allows producers to compare his/her current practices to those recommended. SG 2000 views farmers' direct involvement as an irreplaceable part of the change process because what a farmer hears, he rarely believes; what he sees in his neighbour's field, he doubts; but what he does himself, he cannot deny (Nubukpo and Galiba, 1999).

2.7.3 Promote agricultural intensification with appropriate, financially viable technology

Different technology packages are recommended (Galiba 1989, 1994). Farmers receive input credit to allow them to accurately evaluate the innovation and temper the risk

associated with each new approach. The investment made with the input credit represents in most cases a source of capital for future activities. As farmers are faced with soil degradation and negative mineral balances (Smaling, 1993), SG 2000 stresses the use of organic and mineral fertilizer. Intensification practices are recommended (Brown and Haddad, 1994) as well as the use of local resources such as natural phosphate (Bationo *et al.*, 1997). The use of complex fertilizers (i.e., NPK) and urea was improved by the introduction of bulk blend fertilizers specific to cereals. In combination with improved varieties and cropping practices, SG 2000 is able to offer a menu of technological package options to farmers (Galiba *et al.*, 1999).

Quality seed is very important for improving productivity of small holder farmers. However, the challenge is farmers' access to high quality seed, available at the time of planting. Some farmers are given seed handouts which are viewed by many as reinforcing dependency. Those who believe in seed handouts, argue that they are a necessary first step for the successful application and dissemination of new varieties. Beyond direct hand-outs, some strategies focus on improving the availability of commercially high-yielding varieties on the formal market, others aim to strengthen informal seed systems, e.g. by implementing seed banks (FAO, 2010).

Therefore initiatives to improve access to improved seed varieties must primarily target the informal sector and integrate it with formal sector to efficiently provide seed. This involves establishing local seed producers who can then supply their community members with seed. A seed producer does not only require technical skills for seed production, but also a basic training to market his seed locally. Crucial to successful marketing is reputationbuilding, which is a lengthy process. Secondly, seed companies

and other actors involved in seed multiplication (like Sasakawa Global 2000) have an interest to work with local seed producers since they produce seed more cheaply than in commercial breeding and carry the risk of production failure. Thirdly, local seed producers must be linked to plant breeders to access, experiment with and eventually multiply new varieties.

The success story of Sasakawa Global 2000 is development of self sustaining informal seed systems for soy bean. Soybean is a crop grown in Nigeria and farmers cannot rely on traditional seeds or local knowledge about the production of the crop. Thus, the technology needs for soybean cultivation are higher than for traditional crops and make the successful introduction of soybeans even more remarkable. The project has been so successful that the largest soybean oil extracting plant (300 tones/day capacity) in Sub-Saharan Africa (FAO, 2010).

Soya bean production practices under SG 2000 project include site selection, ditribution of imptoved variaties such as SAMSOY 1 (M-79), SAMSOR 2 (M-216) and TGX-144-2E, TGX-1835-10E, TGX-1485-1D and TGX-1440-IE. SG 2000 also assist framers in the areas of land preparattion and sowing which involves proper spacing (60-90cm) and seed rates (50-75kg/ha). The sowing depth which rages between 2.5-5cm. Fertilization and weed control are also part of the production pratcices under SG 2000 project. The recomended fertiizer rate is 20kg N, 40kg P_2O_5 and 20kg K_2O per ha. Soyabean do not compete with weed in the early stage of growth therefore, SG2000 recommended two hand hoe-weeding before the plant reaches 15cm in height when it will be able to supress the newly emerging weeds. The example of herbicides recomended by SG 2000

project are Metolachlor + Terbutryn at 2kg a.i/ha pre-emergence (1 MTM in 10 litres-Knapsack sprayer) or Metolachlor + Metobromuron at 2.5 kg a.i/ha pre-emergence (11/4 MTM in 10 litre-Knapsack sprayer). SG 2000 also involves in harvesting (SG 2000, 2010).

2.8 Production Function Analysis

The production process involves the transformation of inputs into outputs. What is put into production process comes out either as a product or in the form of waste. The product is that part of the output that is valuable to the producer while that which has no value to him is the waste or waste product. Every production process therefore generates some waste products. As long as the production generates sufficient profit from the valuable part of the output, the investor is satisfied with the investment (Olukosi and Ogungbile, 1989). In agriculture, inputs are usually classified into land, labour, capital, and management. These are usually coordinated by the producing unit whose ultimate objectives or goals may be profit maximization, output maximization, cost minimization, the maximization of satisfaction, or a combination of these motives (Olayide and Heady, 1982).

In a production process, a relationship exists between the quantity of output produced and the quantity of inputs used. In otherwords, variability in the quantity of output is determined by the variability in the quantity of inputs used. The production function describes the technical or physical relationship existing between inputs and outputs in any production process. In mathematical terms, this function is assumed to be continuous and differentiable thus, enabling us to estimate the rates of returns (Olayide and Heady, 1982). The production function takes many forms and has become one of

the most widely used tools in economic analysis. The choice of any form will depend on its desirable characteristics. Griffins *et al.* (1987), suggested choice of functional form based on statistical and econometric criteria. These include the goodness of fit (R^2), statistical significance of the regression coefficients and the correctness of the signs of the regression coefficients (Olayemi and Olayide, 1981).

2.9 Theoretical Framework for Efficiency Measurement

Three types of efficiency are identified in literature. These are technical efficiency, allocative efficiency and overall or economic efficiency (Farrell, 1957; Olayide and Heady, 1982). Technical efficiency is the ability of a firm to produce a given level of output with minimum quantity of inputs under a given technology. Allocative efficiency is a measure of the degree of success in achieving the best combination of different inputs in producing a specific level of output considering the relative prices of these inputs. Economic efficiency is a product of technical and allocative efficiency (Olayide and Heady, 1982). In one sense, the efficiency of a firm is its success in producing as large an amount of output as possible from given sets of inputs. Maximum efficiency of a firm is attained when it becomes impossible to reshuffle a given resource combination without decreasing the total output.

Since the seminal work of Farrell in 1957, several empirical studies have been conducted on farm efficiency. These studies have employed several measures of efficiency. These measures have been classified broadly into three namely: deterministic parametric estimation, nonparametric mathematical programming and the stochastic parametric estimation. There are two non-parametric measures of efficiency. The first, based on the work of Chava and Aliber (1983) and Chava and Cox (1988)

evaluates efficiency based on the neoclassical theories of consistency, restriction of production form, recoverability and extrapolation without maintaining any hypothesis of functional form. The second, first used by Farrell (1955) decomposed efficiency into technical and allocative. Fare *et al.* (1985) extended Farrell's method by relating the restrictive assumption of constant returns to scale and of strong disposability of inputs (Llewelyn and Williams, 1996; Udoh and Akintola, 2001).

Several approaches, which fall under the two broad groups of parametric and non-parametric methods, have been used in empirical studies of farm efficiency. These include the production functions, programming techniques and recently, the efficiency frontier. The frontier is concerned with the concept of maximality in which the function sets a limit to the range of possible observations (Forsund *et al.*, 1980). Thus, it is possible to observe points below the production frontier for firms producing less than the maximum possible output but no point can lie above the production frontier, given the technology available. The frontier represents an efficient technology and deviation from the frontier is regarded as inefficient.

The literature emphasizes two broad approaches to production frontier estimation and technical efficiency measurement: (a) The non-parametric programming approach, and (b) the statistical approach. The programming approach requires the construction of a free disposal convex hull in the input-output space from a given sample of observations of inputs and outputs (Farrell, 1957). The convex hull (generated from a subset of the given sample) serves as an estimate of the production frontier, depicting the maximum possible output. Production efficiency of an economic unit is thus measured as the ratio

of the actual output to the maximum output possible on the convex hull corresponding to the given set of inputs.

The statistical approach of production frontier estimation can be sub-divided into two, namely, the neutralshift frontiers and the non-neutralshift frontiers. The former approach measures the maximum possible output and then production efficiencies by specifying a composed error formulation to the conventional production function (Aigner *et. al*., 1977; Meeusen & van den Broeck, 1977). The non-neutral approach uses a varying coefficients production function formulation (Kalirajan & Obwona, 1994). The main feature of the stochastic production frontier is that the disturbance term is composed of two parts-a symmetric and a one-sided component. The symmetric (normal) component, v_i captures the random effects due to the measurement error, statistical noise and other non-symmetric influences outside the control of the firm. It is assumed to have a normal distribution. The one-sided (non-positive) component, μ_i with $\mu_i \geq 0$, captures technical inefficiency relative to the stochastic frontier. This is the randomness under the control of the firm. Its distribution is assumed to be half normal or exponential. The random errors, v_i are assumed to be independently and identically distributed as N $(0, \delta v^2)$ random variables, independent of μ_is. The μ_is are also assumed to be independently and identically distributed as, for example, exponential (Meeusen & van den Broeck, 1977), half normal (Aigner *et al*., 1977), truncated normal and gamma (Greene, 1990).

2.9.1 Model specification of stochastic frontier function

The stochastic frontier function is typically specified as:

$$Y_i=f(X_{ij}; ß) + v_i-\mu_i \quad (i = 1, 2, n) \text{ ---------- (1)}$$

Where:

Y_i = Output of the ith firm;

X_{ij} = Vector of actual jth inputs used by the ith firm;

ß = Vector of production coefficients to be estimated;

v_i = Random variability in the production that cannot be influenced by the firm and;

μ_i = Deviation from maximum potential output attributable to technical inefficiency.

The model is such that the possible production Yi, is bounded above by the stochastic quantity, f (X_i; ß) exp(V_i) (that is when $\mu_i = 0$) hence, the term stochastic frontier.

Given suitable distributional assumptions for the error terms, direct estimates of the parameters can be obtained by either the Maximum Likelihood Method (MLM) or the Corrected Ordinary Least Squares Method (COLS). However, the MLM estimator has been found to be asymptotically more efficient than the COLS (Coelli, 1995). Thus, the MLM has been preferred in empirical analysis (Umoh, 2006).

2.9.2 Empirical studies utilizing the stochastic frontier approach

Stochastic frontier approach has found wide acceptance within the agricultural economics literature because of their consistency with theory, versatility and relative ease of estimation. The measurement of efficiency (technical, allocative and economic) has remained an area of important research both in the developing and developed countries. This is especially important in developing countries, where resources are meagre and opportunities for developing and adopting better technologies are dwindling. Efficiency measures are important because it is a factor for productivity growth. Such studies benefit these economies by determining the extent to which it is possible to raise productivity by improving the neglected source of growth i.e. efficiency, with the existing resource base and available technology.

Several empirical applications have followed the stochastic frontier specification. These studies are basically based on Cobb-Douglas function and transcendental logarithmic (translog) functions that could be specified either as production or cost function (Udoh & Akintola, 2001). The first application of the stochastic frontier model to farm level data was by Battese and Corra (1977) who estimated deterministic and stochastic Cobb-Douglas production frontiers for the grazing industry in Australia. The variance of the farm effects was found to be a highly significant proportion of the total variability of the logarithm of the value of sheep production in all states. Their study did not, however, directly address the technical efficiency of farms.

A study by Battese and Coelli (1995) on paddy rice farms in Aurepalle India used panel data for 10 years and concluded that older farmers were less efficient than the younger ones. Farmers with more years of schooling were also found to be more efficient but declined over the time period. Battese *et al*. (1996) used a single stage stochastic frontier model to estimate technical efficiencies in the production of wheat farmers in four districts of Pakistan ranging between 57 and 79 percent. The older farmers had smaller technical inefficiencies. Bedassa and Krishnamoorthy (1997) used a two-step approach to estimate technical efficiency in paddy farms of Tamil Nadu in India. They concluded that the mean technical efficiency was 83.3 percent, showing potential for increasing paddy production by 17 percent using present technology. Small and medium-scale-farmers were more efficient than the large-scale farms. In addition, the study concluded that animal power was over utilized and therefore suggested reduction. However, the paddy rice farmers could still benefit by increasing the fertilizer use and expansion of land.

In measuring technical efficiency of maize producers in Eastern Ethiopia for farmers within and outside the Sawakawa–Global 2000 project, Seyoum *et al*. (1998) used a translog stochastic production frontier and a Cobb-Douglas production function. Some of the key conclusions from this study were that younger farmers are more technically efficient than the older farmers. In addition, farmers with more years of school tended to be more technically efficient. On the other hand, those that obtained information from extension advisers tended to reduce the technical inefficiency. The mean technical efficiency of farmers within the SG 2000 project was estimated to be 0.937 while the estimate of the farmers outside the project was 0.794. However, this study should have squared the age to address the linear relationship of the age variable. A study by Wilson *et al*. (1998) on technical efficiency in UK potato production used a stochastic frontier production function to explain technical efficiency through managerial and farm characteristics. Mean technical efficiency across regions ranged from 33 to 97 percent. There was high correlation between irrigation of the potato crop and technical efficiency. The number of years of experience in potato production and small-scale farming were negatively correlated with technical efficiency. A study by Liu *et al*. (2000) on technical efficiency in post-collective Chinese Agriculture concluded that 76 and 48 percent of technical inefficiency in Sichuan and Jiangsu, respectively, could be explained by inefficiency variables. They used a joint estimation of the stochastic frontier model. Awudu and Huffman (2000) studied economic efficiency of rice farmers in Northern Ghana. Using a normalized stochastic profit function frontier, they concluded that the average measure of inefficiency was 27 percent, which suggested that about 27 percent of potential maximum profits were lost due to inefficiency. This corresponds to a mean loss of 38,555 cedis per hectare. The discrepancy between observed profit and frontier profit was due to both technical and allocative efficiency.

Higher levels of education reduced profit inefficiency while engagement in off-farm income earning activities and lack of access to credit experience higher profit inefficiency. The study also found significant differences in inefficiencies across regions.

Awudu and Richard (2001) used a translog stochastic frontier model to examine technical efficiency in maize and beans in Nicaragua. The average efficiency levels were 69.8 and 74.2 percent for maize and beans, respectively. In addition, the level of schooling represented human capital, access to formal credit and farming experience (represented by age) contribute positively to production efficiency, while farmers' participation in off-farm employment tended to reduce production efficiency. Large families appeared to be more efficient than small families. Although a larger family size puts extra pressure on farm income for food and clothing, it does ensure availability of enough family labour for farming operations to be performed on time. Positive correlation between inefficiency and participation in non-farm employment suggests that farmers reallocate time away from farm-related activities, such as adoption of new technologies and gathering of technical information that is essential for enhancing production efficiency. The result indicated that efficiency increased with age until a maximum efficiency was reached when the household head was 38 years old. The age variable probably picks up the effect of physical strength as well as farming experience for the household head.

In a study by Wilson *et al.* (2001) a translog stochastic frontier and joint estimate technical efficiency approach was used to assess efficiency. The estimated technical efficiency among wheat producers in Eastern England ranged between 62 and 98

percent and found farmers who sought information, and had more years of managerial experiences and had large farm, were associated with higher levels of technical efficiency. A study by Mochebelele and Winter-Nelson (2002) on smallholder farmers in Lesotho used a stochastic production frontier to compare technical inefficiencies of farmers who sent migrant labour to the South African mines and those who did not. They concluded that farmers who send migrant labour to South Africa are closer to their production frontier than those who do not. Belen *et al*. (2003) made an assessment of technical efficiency of horticultural production in Navarra, Spain. They estimated that tomato producing farms were 80 percent efficient while those that raised asparagus were 90 percent efficient. Therefore, they concluded that there exists a potential for improving farm incomes by improving efficiency. Gautam and Jeffrey (2003) used a stochastic cost function to measure efficiency among smallholder tobacco cultivators in Malawi. Their study revealed that larger tobacco farms are less cost inefficient. The paper uncovered evidence that access to credit retards the gain in cost efficiency from an increase in tobacco acreage. This suggested that the method of credit disbursement was faulty. Bravo-Ureta *et al*. (1994) concluded that Paraguan cotton had 40.1 percent average economic efficiency while cassava producers were 52.3 percent efficient. They concluded that there was room for improvement in productivity for these basic crops. However they did not find a relationship between economic efficiency and socioeconomic characteristics. This observation was explained by the possibility of existence of a stage of development threshold below which this type of relationship is not observed. In this case the sampled Paraguan farmers were yet to reach the threshold.

The use of the stochastic frontier analysis in studies in agriculture in Nigeria is a recent development. Such studies include that of Udoh (2000), Okike (2000) and Amaza

(2000). Udoh used the Maximum Likelihood Estimation of the stochastic production function to examine the land management and resource use efficiency in South-Eastern Nigeria. The study found a mean output-oriented technical efficiency of 0.77 for the farmers, 0.98 for the most efficient farmers and 0.01 for the least efficient farmers. Okike's study investigated crop-livestock interaction and economic efficiency of farmers in the savanna zones of Nigeria. The study found average economic efficiency of farmers was highest in the Low-Population-Low Market domain; Northern Guinea and Sudan Savannas ecological zones; and Crop-based Mixed Farmers farming system.

2.10 Profitability Analysis

Profit is a major indicator of viability of any business. The amount of revenue realized and operating cost of a business enterprise determines how much gain or loss an enterprise can achieve within a certain period (Okine and Onu, 2008). Cost and return analysis usually forms the basis for farm profitability analysis. This involves itemizing the costs and returns of production and using them to arrive at such estimates as the return to one unit of the resource used (Osifo and Antonio, 1970). Factors which affect the profitability of an enterprise as outlined by Osifo and Antonio, 1970 include land, labour, capital, management, farm size and time.

2.10.1 Gross margin analysis

Gross Margin Analysis involves evaluating the efficiency of an individual enterprise so that comparison can be made between enterprises on the farm. It is a very useful tool in situations where fixed capital is a negligible portion of the farming enterprise as is the case in subsistence farming (Olukosi and Erhabor, 1988). Gross Margins are widely in farm planning. They can be used to prepare partial budgets for minor changes in the

farm programme, or to prepare completed budgets for major changes in farm programmes (Styrrock, 1971). Gross Margin analysis involves determining all variable costs and revenue associated with an enterprise. The difference between revenue and total variable costs is the gross margin for the enterprise, and, in essence, this is the return to capital, management and risk (Mlay, 1984). Olukosi and Erhabor (1988), summarised the usefulness of gross margin as being easy to compute and interpret, highly applicable to subsistence system of farming involving small fixed capital component, useful where the same capital items are used in many different enterprises in a given farm, used to determine net farm income, serves as a guide to the selection of enterprises by comparing their margins, helps the farm manager to critically examine the variable cost components in production and helps in building partial budgets for the farm.

Cost and return analysis has been widely used in a variety of research studies. For instance, Olorunsanya *et al*. (2009) employed cost and return analysis in the economic analysis of soyabean production in Kwara State, north central Nigeria. The result obtained shows a gross margin of ₦9,84.33 per hectare and a net farm income of ₦8,217.5 per hectare per season was realized by soybean producers in the study area. This gives an indication of high profitability of soybean production in the study area. Alamu and Ibrahim (2004) used gross margin analysis to estimate the costs and returns to cotton production among small scale farmers in Katsina State, Nigeria. Gross margin per hectare was estimated at ₦11,546.

Ojo and Ehinmowo (2010), employed gross margin analysis in determining the economic analysis of Kola-nut production in Nigeria. The result showed that Kola-nut

production was a profitable business in Ondo state, Nigeria as shown by the average gross margin of ₦100,769.58. Luke, Lewis, and Kent, (2002) conducted an economic analysis of soybean-wheat cropping systems in Oklahoma. The result showed that mixed cropping system with 15-inch row spacing produced a net return of $308 per acre while the mixed cropping system using 30 inch row spacing produced a net return of $299 per acre. Onor and Ibekwe (2006) compared the costs and returns to improved cassava production technology and alternative technology in Enugu State, Nigeria. The results showed that the improved cassava technology was more profitable when compared to the farmers' alternative technology. The ratio of the gross margin of improved cassava technology to that of alternative technology was found to be 3:1. This implied that improved cassava technology was three times more profitable than the farmers' alternative technology.

CHAPTER 3

METHODOLOGY

3.1 Description of the Study Area

This study was conducted in Samaru Zone of Kaduna Agricultural Development Project (KADP). The KADP had zoned the state into four zones namely: Samaru, Lere, Birnin Gwari and Maigana zones. Samaru KADP zone comprises of seven Local Government Areas (L.G.As) namely: Jema'a, Zango-Kataf, Sanga, Kaura, Kagarko, Kachia and Jaba. The choice of Samaru KADP zone was essentially on the basis of its high potentials for soyabean production (KADP, 2010).

Kaduna state is located in the northern part of Nigeria and is located between latitudes $10^{0}21^{1}$N to 10.33^{0}N and longitudes $7^{0}45^{1}$ to 7.75^{0}E (Wikipedia, 2008). It shares common borders with Abuja in the South-East and six other states namely: Katsina, Kano, Zamfara in the North, Nasarawa and Plateau in the North-East and Niger in the North-West. The hottest months are March-April while the coldest are December-January. Rainfall is heaviest in the south and decreases northwards with an annual mean rainfall varying between 942mm and 1000mm which lasts from May till October (National Agricultural Extension and Research Liaison Services (NAERLS, 2002). The vegetation in the state is divided into Northern Guinea Savannah in the North and Southern Guinea Savannah in the South. In the south, savannah woodland with trees like shear butter and locust bean predominate, while in the north, Baobab, silk cotton and date palm are predominant (Wikipedia, 2010).

The people of the state are engaged in agricultural production activities. The main crops which are grown in the state include Maize, Sorghum, Soya bean, Millet, Rice, Groundnut, Yam and Sugar cane. By the 2006 census of the National Population Commission, Kaduna State had a population of 6,113,443 people; hence, the projected population of the State for the year 2011 is 7,030,469 people, using the stipulated growth rate of 2.5% per annum (Indexmundi, 2012). There are 23 L.G.As in the state. Kaduna state has a land area of about 7,627.20sqkm.

3.2 Sampling Procedure

Based on a reconnaissance survey conducted in the area with the extension officers of the Kaduna State Agricultural Development Project (KADP), a multi-stage sampling technique was used as a sampling plan for this study. In the first stage, out of the four KADP zones in Kaduna State, the Samaru KADP zone was purposively selected on the basis of its high level of soya bean production in the state (KADP, 2010). In this zone, there are seven Local Government Areas (L.G.As). In the second stage, two Local Government Areas were purposively selected based on high concentration of soya bean farmers (KADP, 2010). The third stage involved simple random sampling by lottery method without replacement which was used to select two villages in each of the selected L.G.As, making a total of four villages. Out of the four hundred and twenty six (426) participating SG 2000 Soya bean farmers in these villages, 25% were randomly selected by lottery method and without replacement in proportion to the total population of farmers in each of the selected L.G.As. A total of 107 farmers constituted the sample size. The breakdown of the sampling procedure is given in Table 4.

Table 4: Distribution of SG 2000 Soyabean Farmers in Kagarko and Sanga LGAs of Kaduna State, Nigeria

Zone	L.G.A	Selected Villages	Population of SG 2000 Soya bean Farmers	25% of the SG 2000 Farmers
Samaru	Kagarko	Kagarko	131	33
		Jere	88	22
	Sanga	Ancha	105	26
		Wasa	102	26
Total	**2**	**4**	**426**	**107**

Source: Reconnaissance Survey, 2010.

3.3 Data Collection

Data for this research were collected from primary sources, using structured questionnaires. The questions were structured to elicit answers on the objectives of study. The data collected include the following:

I. Socio-economic characteristics of respondents such as age, sex, household size, educational status, farm size, access to credit, off-farm income, use of machines, major occupation, farming experience and membership of cooperative organization.

II. Farm production information such as land size, quantity of fertilizer used, quantity of seeds, quantity of agrochemicals, types and amount of labour, output of soya beans as well as prices of inputs and output.

The variables that were used in this study are as follows:

i. Age of Respondents: the age of an individual is measured in years

ii. Educational Status of Respondent: Education in this study refers to the acquisition of knowledge through formal or informal means or through schooling. This was measured on years a respondent spent in formal education.

iii. Household Size: this refers to the total number of people in the house which includes wives, children and dependants who reside within the same family and eat from the same pot.

iv. Years of Farming Experience: this refers to the number of years the farmer has actively undertaken farming. This was measured in years.

v. Access to credit was measured in terms of the amount of credit received.

vi. Total Land Area Cultivated: this refers to the amount of land put to cultivation, measured in hectares.

vii. Total Labour Cost: this was measured in man-days and multiplied by the unit cost to obtain the total labour cost.

viii. Total Cost of Planting Materials: this refers to the product of the quantity of seeds in kilogrammes used in production and cost per unit kilogramme.

ix. Total Cost of Agrochemical: this refers to the volume of herbicides and pesticides (in litres) used for agricultural production. It was obtained by multiplying the quantity used with unit price, in the study area.

x. Total Cost of Fertilizer: the cost per kilogramme of fertilizer is multiplied by the amount of kilogrammes used. The unit price per kilogramme that was used was that supplied by respondents themselves. This gave us the total cost in naira expended on fertilizer.

xi. Cost of Tractor Hiring: this is the cost of hiring the use of a farm tractor on the farm, measured in naira terms.

xii. Total Farm Output: this is the total yield of soya bean crop from the farm, measured in grain equivalent.

xiii. Total Farm Income: this is the sum total of revenues of the respondents from the

assumed sales of each soya bean farmer's produce with respect to unit price of the output.

xiv. Non-farm Income: this is the total income earned from wage, and other non-farm activities in naira.

3.4 Analytical Techniques

The analytical tools used in achieving the objectives of the study include the following:

i. Descriptive Statistics;

ii. The Stochastic Frontier Function; and

iii. Gross Margin Analysis

3.4.1 Descriptive statistics

Descriptive Statistics such as central tendency (mean, median, mode, frequency distribution, percentages, ranking and measures of dispersion such as range, variance and standard deviation) were used. This tool was used to achieve objectives (i) and (vi) of the study.

3.4.2 Gross margin analysis

The Gross Margin analysis was used to achieve objective (ii) and was expressed as:

GM = GI – TVC ---------- (2)

Where:

GM = Gross Margin (₦)

GI = Gross Income (₦)

TVC = Total Variable Cost (₦)

3.4.3 The stochastic frontier model

In order to achieve objectives iii and iv and v, Cobb-Douglas production frontier function was estimated using the Maximum Likelihood Techniques. From the production frontier, the corresponding dual cost frontier was determined. These two frontiers are the basis for deriving farm level efficiency measures. The stochastic production frontier was written as:

$$ln\ Y_i = ln\beta_0 + \sum_{i=1}^{5} \beta_j\ lnX_{ij} + v_i - \mu_i \quad \text{..... (3)}$$

Where:

ln = the natural logarithm

Y_i = Farm output (kg)

X_{ij} = Vector of farm inputs ($X_1 – X_5$) used

X_1 = Farm Size (hectares)

X_2 = Quantity of seeds (kg)

X_3 = Fertilizer (kg)

X_4 = Total Labour used (man hours) and

X_5 = Volume of Agrochemicals (litres)

v = random variability in the production that cannot be influenced by the farmer;

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

β_o = intercept;

β_i= vector of production function parameters to be estimated;

i = 1, 2, 3, n farms;

j = 1, 2, 3, m inputs.

The inefficiency model (technical and allocative) was used to achieve objective (v), it is specified as:

$$u_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 \quad \text{---------- (4)}$$

Where,

u_i = technical inefficiency effect of the ith farm;

Z_1 = educational level of farmer in years of formal education completed;

Z_2 = household size (no.);

Z_3 = age of farmer in years;

Z_4 = farming experience in years

Z_5 = amount of credit received in Naira

Z_6 = membership of cooperative society

δ_0 = constant

$\delta_1 - \delta_6$ = parameters to be estimated.

These socio-economic characteristics are included in the model to investigate their influences on the technical, allocative and economic efficiencies of resources employed by SG 2000 project soya bean participating farmers. The ß and δ coefficients are un-known parameters to be estimated along with the variance parameters δ^2 and γ. Aigner et al. (1977), Jondrow et al. (1982), and Green (1993) defined δ^2 and λ as:

$\delta^2 = \delta^2 v + \delta^2 u$ and $\lambda = \delta_u / \delta_v$ ---------- (5)

Battese and Corra (1977) defined γ as total variation of actual output towards its frontier such that $\gamma = \delta^2_u / \delta^2$

Consequently, $0 < \gamma < 1$ and one may obtain the estimated value of γ

The δ^2, and γ, coefficients are the diagnostic statistics that indicate the relevance of the use of the stochastic production frontier function and the correctness of the assumptions made on the distribution form of the error term. The δ^2 indicates the goodness of fit and the correctness of the distributional form assumed for the composite error term. The γ,

indicates that the systematic influences that are unexplained by the production function are the dominant sources of random errors.

In the context of the stochastic frontier production function, the technical efficiency of an individual firm is defined as the ratio of the observed output to the corresponding frontier output, conditional on the levels of inputs used by the firm. Thus, the technical efficiency of firm i is:

$TE_i = \exp(-\mu_i)$, that is

$TE_i = Y_i/Y_i^* = f(X_i; ß) \exp(v_i - \mu_i) / f(X_i; ß) \exp(v_i) \exp(-\mu_i)$. ---------- (6)

TE_i = Technical efficiency of farmer i; Y_i = observed output and; Y_i^* = frontier output. The technical efficiency of a firm ranges from 0 to 1. Maximum efficiency in production has a value of 1.0. Lower values represent less than maximum efficiency in production.

Technical inefficiency= 1- TE_i

The allocative efficiency is determined using the cost frontier dual to the production frontier as:

$$ln\ C_i = ln\alpha_0 + \sum_{i=1}^{6} \alpha_i\, lnP_{ij} + \gamma \ln(Y_i^*) \quad \text{..... (7)}$$

Where C_i is the minimum cost to produce output Y, P_{ij} is a vector of input price, and α is a vector of parameters.

The stochastic frontier cost function can be expressed as follows:

$$\ln C_i = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + V_i + U_i \quad \text{- (8)}$$

Where:

C_i = Total cost of production (Naira/ha)

X_1 = Cost of land rent for year (Naira/ha)

X_2 = Cost of seed (Naira)

X_3 = Cost of fertilizer (Naira)

X_4 = Cost of Agrochemical (Naira)

X_5 = Cost of labour (Naira)

X_6 = Output of soya bean produced (kilogramme)

β = vector of the coefficients for the associated independent variables in the production function

U_{it} = one sided component, which captures deviation from frontier as a result of inefficiency of the farmer

V_{it} = effect of random stocks outside the farmers' control, observation and measurement error and other stochastic (noise) error term.

Economic Efficiency (EE_i): Farm specific economic efficiency (EE_i) is the product of technical and allocative efficiencies. It was estimated using the following equation:

$$EE_i = TE_i * AE_i \quad (9)$$

Where:

EE = Economic efficiency,

TE = Technical efficiency, and

AE = Allocative efficiency

The parameter estimates were obtained using the Maximum Likelihood Method (MLM) of estimation.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Socio-economic Characteristics of the Respondents

Socio-economic characteristics of soybean farmers were considered in this study because of their perceived effects on the agricultural activities of soya bean farmers under the SG 2000 project. These are age, educational level, farm size, credit obtained and membership of cooperative organisations.

4.1.1 Age

Age has a significant influence on the decision making process of farmers with respect to risk aversion, adoption of improved agricultural technologies, and other production-related decisions. According to Adeola (2010), young people tend to withstand stress, put more time in agricultural operations which can lead to increased output. Table 5 reveals age distribution between 21 – 80 years. The mean age of the sampled soybean farmers was 49 years. This means that the respondents were not too old, and so, they are still in their active age. Majority (65%) of the farmers were within the active age of 21 – 50 years, while 22% of the farmers were between 51 and 60 years of age.

Table 5: Distribution of respondents according to age

Age	Frequency	Percentage
21-30	3	2.80
31-40	22	20.56
41-50	44	41.12
51-60	24	22.43
61-70	9	8.41
71- 80	5	4.67
Total	**100**	**100**
Mean	49	
Minimum	30	
Maximum	79	

4.1.2 Educational level

Adoption of innovations can be influenced by education (Ahmadu, 2011). Therefore, education plays an important role in agricultural development. Ojuekaiye (2001) reported that education is an essential socio-economic factor that influences farmer's decision because of its effect on the awareness, perception, reception and quick adoption of innovation that can increase productivity. The findings of the study as shown on table 6 reveal that 11% of the respondents never attended formal education while 36% of the respondents had primary education. On the other hand, respondents who had secondary and tertiary education constitute 17% and 36% respectively. This implies that majority (89%) of the respondents had western education, meaning that they are literate. Illiteracy is believed to have a negative implication on efficient use of productive resources and adoption of farm innovation. Educational attainment is very important because it could lead to awareness of the possible advantages of modern farming techniques thereby increasing household productivity.

Table 6: Distribution of respondents according to educational attainments

Educational attainment	**Frequency**	**Percentage**
No education	12	11.21
Primary	38	35.51
Secondary	18	16.82
Tertiary	39	36.45
Total	**107**	**100**

4.1.3 Farm size

Size of farm cultivated is a function of population pressure, family size and financial back ground of the farmer (Ahmadu, 2011). One of the major characteristic of small-scale farming is fragmented land holding. As presented in table 7, the result of this

study shows that 78% of the respondents cultivated on less than or one hectare while 15% cultivated between 1.1 and 2.0 hectares each whereas 7% of the respondents farmed above 2 hectares of land. Also, the mean farm size was 0.89 hectares. This implies that most of the Sasakawa Global 2000 soybean farmers were small-scale farmers. Small farm size is an impediment to agricultural mechanization because it will be difficult to use farm machines on small and fragmented farms. This also conforms to the study of Ekong (2003) who opined that most Nigerian farmers are small sized family farms in which family members contribute the required labour.

Table 7: Distribution of respondents according to farm size

Farm Size(ha)	Frequency	Percentage
0.1 – 1.0	83	77.57
1.1 – 2.0	16	14.95
2.1 – 3.0	5	4.67
3.0 and above	3	2.80
Total	**107**	**100**
Mean	0.89	

4.1.4 Amount of credit received

The results presented in Table 8 showed the distribution of the respondents based on the amount of credit obtained. The results show that 38% had no credit facility, 42% got between ₦1 and ₦50,000, 10.28% received between ₦50,001 and ₦100,000, 1.87% received between ₦150,001 and ₦200,000, and 0.93% received above ₦200,000. The result further show that the minimum and maximum amounts of credits obtained were ₦20, 000.00 and ₦240,000.00 with a mean of ₦30,607.76. Credit obtained may increase farmers' liquidity which may enhance their ability to purchase inputs and pay for hired labour.

Table 8: Distribution of respondents based on amount of credit obtained

Credit obtained (₦)	**Frequency**	**Percentage**
No credit	41	38.32
1-50,000	45	42.06
50,001-100,000	11	10.28
100,001-150,000	7	6.54
150,001-200,000	2	1.87
200,001-250,000	1	0.93
Total	**107**	**100**

Mean	₦30, 607.76
Minimum	₦20, 000.00
Maximum	₦240, 000.00

4.1.5 Membership of cooperative organization

Membership of cooperative organization provides means of interaction among farmers which can enhance diffusion of innovation easily among members. Membership of cooperative organization was found to be a strong determinant of adoption of cassava technologies in Benue State (Oboh *et al.,* 2011). From table 9, the mean years spent in cooperative organization was 8 years with 74% not belonging to any cooperative organization while 12% and 11% have stayed between 4 and 6 years; and 7 and 12 years respectively as members of cooperative organisation. Majority (74%) of the respondents were not members of cooperative organisation, implying the existence of a wide gap on information sharing and assimilation as regards soya bean production and processing activities. Membership of cooperative organization is important because it affords the farmers the opportunities of sharing information on modern agricultural production practices.

Table 9: Distribution of respondents according to cooperative organization

Years of membership of cooperative organization	**Frequency**	**Percentage**
0	79	73.83
1 – 3	3	2.80
4 – 6	13	12.15
7 – 9	5	4.67
10 – 12	7	6.54
Total	**107**	**100**
Mean	8	

4.2 Costs and Returns Analysis

The viability of an enterprise is indicated by the amount of profit realized per period of time. Profit is the difference between the monetary value of goods produced and the cost of the resources used in their production. The amount of revenue realized and operating cost of a business venture determines how much gain or loss the enterprise can achieve within a certain period. The profitability analysis which was used to achieve objective ii is shown in Table 10.

Table 10: Gross margin analysis of SG 2000 soya bean per hectare cultivated

Cost and Yield Items	Mean Value (Naira)	Percentage of Variable Cost
(A) Variable Cost (Naira)		
Seed	7,663.423	6.64
Fertilizer	7,388.37	6.40
Labour	94,684.33	82.01
Agrochemicals	5,712.63	4.94
(A) Total Variable Cost (TVC)	115,448.80	
(B) Yield (kg)	6,600.01	
(C) Gross Income (GI)	356,400.54	
Gross Margin (GM) (C – A)	240,951.90	
Return per naira invested (GM/TVC)	2.08	

Gross Income is calculated on the basis of multiplying the average yield by the average price of N54/kg

Total Variable Cost is the operating costs of the respondent which are the day-to-day cost incurred for producing soya bean. The Total Variable Cost (TVC) incurred by the respondents averaged ₦115,448.80/ha, with an average Gross Income (GI) of ₦356,400, which resulted in a Gross Margin (GM) of ₦240,951.90/ha.

Labour was sourced from both family and hired. Family labour was evaluated using the principle of opportunity cost and it was assumed that family labour served as a substitute for hired labour. Consequently, the imputed cost of labour used for family labour equals the prevailing wage rate of hired labour. Hence, labour cost accounts for 82% of the TVC, while seed, fertilizer and agrochemicals costs account for 7%, 6% and 5% respectively for the SG 2000 project soya bean farmers in the study area. The analysis revealed that labour is the most used variable among the respondents. This conforms to the study of Bamidele (2008) where labour cost dominates the Total

Variable Cost of Cassava-Based Production Systems in the Guinea Savannah, accounting for over 80% of the TVC.

4.3 Measurement of Efficiencies

The efficiencies were measured using stochastic frontier to determine technical, allocative and economic efficiencies and are as discussed:

4.3.1 Technical efficiency

The result presented in Table 11 shows the gamma statistics of 0.98, implying that 98% of the changes in the output are attributable to respondents' inefficiency factors. The result shows that technical inefficiency effects were present in the production of soya bean under Sasakawa Global 2000 project. Therefore, the hypothesis that the parameter estimate of $\gamma = 0$ is strongly rejwected. The significant level of the gamma indicates the presence of one- sided error component, v_i in the model specified. Due to the presence of this one-sided error component, the traditional response function estimated by the Ordinary Least Square cannot represent the data adequately. Thus, the stochastic frontier function estimated by the Maximum Likelihood Estimation procedure is best fitted for the data. Therefore, the second null hypothesis, which specifies that the inefficiency effects are not stochastic, is also rejected. The positive and significant (10%) coefficient of the Sigma-square (σ^2) indicates the correctness of the specified assumption of the distribution of the component error terms. The generalized likelihood ratio statistics was -166.826 which exceeds the critical chi-square value at 1% level of significance with number of restriction (degree of freedom) of 8, (Table 11).

Table 11: Technical efficiency of Sasakawa Global 2000 project respondents

Variables	Coefficient	Standard error	t-ratio
Constant (β_o)	10.1935	0.7842	12.999***
Farm size (X_1)	0.5898	0.1456	4.051***
Quantity of seed (X_2)	0.0842	0.0426	1.975**
Quantity of fertilizer (X_3)	0.0606	0.1069	0.567
Labour used (X_4)	-0.2042	0.1347	-1.517
Volume of agrochemicals(X_5)	-0.2076	0.0607	-3.418***
Inefficiency model			
Constant (δ_0)	-7.0824	5.7940	-1.222
Educational level (Z_1)	-0.1667	0.1013	-1.646*
Household size (Z_2)	-0.5789	0.1470	-.938***
Age (Z_3)	-0.4948	0.3692	-1.340
Farming experience (Z_4)	-0.2042	0.0184	-1.093***
Amount of Credit (Z_5)	-0.5873	0.3450	-1.703*
Cooperative society (Z_6)	-0.0041	0.0077	-0.542
Variances			
Sigma-squared (σ^2)	29.9586	16.1958	1.850*
Gamma (γ)	0.9848	0.0077	128.331***
Log likelihood function	-166.8265		
LR test	53.8959		
Number of restrictions	8		

n=107
Log likelihood = -166.826***
***, **, *, Significant at 1%, 5% and 10% levels respectively

Farm size (X_1): The estimated coefficient was 0.59. This positive effect of farm size on soya bean output implies that a 1% increase in the size of farm holding will lead to an increase in output of soya bean by 0.59kg. This could be so because large farm size motivates adoption of innovations which can translate into higher output. The coefficient of farm size was significant at 1% level of probability, indicating the relevance of farm size on soya bean production in the study area.

Quantity of seed (X_2): The coefficient of seed used positively affects output with a value of 0.08. The implication of this positive effect is that if quantity of seed used increases by 1%, output will rise by 0.08 kilogrammes of soya bean produced under the project. Production of soya bean cannot be embarked upon if seed is not involved in the production process; hence, quantity of seed used was significant in soya bean production at 5% probability level.

Quantity of fertilizer (X_3): The estimated coefficient (0.06) of the variable was positive. This agrees with the *a priori* expectation that as the quantity of fertilizer used increases, yield increases as well. However, fertilizer use was not significant because Soya bean does not require much fertilizer. Also, Soya bean improves soil fertility by converting and fixing nitrogen from the atmosphere into the soil.

Labour used (X_4): The estimated coefficient was inversely (-0.204) related to output. The negative effect of labour on output is against *a priori* expectation. The sign indicates that as labour used in the production of soya bean increases, quantity of soya bean produced decreases. Labour used was not significant. The negative coefficient implies that a unit increase in the use of labour would decrease output by 0.204kg. This may be attributed to greater accessibility of farmers to labour input in the study area.

Volume of agrochemicals (X_5):- The coefficient for volume of agrochemicals was negatively signed (-0.21) and significant for the production of soya bean by the respondents. The implication of the result is that as the volume of agrochemicals used for the production of soya bean increases by a litre, the quantity of soya bean produced decreases. The sign was not as expected because use of agrochemicals reduces drudgery

in farm operations such as weeding and clearing as well as increase quantity of output produced stemming from control of pests and diseases.

4.3.2 Technical inefficiency

The result presented in Table 11 also reveals the technical inefficiency variables as follows:

Educational level (Z_1): The negatively estimated coefficient for education in SG 2000 soya bean production implies that respondents with greater years of schooling tend to be more efficient, because as schooling years increases, technical inefficiency tend to reduce. Technical inefficiency tends to decrease by 0.17 as schooling years rise by 1%. It could be plausible to say that respondents with considerable years of education respond readily to effective decision making in agriculture. This finding is supported by findings obtained by Battese and Coelli (1995) in their study on model for technical inefficiency effect, in stochastic frontier production function for Panel Data. Educational level was statistically significant at 10% probability level. The significance of education to the production of SG 2000 project soya bean implies that education is an important variable because educational attainment facilitates adoption of innovation.

Household size (Z_2): Household size coefficient had a negative sign in the model. An increase in the number of people in a household will lead to a decline in technical inefficiency of the farmers. Therefore, respondents with larger household sizes tend to be more technically efficient than households with smaller number of people. This could be as a result of the fact that large household size translates into cheaper and available labour which can reduce cost of production.

Age (Z_3): Coefficient of age has negative effect on SG 2000 project respondents' technical inefficiency implying that it has positive effect on technical efficiency. This suggests that the older the respondents, the lower the technical inefficiency. As the respondents' age increases by 1% the technical inefficiency decreases by 0.49%. The positive effect of age on technical efficiency indicates that the agility and energetic capability of the respondents contribute to the production of soya bean under SG 2000 project. If young and virile farmers engage in the production of soya bean under SG 2000 project, output will increase thereby leading to higher income and standard of living. As farmers' age increases their experience in Soya bean production is increased.

Farming experience (Z_4): This variable had negative and significant coefficient of -0.20, implying that respondents with higher farming experience tend to be more technically efficient in the production of soya bean. A rise in farming experience of the respondents could enhance the skill of the farmers which in turn increase their efficiency. Farming experience was significant at 1% level of probability indicating the relevance of accumulation of experience in a farming activity.

Amount of Credit (Z_5): The parameter estimate for the variable was found to be negative (-0.59) indicating a decline in technical inefficiency as respondents' access to credit increase. Credit obtained was statistically significant at 10% level of probability. This shows the importance of credit to soya bean farming because credit enhances capacity to acquire production inputs on time thereby enhancing productivity. If production credit is invested into an enterprise on time, it is expected that it should lead to higher levels of output, because farmer would have access to production inputs. This

disagrees with Okike *et al*. (2001) and Bifarin *et al*. (2010) in a separate report that receiving credit contributes to farmers' inefficiency.

Membership of cooperative society (Z_6): Membership of cooperative society was found to have negative effect on technical inefficiency of respondents indicating a rise in technical efficiency as years of cooperative society membership increases and vice versa. However, it was not significant as majority (74%) of the respondents were not members of any cooperative group. Cooperative society serves as a medium for information exchange that can improve farm output of respondents. The negative sign for cooperative society implies that respondents who are members of cooperative society are more technically efficient in farming soya bean under SG 2000 project. Membership of cooperative society can enhance the accessibility of farmers to credit facility and serve as a medium for exchange of ideas that can improve their farm activities.

4.3.3 Allocative efficiency

The estimated parameters for the stochastic frontier cost function for Sasakawa Global 2000 soya bean production presented in Table 12 revealed that the coefficient obtained for Gamma (γ) was 0.95 and was statistically significant at 1% level of probability fulfilling the assumption of the model. The estimated gamma (γ) parameter of 0.95 implies that about 95 percent of the variations in the total cost of production of soya bean under the SG 2000 project was due to differences in their cost efficiencies. This means that cost inefficiency effects do make significant contributions to the cost of producing SG 2000 project soya bean in the study area**.** Therefore, the hypothesis that

the parameter estimate of γ = 0 is rejected. The test was confirmed by the test of hypothesis using the Log likelihood-ratio test presented in Table 12 which shows the estimated value of 100.71 exceeding the chi-square critical value at 1 percent level of probability with number of restriction (degree of freedom) of 8, χ^2(1%,8) which was 8.86, indicating the presence of allocative inefficiency. Therefore, the null hypothesis, which specifies that the inefficiency effects are absent from the model, is strongly rejected.

Table 12: Allocative efficiency of Sasakawa Global 2000 project respondents

Variables	**Coefficient**	**Standard-error**	**t-ratio**
Constant	3.4822	0.9486	3.6710***
Cost of farm land **(X_1)**	0.1462	0.0470	3.1092***
Cost of seed (X_2)	0.2126	0.1079	1.9699**
Cost of fertilizer (X_3)	0.1503	0.0889	1.6901*
Cost of agrochemical(X_4)	0.1739	0.0248	7.0139***
Labour Cost (X_5)	0.3384	0.1190	2.8430***
Output (X_6)	0.1268	0.0722	1.7554*
Inefficiency model			
Constant (δ_0)	-18.9020	20.0491	-0.9428
Educational level (Z_1)	-0.0384	0.0063	-6.1381***
Household size (Z_2)	-0.1946	0.0920	-2.1141**
Age (Z_3)	-0.1010	0.1164	-0.8671
Farming experience (Z_4)	-0.1105	0.0261	-4.2364***
Amount of Credit (Z_5)	-0.0044	0.0038	-1.1590
Cooperative society (Z_6)	-0.5239	0.5341	-0.9810
Variances			
Sigma-squared	5.1543	4.9107	1.0496
Gamma	0.9541	0.0510	18.6912***
Log likelihood function	- 100.7079		
LR test	8.8648		
Number of restrictions	8.00		

n=107

***, **, *, Significant at 1%; 5% and 10% probability levels respectively

Cost of farm land (X_1):- An estimated positive coefficient of 0.146 shows direct effect on cost allocation. The positive relationship of cost of farm land and cost allocation indicates that an increase in cost of farm land will result to an increase in total cost of production for soya

bean in SG 2000 project. Cost of farm land was significant at 1% level of probability for producing soya bean under SG 2000 indicating that the cost of acquiring farm land is very pertinent in the cultivation of soya bean in the study area.

Cost of seed (X_2): The coefficient of cost of seed was positively related to the total cost of producing soya bean under SG 2000 project. This implies that a rise in the cost of seed would result in increase in the total cost of production. Cost of seed was significant at 5% probability level, indicating the relevance of seed to the production of soya bean under SG 2000 project. This is obvious as seed is the variable that is transformed into output, hence output cannot be realised without seed.

Cost of Fertilizer (X_3): The estimated coefficient was positively signed, implying a positive effect of cost of fertilizer on allocative efficiency of soya bean under the SG 2000 project. This relationship conforms to *a priori* expectation. The positive effect of cost of fertilizer implies that an increase in the cost of fertilizer will increase the total cost used for the production of soya bean in the study area. With this, if the price of fertilizer increases, total cost of production will be affected. Cost of fertilizer was significant at 10% probability level indicating the relevance of the variable to allocative efficiency. This is obvious as fertilizer increases fertility of the soil which can affect output positively.

Cost of Agrochemical (X_4): Increase in the cost of agrochemicals would bring about increase in the Total Cost of production of soya bean in the area. This stemmed from the positive sign (0.17) of the variable which indicates that the cost of agrochemical can increase the Total Cost of production by 0.17% if the cost of agrochemical is increased by 1%. Hence, price of agrochemical could affect production cost positively vis-a-vis income being negatively affected as a result of high production cost. Agrochemical cost was significant at 1% level of probability signifying the importance of agrochemicals to the production of soya bean. This variable could bring about higher output as a result of control of pest and diseases which could damage the produce in the field and off-field.

Labour cost (X_5):- The result revealed the estimated coefficient for labour cost to be 0.34 Labour cost had positive effect on allocative efficiency in the production of SG 2000 soya bean, implying that farmers' Total Cost of producing soya bean increased as more labour is put into use. This implies that if labour employed into the production of soya bean increases by 1%, the total cost of soya bean production will increase by 0.34%. Similar result was obtained by Ogundari *et al.* (2006). Labour cost was positively significant at 1% level of probability, indicating that the variable is important in the allocation of cost for soya bean production in the area.

Output (X_6): The estimated coefficient of the variable was positively signed (0.13) indicating that if there is an increase in soya bean output, the total cost of production will increase by 0.13%. With this increase, it shows that the cost of production can be highly influenced by the quantity of output realised. The goal of production is to maximize profit through the sale of output realised. The effect of output on total cost of production is significant at 10% level of probability implying the relevance of output to

the production cost of soya bean under SG 2000 project. A similar result of direct effect of output on cost of production was obtained by Ogundari *et al.* (2006).

4.3.4 Allocative inefficiency

Educational level (Z_1): The negative value of the estimated coefficient for educational level was -0.038. The implication of this result is that as educational level of the respondents increases by 1%, allocative inefficiency will reduce by the value of the coefficient of the variable. The negative effect of educational level with allocative inefficiency implies increase in allocative efficiency of the respondent stemming from higher educational level. Respondents with more years of schooling tend to allocate their input cost more efficiently than their counterparts with lower years of schooling. The findings are in line with the expectation that educational level affects financial planning which invariably affects cost efficiency. Educational level improves adoption of technology; therefore, technological improvement would be attained by respondents as their educational level increases. Educational level of an individual brings about financial understanding of the enterprise. The result revealed that educational attainment has significant effect on cost allocation of respondents under study at 1% level of probability. This indicates that education is vital in decision taking that affects input cost allocation.

Household size (Z_2): The value of the estimated coefficient was negatively signed implying a negative effect on allocative inefficiency of the respondents. Respondents with higher household size tend to be more cost efficient than their counterparts with smaller household size. This may be attributed to the fact that, family labour and farming advice could be sourced from the family members with little or no payment.

This confirms that family labour is a substitute for hired labour. Household size was significant at 5% level of probability, indicating its relevance in allocative efficiency of respondents using SG 2000 project soya bean technology packages.

Age (Z_3): Respondents' estimated coefficient for age was negative (-0.1010), implying that older respondents tend to be cost efficient than younger respondents cultivating soya bean under the SG 2000 project. The negative relationship of age with SG 2000 project soya bean farmers indicates a negative effect on cost allocation of older respondents. This means if younger and energetic soya bean farmers indulge into the enterprise, allocative efficiency would rise thereby reducing total cost of production and vis-a-vis increasing profit. Age was found not to be significant, indicating that age is not relevant in allocative efficiency of the respondents.

Farming experience (Z_4): The coefficient of farming experience was -0.1105, indicating a negative effect on allocative inefficiency. This means a 1% increase in farming experience would result to a 0.11% decline in total cost of producing soya bean under SG 2000 project. Farming experience had a negative relationship with allocative inefficiency. A significant probability level of 1% was obtained for farming experience. This suggests that farming experience is relevant in soya bean production in the area. Farming experience is expected to influence allocative efficiency because of the accumulation of skills over time by older farmers.

Amount of credit (Z_5): Estimated coefficient of amount of credit was negatively signed showing positive effect on cost efficiency of respondents who produce soya bean under SG 2000 project. Respondents with access to credit tend to be more efficient in cost

allocation than respondents without access. This is in line with the a *priori* expectation, as credit enhances adoption of technologies as well as enables farmers to buy inputs at affordable price and on time. This is adjudged so because access to credit helps farmers to purchase the needed inputs on time. Access to credit was not significant probably due to incidences of diversion of credit to other uses or as a result of untimely access by the farmers due to bureaucratic bottle necks. Credit determines pricing strength of an individual; hence, credit is important in agricultural activities.

Membership of cooperative society (Z_6): The coefficient estimated had a negative sign of -0.5239 signifying that the longer a respondent stayed in a cooperative society, the lower is his allocative inefficiency. However, it is not significant which may be attributed to the less number (26%) of the respondents who belonged to cooperative society in the study area as shown on table 9. Membership of cooperative can enhance farmers' access to credit facility and serve as a medium for exchange of ideas that can improve their farm activities.

4.3.5 Economic efficiency

Economic efficiency indicates the welfare and the economic status of the respondents. The result presented in Table 13 is the product of technical and allocative efficiencies. The positively significant value of the sigma-square conforms to the expectation of the data being fit into the model of the stochastic function. The gamma coefficient of the economic efficiency lies between 0 and 1 as expected (0.94). This implies that about 94% of the variations in the economic status of the respondents are attributable to differences in their economic efficiencies. This implies that economic inefficiency

significantly contributes to the production of soya bean under SG 2000 project in the study area**.** Hence**,** the hypothesis that gamma(γ) = 0 is rejected.

The included production variables show both positive and negative signs. Farm land, seed and fertilizer revealed positive effect on economic efficiency of the respondents. The positive relationship of these variables to economic efficiency implies that an increase in the use of these variables by 1% would result to an improvement in the economic status of the respondents. The combination of larger farm holdings and application of fertilizer to SG 2000 project soya bean would lead to increased output vis-a-vis income of the respondents; thereby, improving the living standard of the respondents. This is in conformity with the assertion of larger farm holding bringing about higher output as well as encouraging adoption of innovation. On the other hand, agrochemical and labour were negatively signed, implying a negative effect on economic efficiency of the respondents. If volume of agrochemical and labour used for the production of SG 2000 project soya bean are increased by 1%, economic efficiency would decrease. This sign which is against *a priori* expectation could be stemming from inappropriate utilization of the inputs by the farmers. Apart from fertilizer, all the other production variables were found to be significant at various levels of probability for economic development of the respondents. This may be attributed to the fact that soya bean being a leguminous crop does not require much fertilizer application because of its ability to fix atmospheric nitrogen into the soil.

The estimated parameters for educational level, household size and farming experience were negative and significantly related to economic inefficiency at 1 percent level of probability. This implied that increase in educational level, household size and farming

experience would reduce economic inefficiency. The coefficient obtained for amount of credit was negative and significant at 5 percent whereas the coefficients for age and membership of cooperative organization were also negative but not significant. The negative sign indicates that a unit increase in the value of these variables will lead to a unit increase in economic efficiency by the corresponding coefficients of the variables. Age was not significant implying that age does not really matter in terms of efficiency but the farming experience exerts more influence on efficiency than age. Also, membership of cooperative organization was not significant because majority (74%) of the respondents did not belong to any cooperative organization.

Table 13: Economic efficiency of Sasakawa Global 2000 Project respondents

Variables	Coefficient	Standard-error	t-ratio
Constant	35.4958	7438.921	47.7175***
Farm land	0.0862	0.0068	12.5948***
Seed	0.0179	0.0046	3.8913***
Fertilizer	0.0091	0.0095	0.9583
Agrochemical	-0.0703	0.0072	-9.7168***
Labour	-0.0355	0.0033	-10.6366***
Constant	-133.8715	116.1645	-1.1524
Educational level	-0.0064	0.0006	-10.1039***
Household size	-0.1127	0.0135	-8.3245***
Age	-0.0410	0.0430	-1.1620
Farming experience	-0.0226	0.0005	-46.9952***
Amount of credit	-0.0026	0.0013	-1.9732**
Cooperative society	-0.0021	0.0041	-0.5320
Sigma-squared	154.4156	79.5327	1.9416**
Gamma	0.9396	0.0004	2398.6570***
Log likelihood function	-16800.75		
LR test	477.78		
Number of restrictions	8.00		

4.4 Distribution of Technical, Allocative and Economic Efficiencies

The general distribution of respondents' efficiency presented in Table 14 shows a minimum of 10% and a maximum of 99% with a mean efficiency of 86%. The obtained mean technical efficiency of the respondents indicates that soya bean farmers in the study area have 14% chance for improving production efficiency using the existing technology of the best farmer. Therefore, there is need to increase production by utilizing available resources to attain the frontier level. About 54% of the respondents fall between technical efficiency of 0 - 30%. Respondents operating at technical efficiency of between 31 and 60% were 23% while respondents with technical efficiency above 60% were 21%. This revealed that there is room for improvement since most farmers had technical efficiency less that 50 percent.

The individual technical efficiency ranged from 10 to 99% with an average of 89%. Supposed the average technically efficient farmer in the sample was to achieve the technical efficiency position of the most efficient farmers, then the average technical efficient farmers could realize a 10% cost savings (1 − [89/99]). On the other hand, the least efficient farmers could save cost of 90% (1 − [10/99]) if the same level of technical efficiency with the technically efficient respondents is achieved.

The distribution of allocative efficiency among the respondents spread from 10 to 97%. The allocative efficiency mean, minimum and maximum values were 73%, 10% and 97% respectively. This shows a wide distribution of allocative efficiency among the respondents, though, none of the respondents had attained the cost frontier level of 100%. The mean allocative efficiency of 73% implies that there is 27% shortfall in allocative efficiency of an average farmer. Respondents allocating the cost resources

between 0 – 30% were 37% of the sample whereas, 32% of the respondents allocate cost resources between 31 to 60% while respondents with allocative efficiency above 60% were 29%.

Economic efficiency which is the product of technical and allocative efficiencies shows that the average economic efficiency level was about 65%, with a minimum of 1% and a maximum of 96%. With this, the most economically inefficient respondent can gain economic efficiency of 99% (1 − [1/96]) while if the average economic efficiency operator in the sample is to achieve the economic efficiency level of the most economic efficient farmer, 32% of the cost would be saved.

Table 14: Distribution of Efficiencies for Sasakawa Global 2000 project soya bean respondents

Class	Technical Efficiency		Allocative Efficiency		Economic Efficiency	
	Freq	Per	Freq	Per	Freq	Per
0.00- 0.10	0	0	2	1.869	43	40.186
0.11-0.20	44	41.121	13	12.149	36	33.644
0.21-0.30	14	13.084	26	24.299	14	13.084
0.31-0.40	8	7.477	12	11.215	5	4.673
0.41-0.50	11	10.280	13	12.149	2	1.869
0.51-0.60	6	5.607	9	8.411	4	3.738
0.61-0.70	6	5.607	11	10.280	2	1.869
0.71-0.80	8	7.477	8	7.477	0	0.00
0.81-0.90	5	4.673	7	6.542	1	0.934
0.91-1.00	5	4.673	6	5.607	0	0.00
Total	**107**	**100**	**107**	**100**	**107**	**100**
Maximum	0.991		0.969		0.960	
Minimum	0.103		0.100		0.010	
Mean	0.885		0.731		0.647	

Freq= Frequency, Per=Percentage

4.5 Constraints Encountered by Sasakawa Global 2000 Soya Bean Farmers

Constraints could be seen as the hindrances or difficulties experienced by the respondents utilizing Sasakawa Global 2000 soya bean production technology package. The data on constraints are presented in Table 15 and discussed accordingly.

The sampled Sasakawa Global 2000 soya bean farmers ranked insufficient credit as their 1st constraint. About 25% of the respondents identified this as a problem. Adekunle *et al*. (2009) identified perceived constraints that militate against active participation in agricultural production activities to include inadequate credit facilities, poor returns of agricultural investment and lack of agricultural insurance for produce during glut period.

Insufficient land was ranked 2nd with 18% of the respondents listing it as a problem they encountered. This confirmed why majority of the farmers had small farm holdings. Lack of land ownership refers to lack of land to be used on a sustainable level owing to lack of ability to own it on a permanent basis. Land ownership is a critical problem in agricultural production and is not limited to age or gender. Josue Mamder (1986), noted that a greater proportion of the rural farmers in african countries work in family farms and do not possess any title hold to the land and this discourages them from continuing the agricultural or rural work.

Ranked 3rd among the constraints highlighted was absence of threshing machines /equipment. There were 12% of the respondents identifying it as a constraint. About 11% of the respondents highlighted bad roads as a constraint ranking 4th among the identified constraints. Ahmadu (2011) in his work on socio-economic factors

influencing the level of rural youth involvement in cassava production activities in Benue State, stated that lack of modern equipment was ranked first with 64% of the respondents highlighting it as their major constraint to cassava production by the rural youth and amongst rural farmers.

Participating Sasakawa Global 2000 farmers in the area stated that inadequate labour was their 5th ranked constraint with 11% of the respondents agreeing to this constraint. This is in conformity with Dauda *et al*. (2009) where they asserted that the major factor that inhibit or limits agricultural activities as perceived by farmers was unavailability of labour. Inadequate Capital was ranked 6th among the constraints highlighted by the respondents. Availability of capital could facilitate adoption of a technology in that farmers will be able to purchase improved seeds, fertilizer and chemicals, pay for hired labour and purchase or hire modern farm implements and machines. This constraint was also identified by Kibwika and Semaru (2000) where they stated that lack of access to capital impedes investment in important agricultural technologies such as improved seeds, agricultural chemical and irrigation, whereas these are keys to modernization of agriculture.

Table 15: Constraints encountered by Sasakawa Global 2000 soya bean respondents.

Constraints	Frequency	Percentage	Ranking
Insufficient Credit	53	25.12	1st
Inadequate Land	39	18.48	2nd
Absence of Threshing Machines	25	11.85	3rd
Bad Roads	24	11.37	4th
Inadequate Labour	21	9.95	5th
Inadequate Capital	13	6.16	6th
Inadequate Fertilizer	12	5.69	7th
Unfavourable Government Policies	9	4.27	8th
High cost of Inputs	8	3.79	9th
Poor market Price of soya bean	3	1.42	10th
Insufficient extension staff	2	0.95	11th
Lack of Incentives	2	0.95	11th
Total	**211**	**100**	

About 6% of the respondents highlighted inadequate fertilizer as their 7th constraint. This could reduce output of soya bean in the area. Oladele and Karem (2003) suggested that the use of fertilizer is the least sustained technology under cassava production due to high cost of purchase. Similarly, Ojuekaiye (2001), study revealed that lack of fertilizer and high prices were responsible for the reduction in most agricultural production through reduced hectares. The 8th rank constraint was unfavourable government policies such as inputs distribution, incentives, subsidies on inputs, price control of produce, importation and value chain policy which 4% of the respondents identified as a constraint. These policies can improve the productivity of agricultural production.

About 4% of the respondents highlighted high cost of inputs as a constraint, hence it was ranked 9th among the constraints identified. Production depends on available

inputs; if cost of inputs increases and the price of the commodity remain constant, profit will decrease. With high cost of inputs, insufficient capital and credit, adoption of a certain technology will eventually be low. Pricing can induce farmers over a particular crop production. If farmers perceived the price of a certain crop is discouraging they may opt out of the production of that crop. Poor market price of soya bean was identified as a constraint to the sampled Sasakawa Global 2000 soya bean farmers in the study area as 1% of the respondents highlighted it as a constraint; hence, it ranked 10^{th} among the identified constraints. Insufficient extension staff and lack of incentives were ranked (11^{th}) among the constraints each having about 1% of the respondents identifying it as a constraint. Extension agents play vital roles in disseminating new technologies, practices and information on modern farming techniques to help boost farmers' level of production.

CHAPTER 5

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

The study was conducted to evaluate the economics of Soya bean production under Sasakawa Global 2000 project in Kaduna State, Nigeria. Data collected with the aid of structured questionnaire and was analysed using descriptive statistics, stochastic frontier production function and Gross Margin analysis. The socio-economic characteristics of Soya bean farmers were considered in this study to elicit relevant information on soybean production in the study area. The result shows that age ranged between 22 - 76 years, with a mean age of 49 years. This means that the respondents were young and in their active productive age. The findings show that 11% of the respondents never attended formal education, 36% had primary education, 17% secondary and 36% tertiary education. This implies that majority (89%) of the respondents had some levels of educational attainment, meaning that they are literate. Illiteracy is believed to have a negative implication on efficient use of productive resources and adoption of farm innovation.

The result show that 78% of the respondents cultivated on less than one hectare. This implies that Sasakawa Global 2000 project soybean farmers are mostly small-scale farmers. The result showing the amount of credit indicated that 38% of the respondents never had access to credit facility whereas 62% of them had access to one form of credit or the other. The mean years spent in cooperative society was 8 with 74% not belonging to any cooperative organization.

The Total Variable Cost (TVC) incurred by the respondents averaged ₦115,449/ha, with an average gross income (GI) of ₦356,401, which resulted to a gross margin (GM) of ₦240,952/ha. Labour cost accounted for 82% of the TVC. Seed, fertilizer and agrochemicals costs accounted for 7%, 6% and 5% respectively for the SG 2000 soya bean production in the study area. The income earned from soya bean production was noticed to be profitable in the area. Therefore, the null hypothesis which states that Sasakawa Global 2000 Soya bean production is not profitable was rejected and the alternative accepted.

The result shows that technical inefficiency effects were present in the production of soya bean under Sasakawa Global 2000 project. Farm size, quantity of seed used, quantity of fertilizer used were positive, implying that a 1% increase in the values of the variables will lead to an increase in the yield of Soya bean by their corresponding coefficients. On the other hand, labour used and quantity of agrochemicals were negative, indicating a negative effect on output if these variables are increased. A 1% increase in any of these variables would lead to a decrease in the quantity of output by the corresponding coefficients of the variables. Farm size and volume of agrochemicals used were both significant at 1% level of probability, while quantity of seed used was significant at 5% level of probability. This indicates the importance of these variables to the production of Soya bean in the area.

The determinants of technical inefficiency for the production of soya bean under SG 2000 project were educational level, household size, age, farming experience, amount of credit and membership of cooperative societies. These variables were negatively signed indicating a negative effect on technical inefficiency. An increase in a negatively signed

variable would result to a decrease in technical inefficiency. Educational level, household size, farming experience and amount of credit were found to be significant at various levels of probabilities in the production of soya bean under the SG 2000 project. This indicates their importance in the production of the crop. Age was not significant because farming experience exerts more influence on efficiency than age. A farmer can be older but without farming experience whereas a farmer can be young but with enough farming experience. Again membership of cooperative organization was not significant as majority of the respondents (74%) never belonged to any cooperative organization.

Cost of farm land, cost of seed, cost of fertilizer, cost of agrochemical, labour cost and output all affect total cost of production positively and significantly, meaning an increase in the cost of any of these variables would lead to increase in the total cost of production of soya bean under the SG 2000 project. Therefore, prices of these variables contribute to the cost of production. The included socio-economic factors that determine allocative inefficiency in soya bean production under SG 2000 were educational level, household size, age, farming experience, amount of credit and membership of cooperatives and were negatively related to allocative inefficiency. The negative effect of these variables on allocative inefficiency implies that a 1% rise in any of these variables would result to a decline in allocative inefficiency by the corresponding coefficient of the variable, thereby, increasing allocative efficiency. Educational level and farming experience were significant at 1%, while household size was significant at 5% level of probability, indicating their relevance in allocative efficiency of respondents.

The general distribution of respondents' technical efficiency reveals that the minimum, maximum and mean technical efficiencies were 10%, 99% and 89% respectively. On the other hand, allocative efficiency distribution among respondents ranged from 10 to 97% with mean, minimum and maximum of 73%, 10% and 97% respectively. This shows a wide distribution of allocative efficiency among the respondents. The average economic efficiency level was 65%, with a minimum value of 1% and a maximum value of 96%.

Insufficient credit, inadequate land, absence of threshing machines /equipment and bad roads were the major constraints identified by the respondents in the order of declining severity. Other constraints include inadequate labour, inadequate capital, inadequate fertilizer, unfavourable government policies, high costs of inputs, poor market price of soya bean, insufficient extension staff and lack of incentives.

5.2 Conclusion

Sasakawa Global 2000 soya bean production was a profitable enterprise in the study area as significant profit was recorded per hectare of land cultivated. The study established that if younger and educated farmers are engaged in the production of soya bean as in under SG 2000 project and with proper access to credit, more profit will be realized, hence, the enterprise can serve as a means of employment for the populace as well as improving level of living of the farmers.

The average technical, alloctaive and economic efficiencies which were estimated to be 0.89, 0.73 and 0.65 respectively implying that there is a significant potential for the farmers to increase their efficiencies. If the efficiency level of the most efficient farmer

is to be attained by all the farmers, cost savings can be achieved with the present level of technology and prices of inputs.

5.3 Recommendations

The following recommendations are made based on the findings of this study:

1. Farm inputs such as seeds, fertilizer and agrochemicals were the major inputs influencing the production of soya bean in the study area. Therefore, these inputs should be made available on time, in right quantities and at affordable prices to the farmers by SG 2000 project and other stakeholders in agriculture.
2. Insufficient credit was identified as a major constraint to the production of soyabean under the project. Therefore, the project should make available soft loans to the participating farmers to enable them acquire needed inputs on time and in the right quantity.
3. SG 2000 should incorporate value addition activities into her programme in order to enhance soya bean processing thereby enhancing more production and improving farmers' standard of living.
4. Farmers should be encouraged by SG 2000 project to join existing associations and participate fully in their activities. This will enhance farmers' accessibility to interventions provided by the SG 2000 project as well as other stakeholders and enable them pull more resources together in order to improve their financial base as group and hence, grant credits to individual members as well as purchase farm machines and equipment needed for renting and hiring to members.
5. The provision of adequate rural infrastructural facilities such as schools, portable water, markets, feeder roads, recreational facilities and other social amenities should be the focal point of government decision making. This will discourage

rural-urban drift by youths who can provide labour to the agricultural industry and also promote good investment climate for agricultural development activities in the study area.

6. It was revealed that inefficiency exists in the production of soya bean in the study area. Therefore, there is no need for the development of a new technology package to raise productivity; instead, efficiencies can be increased by increasing the usage of inputs already available by farmers.

5.4 Contribution to Knowledge

1. The mean technical, allocative and economic efficiencies obtained from the research were 0.89, 0.73 and 0.65 respectively. This clearly indicates that the yield of soya bean under SG 2000 Project can be increased if the farmers can improve on their present levels of efficiencies. This will increase farmers' living standards as more income will be generated when yield is increased.
2. Soya bean production as an enterprise can serve as a means of generating more employment for the populace as a significant profit of ₦240,952 was recorded per hectare of land cultivated.
3. The research shows that the determinants of the farmers' inefficiencies were educational level, household size, farming experience, amount of credit obtained and membership of cooperative organisation. These factors when increased can have positive effects on the efficiencies of the farmers. Also, major constraints encountered by the farmers were insufficient credit, inadequate land, absence of threshing machines and equipment, bad roads and inadequate labour.

REFERENCES

Adedoyin, S.F.,Torimiro, D.D.,Joda, A.O. and Ogunkoya, A.O. (1998): Adoption of Soybeans Planting, Processing and Utilisation Packages in Ago Iwoye, Proceeding of the 3rd Annual National Conference of the Agricultural Extension Society of Nigeria, 4-6 March.

Adekunle, O.A., Ogunlade, I. and Oladele, O.I. (2003): Adoption of Soybeans Production Technology in Kwara State, Nigeria. *Journal of Extension System, 19 (2):32-3.*

Adekunmi, A.O., Adisa, B.O., and Yusuf O.J. (2010). " Factors Associated with the Adoption of Soybean Production Package Among Farmers in Osun State, Nigeria. Proceedings of the 44th Annual Conference of Agricultural Society of Nigeria, "LAUTECH, 2010".

Adewale, J.G. Oladejo J.A. and Ogunniyi, L.T. (2003). Economic Contribution of Farm Children to Agricultural Production in Nigeria. *Journal of Social Science,* 10(2): 149-152

Adeola, S. S. (2010). *Economics of Insecticide Usage Among Cowpea Farmers in Kaduna State, Nigeria*. M.Sc. Thesis, Department of Agricultural Economics and Rural Sociology, Ahmadu Bello University, Zaria.

Agcaoili M., Rosegrant M. (1995). "Global and Regional Food Supply, Demand, and Trade Prospects to 2010" In Population and Food in the Early Twenty-first Century, edited by N. Islam. Washington, D.C., IFPRI.

Ahmadu, G. O. E. (2011). "Socio-economic factors influencing the level of Rural Youth involvement in Cassava Production activities in Benue State". An M.Sc Thesis submitted to the Department of Agricultural Economics and Rural Sociology, Faculty of Agriculture, Ahmadu Bello University, Zaria

Aigner, D.J., Lovell, C.A.K., and Schmidt, P. (1977). Formulation and Estimation of Stochastic Frontier Production Function Model. *J. Econ.*, 6: 21–37.

Ajobo, T. and Akinyemi, A. (2007): Soybean: Food that Prevents Cancer, Diabetes, Menopausal Problems. The Tribune Newspaper, June 6, 2007, page 2.

Akino, M. and Hayami, Y. (1975). Efficiency and Equity in Public Research: Rice Breeding In Japan's Economic Development. *American Journal of Agricultural Economics, 57(10):1-10.*

Alamu, J.F. and Ibrahim, H. (2004). Resource-Use Efficiency in Cotton Production Among Scale Farmers of Katsina State, Nigeria. *Agrosearch 6 (1):1-7.*

Amaza, P.S., (2000). Efficiency of Food Crop Production in Gombe State, Nigeria. *Ph.D Thesis*, Department of Agricultural Economics, University of Ibadan, Ibadan.

Anazonwu-Bello, J.N. ('1978). *Soyabean in National Diet.* The Food Investigation Centre. Ministry of Agriculture and Natural Resources, Enugu. Government Printers, p8.

Ashaya, T,T., Asenime, I.O.E., Afolabi, N.O. and VanRheenen, H.A. (1975). "Soyabean Production in Nigeria ". *Soyabean Production, Protection and Utilization*, Urbana-Champaign INTsoy Series No.14, College of Agriculture, Illinois, International Agricultural Publication , pp 223-226,

Ashaye, O.A., Adegbulugbe, T.A. and Sanni, S. (2005): Assessment of Soybean Processing Technologies in Ilorin East and West Local Government Area of Kwara State. World *Journal of Agricultural Science 1 (1): 59-61.*

Average Maize Yield in Metric Tonnes for Selected Countries, 2000-2008, www.http://faostat.fao.org/faostat/

Awudu, Abdulai and Wallace Huffman. (2000). "Structure Adjustment and Economic Efficiency of Rice Farmers in Northern Ghana." *Economic Development and Cultural Change*, 503-519.

Awudu, Abdulai and Richard Eberlin. (2001). "Technical Efficiency during Economic Reform in Nicaragua: Evidence from Farm Household Survey Data." *Economic Systems*, 25:113-125.

Bedassa, Tadesse and Krishnamoorthy, S. (1997). "Technical Efficiency in paddy Farms of Tamil Nadu: An Analysis Based on Farm Size and Ecological Zone." *Agricultural Economics*, 16:185-192.

Battese, G.E and Coelli, T.J. (1995). "A Model for Technical Inefficiency Effects in a Stochastic Frontier Production Function for Panel Data." *Empirical Economics* 20:325-332.

Battese, G.E and Corra, G.S. (1977): "Estimation of a Production Frontier Model with Application to the Pastoral Zone of Eastern Australia". *Australian Journal of Agricultural Economics. 21: 16a – 17a.*

Battese, G.E., Sohail, Malik, J., and Manzoor A. Gill. (1996). "An Investigation of Technical Inefficiencies of Production of Wheat Farmers in Four Districts of Pakistan." *Journal of Agricultural Economics*, 47 (1): 37-49.

Bationo A., Ayuk, E., Ballo, D., and Koné, M. (1997). "Agronomic and Economic Evaluation of Telemsi Phosphate Rock in Different Agroecological Zones of Mali." Nutrient Cycling in Agroecosystems, 48, pp.179-189.

Belen, Iraizoz, Manuel Rapun and Idoia Zabaleta (2003). "Assessing the Technical Efficiency of Horticultural Production in Navarra, Spain." *Agricultural Systems*,78:387-403.

BIDCO (Business and Industrial Development Cooperation) (2005). BIDCO Oil Refineries Ltd, Thika, Kenya.

Bifarin, J. O., Alimi, T., Baruwa, O. I., and Ajewole, O. C. (2010). Determinant of Technical, Allocative and Economic Efficiencies in the Plantain (Musa spp.) Production Industry, Ondo State, Nigeria. *Proceeding of International Conference on Banana & Plantain in Africa,* Edited by Dubois, T., *et al.* Acta Hort. 879, 199-210.

Bincan J.N. (1990). A Review of Government Policies and Programmes for Livestock Development in Nigeria. A Paper presented at the National Conference on Livestock Industry and Prospects for the 1990s. Lugard Hall, Kaduna, Nigeria.

Boerma, R.H., Specht, J.E. (Eds.) (2004). Soybeans: Improvement, Production, and Uses, Third Edition, No. 16 in the series AGRONOMY, ASA, CSSA, and SSSA, Madison.

Bravo-Ureta, B.E.and Robert. E. Evenson. (1994). "Efficiency in Agricultural Production: A Case of Peasant Farms in Eastern Paraguay." *Agricultural Economics,* 10:27-37.

Brown L. and Haddad, L. (1994). "Agricultural Growth as a Key to Poverty Alleviation." 2020 Brief no. 7. Washington D.C.: IFPRI.

Chandrasekhar, U. and Paul, H. (1989)." Nutrition and Life Style of People: Supplementation Studies on Selected Cancer Patients", *Indian Journal of Nutrition and Dietetics,* Avinashilingu Institute for Home Science and Higher Education for Women, Deemed University, Coimbatore, India, Vol. 26(8) pp 219-228.

Chavas, J. and M. Aliber (1983). An Analysis of Economic Efficiency in Agriculture: A Non-parametric Approach. *J. Agric. Res. Econ*., 18: 1.

Chavas, J.P. and Cox, T.L. (1988). A Non-parametric Analysis of Agricultural Technology. *American J .Agric. Eco.,* 70: 303–10.

Coelli, T.J. (1995). Recent Developments in Frontier Estimation and Efficiency Measurement. *Australian J. of Agric. Econ.*, 39: 219–45.

Dashiell, K.E., Bello, L.L. and Root, W.R. (1987). Breeding soybeans for the tropics. Pages 3–16 *in* Soybean for the tropics. Research, production and utilisation, edited by Singh, S.R., Rachie, K.O. and Dashiell, K.E. John Wiley and Sons Ltd., Chichester, UK.

Dashiell, K.E. (1992), "Soyabean Help Farmers, Urban Dwellers and Industries in Nigeria", A paper presented a t the 5th Annual Conference of the Nigerian Soyabean Association in Makurdi, Benue State.

Dashiell K. (1998). An Effort to Promote the Production and Consumption of Soybean as a Means of Improving Nutrition in Nigeria.

Dauda, S., Okwoche, V.S. and Adegboye, O.G. (2009). Role of Youth in Agricultural Development in Makurdi Local Government Area in Benue State *Journal in Agriculture Extension*, 13(2); 107-112

Doss C.R. (2003). Analyzing technology adoption using micro studies: Limitations, challenges and opportunities for improvement. Agric. Econ., 34: 207-219.

Doss C.R. (2006). Understanding Farm Level Technology Adoption: Lessons learnt from CIMMYT's micro-survey in Eastern Africa. CYMMIT Economic Working, Mexico, D.F. pp. 7-30.

Dugje, I.Y., Omoigui, L.O., Ekeleme, F., Bandyopadhyay, R., Lava Kumar, P. and Kamara A.Y. (2009). Farmers' Guide to Soybean Production in Northern Nigeria.

Ebeniro, C.N., Okpara, D.A., Ano, A.O., and Njoku, S.C. (2010). " Response of Soya bean, Glycine Max (L) Merill to Lime and Potassium on a Haplic Acrisol in Umudike". *The Nigerian Agricultural Journal,* Volume 41 (No 2), 2010.

Ekong, E.E. (2003). *An Introduction to Rural Sociology*. Dove educational Publishers, Uyo, Nigeria.

Fabiyi (2006). Soyabean Processing, Utilization and Health Benefits. *Pakistan Journal of Nutrition 5 (5): 453-457, 2006.*

FAOSTATS (2009). Food and Agriculture Statistical Database Internet: http://apps.fao.org/page/collections?Subset=agriculture. http://www.faostat2009.org.

Food and Agriculture Organization (FAO) (1994). Fats and Oils in Human Nutriton. Reports of a Joint Export Consultants, Rome, FAO Food and Nutrition Paper, No. 57. http://www.fao.org/docrep/V4700E/V4700E00.htm.

Farre, R., Grabowski, R. and Grasskopt, S. (1985). Technical Efficiency of Philippine Agriculture. *Applied Economics,* 17: 205–14

Farrel, M.J. (1957). The Measurement of Productive Efficiency. *Journal of Royal Statitic Society,* 120: 253–81.

Federal Ministry of Agriculture and Rural Development (FMARD), 2006. National Programme for Food Security (NPFS) Expansion Phase Project 2006-2010. (Main Report).

Federal Ministry of Agriculture and National Orientation (FMINO) (2002).

Food and Agricultural Organization (FAO) (1992): FAO Production Year Book Vol. 45, Rome.

Forsund, F.R., Lovell C.A.K. and Schmidt P. (1980). A Survey of Frontier Production Functions and their Relationships to Efficiency Measurement. *J. Econ*., 13: 5–25.

Galiba M. (1993). "The Sasakawa Global 2000 Project in Benin and Togo." In Developing African Agriculture : New Initiatives for Institutional Cooperation, edited by W.D. Swegle, pp. 37-51. Proceedings of a Workshop, Cotonu, 28-30 July. Mexico City: SAA/GLOBAL 2000/ CASIN.

Gilead I. Mlay (1984). The Economics of Smallholder Dairy Production in Hai District, Tanzania. Department of Rural Economy, Sokoine University of Agriculture, Morogoro, Tanzania.

Greene, W.J. (1990). A Gamma–distributed Stochastic Frontier Model. *J. Econ.*, 46: 144–64.

Greene, W.H. (1993). The Economic Approach to Efficiency Analysis. *In* H.O. Fried, C.A.K Lovell, and S.S. Schmidt (Eds.). The Measurement of Production Efficiency. Oxford University Press, New York.

Greenberg, P. and Hartung, H.N. (1998). The Whole Soy Cookbook: 175 Delicious, Nutritious, Easy-to prepare Recipes Featuring Tofu, *Tempeh*, and various forms of nature's healthiest bean. Three Rivers Press, New York.

Griffins, C.R., Mongomery, M.J., and Rister, W.E. (1987). Selecting Functional Forms in Production Analysis. *Western Journal of Agricultural Economics, 12(2):216-217.*

http://www.wikipedia.com. December 8, 2010.

International Institute of Topical Agriculture (IITA) (1995). Annual Report for 1994. IITA, Ibadan, Nigeria.

Indexmundi (2012). Nigeria Population growth rate. http://www.indexmundi.com/nigeria/population_growth_rate.html

Idrisa, Ogunbameru and Amaza (2010). Influence of Farmers' Socio-economic and Technology Characteristics on Soybean Seeds Technology Adoption in Southern Borno State, Nigeria. *African Journal of Agricultural Research Vol. 5(12), pp. 1394-1398, 18 June, 2010.*

Jondrow, J., Lovell, C.A.K., Materov, I.S. and Schmidt, P. (1982). On Estimation of Technical Inefficiency in the Stochastic Frontier Production Function Model. *J. Econometrics 19:233-238.*

Josue' Mamder (1986). Youth Employment in Rural Areas: Situation and prospect. In Youth Employment Promotion in African countries. ILO Report on the Regional Workshop held on November, 24-28, Buea, Cameroon. pp. 187-190.

Kaduna Agricultural Development Project (KADP) (2010). Population of Farmers Within the SG 2000 Project under the Samaru KADP Zone of Kaduna State.

KADP (2010). Agricultural Commodities Produced and their Major Areas of Production in Kaduna State, Nigeria.

Kalirajan, K. and Obwona, M. (1994). Frontier Production Function: The Stochastic Coefficients Approach, *Oxford Bull. Econ. Stat.,* 56: 85.

Kasasa, P., Mpepereki, S. and Giller, K.E. (2000). Quantification of Nitrogen Fixed by Promiscuous Soy bean Varieties under Zimbabwean Field Conditions. In: Forum 4 Working Document 1. Programme Extended Abstracts. Fourth Regional Meeting of the Forum for Agricultural Husbandry, Lilonqwe, Malawi.

Kibwika, P. and Semana A.R. (2002). A Challenge of Supporting Youth for Sustainable Agricultural Development and Rural Livelihood. In Elijah G. An unpublished B. Agriculture Project, Department of Agric Economics and rural Sociology. Ahmadu Bello University, Zaria.

Lee, H.P. (1991). *Dietary Effect on Breast Cancer, Risk in Singapore Lancet.* (British edition). Department of Community, Occupational and Family Medicine. National University of Singapore, Lower Kent Ridge Road, Singapore, 337 (8751).

Luke, A., Lewis, H. and Kent, K. (2002): Economic Analysis of Soybean-Wheat Cropping Systems. Online crop management.

Liu Zinan and Zhuang Juzhong. (2000). "Determinants of Technical Efficiency in Post-Collective Chinese Agriculture: Evidence from Farm-Level Data." *Journal of Comparative Economics,* 28: 545-564.

Llewelyn, R.V. and Williams, J.R. (1996). Non-parametric Analysis of Technical and Scale Efficiencies for Food Production in East Java, Indonesia. *Agric. Eco.*, 15: 113–26.

Malema Beatus A. (2005). Soyabean Production and Utilization in Tanzania. Ministry of Agriculture, Food Security and Cooperatives Crop Development Division, Tanzania.

Masefield, G.B. (1977). The Oxford Books of Plants. Oxford University Press.

Matthews-Njoku, E.C. (2005): Adoption of Soybean Products in Owerri North Local Government Area of Imo State, Nigeria *Agrosearch* 7(1):17-22.

Mbanasor, J.A. (2002). Resource Use Pattern Among Poultry Enterprises in Abia State, Nigeria. *Nigerian Journal of Animal Production. 29 (1 and 2):63-70.*

Meeusen, W. and van den Broeck , J. (1977). Efficiency Estimation from Cobb-Douglas Production Functions with Composed Error. *In: Econ.*, 18: 435–44.

Mochebelele, M. T. and Winter-Nelson, A. (2002). "Migrant Labor and Farm Technical Efficiency in Lesothi." *World Development* 18(1):143-53.

Myaka, F. A., Kirenga, G., Malema, B. (Eds) (2005). Proceedings of the First National Soybean Stakeholders Workshop, 10–11 November 2005, Morogoro, Tanzania.

Naganawa, S. (1988). "Effect of Soya Protein Diet on Patients with liver cirrohis". Nutritional Science of Soy Protein, Japan. First Dept of International Medicine. Gifu university, School of Medicine, Gifu 503 Japan 9 (1) 101-103.

National Agricultural Extension and Research Liaison Services (NAERLS) (2002). Field Situation Assessment of 2002 wet season. *Agricultural Production in Nigeria*. ABU press, Zaria, pp.75-92.

National Population Commission (NPC) (2006). Provisional 2006 Nigeria Census Figures.

Norman, A.G. (1978). *Soya bean Physiology, Agronomy and Utilization*. Academic Press, New York, San Francisco, London.

Nubukpo, K. and Galiba, M. (1999). Agricultural Intensification in West Africa: Insights from Sasakawa Global 2000's Experience.

Oboh, V. U., Nagarajan, L. and Ekpebu, I. D. (2011). A Marginal Analysis of Agricultural Credit Allocation by Arable Crop Farmers in Benue State, Nigeria. *Current Research Journal of Social Sciences*, 3(2): 81-86.

Ogundari, K., Ojo, S. O. and Ajibefun, I. A. (2006). Economies of scale and cost efficiency in small scale maize production: empirical evidence from Nigeria. *Journal of Social Sciences*, 13(2): 131-136.

Ojo, S.O., and Ehinmowo, O.O. (2010). Economic Analysis of Kola-nut Production in Nigeria. *Journal of Social Science, 22(1): 1-5.*

Ojuekaiye, E.O. (2001). Economic Analysis of Cassava Production in Three Local Government Area of Kogi State. Unpublished M.Sc. Thesis Department of Agricultural Economics and Rural Sociology, ABU, Zaria.

Okike, I. (2000). Crop-Livestock Interaction and Economic Efficiency of Farmers in the Savanna Zone of Nigeria. Un-published *Ph.D Thesis*, Department of Agricultural Economics, University of Ibadan.

Okike, I., Jabbor, M. A., Manyong, V., Smith, J.W., Akinwumi, J.A. and Ehui, S.K. (2001). Agricultural Intensification and Efficiency in West Africa Savannahs: Evidence from Northern Nigeria. Socio-economic and Policy Research Working Paper 33. ILRI, Addis Ababa, Ethiopia. pp 47.

Okuneye, P.A. (2002): FAO Production Year Book Vol. 45, Rome.

Okwu, O. J. and Umoru, B. I. (2009). A study of women farmers' agricultural information needs and accessibility: A case study of Apa Local Government Area of Benue State, Nigeria. *African Journal of Agricultural Research*, 4 (12):1404-1409, http://www.academicjournals.org/AJAR

Oladele, I.O. and Kareem, A.I. (2003). Adoption Rate and Continued use of selected Arable crop technologies among farers in Oyo State. *Journal of Food, Agriculture and Environment*. 3&4: 291-294

Olayide , S.O., and Heady, E.O. (1982). Introduction to Agricultural Production Economics. University of Ibadan Press, Ibadan, Nigeria.

Olorunsanya, E. O., Babatunde, R.O., Orebiyi, J.S. and Omotosho, J. O. (2009). Economic Analysis of Soyabean Production in Kwara State, North Central Nigeria. Global Approaches to Extension Practice (GAEP), 5(2), 2009.

Olukosi, J.O. and Erhabor, A.O. (1988). Introduction to Farm Management Economics: Principles and Application. Agitab Publisher Limited, Zaria, Nigeria, pp. 16-18.

Olukosi, J.O and Ogungbile, A.O. (1989). Introduction to Production Economics: Principles and Application. Agitab Publisher Limited, Zaria, Nigeria, pp. 20-30.

Onochie, B.E. (1965), "The Potential Value of Soyabean as a Protein Supplement in Nigerian Diet". Cereal Science Today. Vol.10. pp 438-461.

Onor, P. and Ibekwe, U.C. (2006): Costs and Returns Analysis of Improved and Alternative Cassava Production Technologies in Enugu State, Nigeria. *International Journal of Agriculture and Rural development 7(1) 67-71.*

Osho, S.M. (1991). "Soya Processing and Utilization Research: Why Rapid Rural Appraisal", Soyabean Utilization in Nigeria and Ghana, IDRC/IITA Soyabean Utilization Project Phase 11, 1st Year Technical Report.

Osho, O. and Dashiell, K.E. (1998). Expanding Soybean Production, Processing and Utilization in Nigeria. Pp 151–156 *in* Postharvest Technology and Commodity Marketing, edited by R.S.B. Ferris. Proceedings of a Postharvest Conference, 29 Nov to 1 Dec 1995, Accra, Ghana. IITA, Ibadan, Nigeria.

Osifo, P.E. and Antonio, Q.B.O. (1970). Costs and Returns: A study of Upland Paddy Production Under Traditional Farming Conditions in Wasinin and Ilaro Areas of The Western States of Nigeria. *The Nigerian Journal of Agricultural Economics.* 12: 27 – 35.

Ouma J.O., De Groot H, Owuor G. (2006). Determinants of Improved Maize Seed and Fertilizer Use in Kenya: Policy Implication. Presented at the International Association of Agricultural Economists' Conference, Gold Cost, Australia, August. pp. 12-18.

Owolabi, A.O., Mac-Ingite, J.O., Olowonian F.O. and Chindo, H.O. (1996). A Comparative Study of the Nutritional Status of Children in Villages in Northern Nigeria Using and not Using Soya beans. Food and Nutrition Bulletin, 17:42-48.

Rhyan S.A., Wynstra, R.J., Kauffman, H.E., Jackobs, J.A., and Gleason, J.E. (1986). The Soyabean Solution, Meeting World Food Needs. Urbana-Champaign, College of Agriculture, University of Illinois. P. 13.

Rodomiro. (2003). Sustainable Resource Management Coupled to Resilient Germplasm to Provide New Intensive Cereal-Grain Legume-Livestock Systems in the Dry Savanna. Agriculture, Ecosystems and Environment 100: 305–314.

Sachel, G.F. and Litchfield, L.A. (1965), Technology and Protein Malnutrition. Cereal Science Today. Vol.10 pp 458-461.

Sanginga, P.C., Adesina A.A., Manyong, V.M., Otite, O. and Dashiell, K.E. (1999). Social Impact of Soybean in Nigeria's Southern Guinea Savanna. IMPACT, IITA, Ibadan, Nigeria, 32pp.

Sanginga, N., Dashiell, K., Diels, J., Vanlauwe, B., Lyasse, O., Carsky, R.J., Tarawali, S., Asafo-Adjei, B., Menkir, A., Schulz, S., Singh, B.B., Chikoye D., Keatinge, D. and O. (2003). Social impact of soybean in Nigeria's southern Guinea savanna. P34.

Sasakawa Africa Association (SSA). http://www.ssa.org. December 4, 2011.

Sasakawa Global 2000 Nigeria Project (2010). A Simplified Guide for Crop Production Practices in Nigeria.

Seyoum, E.T., Battese, G.E. and Fleming, E.M. (1998). Technical Efficiency and Productivity of Maize Producers in Eastern Ethiopia: A Study of Farmers Within and Outside the Sasakawa- Global 2000 Project. *Agricultural Economics* (19): 341-348.

SG 2000 (1995). Annual Report: Crop season 1994, Sasakawa Global 2000 Agricultural Project in Ethiopia, Addis Ababa.

Shurtleff, W. and Aoyagi, A. (2007). A Special Report on The History of Soybeans and Soyfoods in Africa and Around the World. A Chapter from the Unpublished Manuscript, *History of Soybeans and Soyfoods: 1100 B.C. to the 1980s,* Soyinfo Center, Lafayette, California. http://www.iita.org. Retrieved on 4th December, 2010.

Singh, S.R., Rachie, K.O. and Dashiell, K.E. (editors). (1987). Soybean for the tropics. Research, Production and Utilisation. John Wiley and Sons Ltd., Chichester. UK.

Smaling, E.M. (1993). "Soil Nutrient Depletion in Sub-saharan Africa." In The Role of Plant Nutrients for Sustainable Food Crop Production in Sub-saharan Africa, edited by H. van Reuler and W.H. Prins. Leidschendam, The Netherlands: Dutch Association of Fertilizer Producers.

Smith, K. and Huyser, W. (1987). World Distribution and Significance of Soybean. In J.R. Wilcox (Ed.) Soybean: Improvement, Production and Uses. Third Ed. Agron. Monograph. 16. ASA, CSSA, and SSSA, Madison. Pp 1–22.

Smith, J., Woodworth, J.B. and Dashiell, K.E. (1995). Government Policy and Farm-Level Technologies: The Expansion of Soybean in Nigeria. IITA Research 11: 14–18.

Udoh, E.J. (2000). "Land Management Resource. Use Efficiency Among Farmers in South Eastern Nigeria" Un-published *Ph.D thesis*, Department of Agricultural Economics, University of Ibadan.

Udoh, E.J. and Akintola, J.O. (2001). Land Management and Resource Use Efficiency Among Farmers in South-Eastern Nigeria, p. 46. Elshada Global Ventures, Ibadan.

Ugwu, D.S. (2009). Problems and Prospects of Commercial Small and Medium Scale Cocoa and Oil Palm Production in Cross River State, Nigeria. *Journal of Applied Sciences Research, 5(7):827-832.*

Ugwu D.S. and Nnaji C.K. (2010). "Soyabean Production in Gboko L.G.A of Benue State, Nigeria. *International Journal of Agriculture and Rural Development (IJARD).* 1(2):145-151.

Umoh, G.S. (2006). "Resource Use Efficiency in Urban Farming": An Application of Stochastic Frontier Production Function. *Int. J. Agric. Biol.,* 8(1):38-44.

Uwaegbute, A.C. (1992). Soyabean Miracle Protein: The Book of Soyabean. Japan Publications Inc. Tokyo and New York.

Valencia J.A. and Breth S. (1999). SG 2000 in Nigeria, the First Seven Years: Sasakawa Africa Association, Mexico City.

Wilson, Paul, Dave Hadley, Stephen Ramsden, and Loannis Kaltsas. (1998). "Measuring and Explaining Technical Efficiency in UK Potato Production." *Journal of Agricultural Economics,* 48 (3): 294-305.

APPENDIX: QUESTIONNAIRE

A. Socio-economic Characteristics

1. Name.....Village.....
   .....
   L.G.A.....
2. Sex: Male ( ) Female ( )
3. Marital Status: Single ( ) Married ( ) Widow/Widower ( )
4. Age (years).....
5. What is your highest educational level attained?.....

   (a) No formal education ( ) (b) Primary education ( )

   (c) Secondary education ( ) (d) Tertiary education ( )
6. What is your family size (in number).....
7. How long have you been farming soya bean?
.....
8. Did you have access to credit for the year 2010? Yes ( ) No ( )

   If yes, specify the amount (₦)..... and source(s) of credit

   (formal or informal).....

   How much interest was paid on credit for the year 2010?
.....
9. Did you have access to Non-farm Income (other income apart from farm income) for

   the year 2010? Yes ( ) No ( )

   If yes, specify the amount (₦).....
10. Do you belong to any cooperative society? Yes ( ) No ( )

    If yes, how long? .....

11. Did you have contact with extension agents for the year 2010 as regards soya

    bean

    production? Yes ( ) No ( )

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

B. Inputs used

i. Farm Size

Field number	Field Size (ha)	Cost of acquisition (₦)
1		
2		
3		
4		
5		

ii. Seed Quantity (Kg)

Field number	Type of seed	Quantity of seed	Cost (₦)
1			
2			
3			
4			
5			

Unit = Kg, Mudu, Tiya, Bags, e.t.c

iii. Fertilizer

Field number	Type of Fertilizer	Quantity	Cost (₦)
1			
2			
3			
4			
5			

Unit = Kg, Mudu, Tiya, Bags, e.t.c

iv. Herbicides (litres)

Field number	Type of Herbicide	Quantity	Cost (₦)
1			
2			
3			
4			
5			

v. Tractor

Field number	Cost of plough (₦)	Cost of harrow (₦)	Total Cost (₦)
1			
2			
3			
4			
5			

vi. Labour

(i) Land clearing

Family Labour						Hired Labour				
Field no	No of men	Days spent	Hours/day	Cost/day	Total cost	No of men	Days spent	Hours/day	Cost/day	TC

(ii) Manual ploughing

Family Labour						Hired Labour				
Field no	No of men	Days spent	Hours/day	Cost/day	Total cost	No of men	Days spent	Hours/day	Cost/day	TC

(i) Planting

Family Labour						Hired Labour				
Field no	No of men	Days spent	Hours/day	Cost/day	Total cost	No of men	Days spent	Hours/day	Cost/day	TC

iii. Fertilizer application

Family Labour						Hired Labour				
Field no	No of men	Days spent	Hours/day	Cost/day	Total cost	No of men	Days spent	Hours/day	Cost/day	TC

iv. Herbicide application

Family Labour						Hired Labour				
Field no	No of men	Days spent	Hours/day	Cost/day	Total cost	No of men	Days spent	Hours/day	Cost/day	TC

v. First weeding

Family Labour						Hired Labour				
Field no	No of men	Days spent	Hours/day	Cost/day	Total cost	No of men	Days spent	Hours/day	Cost/day	TC

(vi) Second weeding

Family Labour						Hired Labour				
Field no	No of men	Days spent	Hours/day	Cost/day	Total cost	No of men	Days spent	Hours/day	Cost/day	TC

(vii) Harvesting

(a) Soya bean cutting

Family Labour						Hired Labour				
Field no	No of men	Days spent	Hours/day	Cost/day	Total cost	No of men	Days spent	Hours/day	Cost/day	TC

(b) Soya bean parking and gathering

Family Labour						Hired Labour				
Field no	No of men	Days spent	Hours/day	Cost/day	Total cost	No of men	Days spent	Hours/day	Cost/day	TC

(c) Threshing

Family Labour						Hired Labour				
Field no	No of men	Days spent	Hours/day	Cost/day	Total cost	No of men	Days spent	Hours/day	Cost/day	TC

(d) Winnowing

Family Labour						Hired Labour				
Field no	No of men	Days spent	Hours/day	Cost/day	Total cost	No of men	Days spent	Hours/day	Cost/day	TC

C Depreciation

SN	Types of tools	Year of purchase	Purchase price	Years of utilization	Resale value
1					
2					
3					
4					
5					

D Marketing Costs

SN	No of bags	Price/bag	Total cost
Transportation			
Cost of warehouse			
Cost of chemicals			
Cost of packaging materials			
Other costs			

E Output

Field number	Quantity harvested	Price per quantity	Value (₦)
1			
2			
3			
4			
5			

Unit = Kg, bags, mudu, tiya

F Constraints faced by SG 2000 Soya bean farmers

1.....

2.....

3.....

4.....

5.....

6.....

7.....

G Suggest the possible solutions to the problems identified above.

.....
.....